Verification and certification report form for GS project activities

VERICATION AND CERTIFICATION REPORT	
Title of the project activity	Papop Biogas and Renewable Energy Project in Thailand
GS Reference number of the project activity	GS 3992
Version number of the verification and certification report	1.1Aa
Completion date of the verification and certification report	10/09/2018
Monitoring period number and duration of this monitoring period	1st Monitoring period Duration: 08/01/2016 to 31/10/2016 (both days included)
Version number of monitoring report to which this report applies	Version 04 of 15/08/2018
Crediting period of the project activity corresponding to this monitoring period	Renewable crediting period (7 years) 08/01/2016 to 07/01/2023
Project participant(s)	Swiss Carbon Value Ltd. (Private Entity) Papop Renewable Company Limited (Private Entity)
Host Party	Thailand
Sectoral scope(s), selected methodology(ies)	13 : Waste handling and disposal; ACM0014: Treatment of wastewater – version 07
Estimated GHG emission reductions or net anthropogenic GHG removals for this monitoring period in the registered PDD	73,325 tCO2
Certified GHG emission reductions or net anthropogenic GHG removals for this monitoring period	83,770 tCO2
Name of DOE	RINA Services S.p.A. (RINA)
Name, position and signature of the approver of the verification and certification report	**Laura Severino** (Authorized officer signing for the DOE) Sustainability & Food Certification Compliance Head

	

SECTION A. Executive summary

Purpose and general description of the project

The proposed project activity involves installation of a new Upflow Anaerobic Sludge Blanket ("UASB") for wastewater treatment and biogas recovery at the Thai San Miguel Liquor ("TSML") distillery ("TSML distillery") located in Amphor Tha Muang, Kanchanaburi Province, Thailand. The proposed project activity is being implemented by the Papop Renewable Company Limited ("Papop") as a builder, operator, transfer scheme, which will be handed over to TSML after a period of 9 years. TSML distillery produces alcohol spirits and as a part of the production process generates large amounts of wastewater, which has high organic matter content. Currently, wastewater is treated in an anaerobic lagoon and the anaerobic conditions lead to the production of biogas that is released directly to the atmosphere. The purpose of the proposed project activity is to use the biogas generated by the UASB for heat generation in the TSML boilers and for electricity generation in a newly installed engine. The electricity generated will be exported to the Thai national electricity grid. The proposed project activity will result in emission reductions from the avoidance of methane emissions from the anaerobic open lagoon, the avoidance of carbon dioxide emissions from the combustion of fuel oil in the TSML boiler and from the displacement of grid sourced electricity which includes fossil fuel based electricity generation. The estimated emission reductions are 87,990 tonnes of CO_2e per year.

Location

The project activity is implemented at the Thai San Miguel Liquor ("TSML") distillery ("TSML distillery") located in Amphor Tha Muang, Kanchanaburi Province, Thailand. The geographical coordinates are 13°56'32.13" N latitude and 99°40'06.83" E longitude.

Scope of verification

Verification is the periodic independent review and ex-post determination by a DOE of the monitored reductions in GHG emissions that have occurred as a result of the registered GS project activity during a defined monitoring period. Certification is the written assurance by a DOE that, during a specific period in time, a project activity achieved the emission reductions as verified. The objective of this verification is to verify and certify emission reductions reported for the GS project (Reference no. 3992) 'Papop Biogas and Renewable Energy Project in Thailand' for the period 08/01/2016 to 31/10/2016.

The scope of the verification is to verify that:

- The project activity has been implemented and operated in accordance with the registered PDD or any approved revised PDD;
- The monitoring plan, including compliance with any guidance provided by the Board regarding deviations from the provisions of a registered plan and/or methodology;
- The data and calculation of GHG emission reductions have been assessed to correctly support the emission reductions being claimed.

The verification shall ensure that reported emission reductions are complete and accurate in order to be certified.

Verification process

Verification is conducted using RINA procedures in line with the GS requirements and requirements specified in the CDM Validation and Verification Standard available at the time of the verification starts, and applying standard auditing techniques. RINA asses and determines that the implementation and operation of the project activity, and steps taken to report emission reductions comply with the GS criteria. The verification assessment involved a document review of relevant documentation and the on-site visit.

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.

Conclusion

RINA commissioned by 'Swiss Carbon Value Ltd.', has performed the verification of the emission reductions reported for the project activity 'Papop Biogas and Renewable Energy Project in Thailand', GS Registration Reference No. 3992 for the monitoring period 08/01/2016 to 31/10/2016, with regard to the relevant GS requirements and principles for project activities. The GS validation was done by RINA (validation report N° 2016-IQ-42-MD, revision 2.0Aa issued on 05/04/2018) /05/ and it was registered on 08/01/2018.

The GHG emission reductions are calculated on the basis of the approved methodology ACM0014: Treatment of wastewater – version 07 and the monitoring plan included in the registered PDD version 4 of 16/02/2018 /03/. In our opinion the GHG emission reductions reported for the project in the monitoring report version 04 of 15/08/2018 are fairly stated.

SECTION B. Verification team, technical reviewer and approver

B.1. Verification team member

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)	Involvement in			
						Desk review	On-site inspection	Interview(s)	Verification findings
1.	Team Leader and technical expert GS	IR	Menon	Rekha	RINA India	√	√	√	√
2.	GS Verifier	IR	Buragohain	Champok	RINA India	√	√	√	√

B.2. Technical reviewer and approver of the verification and certification report

No.	Role	Type of resource	Last name	First name	Affiliation (e.g. name of central or other office of DOE or outsourced entity)
1.	Technical reviewer	IR	Ekinci Ozen	Fulya	RINA Turkey Office
2.	Approver	IR	Severino	Laura	RINA HQ

SECTION C. Application of materiality

C.1. Consideration of materiality in planning the verification

No.	Risk that could lead to material errors, omissions or misstatements	Assessment of the risk		Response to the risk in the verification plan and/or sampling plan
		Risk level	Justification	
1.	Human error in the quantification of emissions (which may be more likely to occur if personnel are unfamiliar with, or not well trained regarding, emissions	*Medium*	Being first verification, there is likelihood to have human error in the quantification of emissions. Although, all data parameters are	During the site visit, the verification team interviewed the staffs of the monitoring team and check all records to confirm whether the monitoring plan has been

	processes or data recording).		monitored through calibrated monitoring devices. Hence, the risk level is medium.	well implemented. The recording of monitoring parameters used for determining the project's baseline emissions are recorded in log books first and then transferred to emission reduction worksheet. The verification team reviewed the whole data set of records, and crosschecked against relevant options. The verification team shall interview the staffs of the monitoring team and check the relevant records to confirm whether the data collection procedure and QA/QC procedure have been well implemented.
2.	Undue reliance on a poorly designed information system, which may have few effective quality controls.	*Low*	The project proponent has already established a well-organized monitoring team, monitoring plan, including data collection procedure and QA/QC procedure consistent with registered monitoring plan. All data parameters are electronically recorded. Log books are also maintained and monitoring equipments are calibrated at defined frequency. Hence, the risk level is low	
3.	Manual adjustment of otherwise automatically recorded activity levels	*Low*	As detailed in section C.2 below, the data of the main monitoring parameters are taken from calibrated meters (energy meter and flow meter) and can be cross checked from log book records. The monitoring equipments are calibrated according to national standards and rules. Hence, the risk level is low.	

C.2. Consideration of materiality in conducting the verification

>> In order to detect errors, omissions or misstatements in emission reductions or removals being claimed by project participants in the monitoring report, the materiality have been applied by RINA a per clause 9.1.2.3 of VVS, Version 01 /**10**/. The project is a large-scale project activity and a 2 percent materiality threshold is applied.

(a) In planning the verification, RINA is able to understand the environment in which the project activity operates, the sources of project emissions within the project boundary and the leakage, the monitoring activities, the equipment used to monitor or measure activity data, the origin and application of data used to calculate or measure the emissions, data flow, the internal quality control system, and the overall organization with respect to monitoring and reporting.

(b) A verification plan has been designed to minimize risks that a material discrepancy would not be detected. The project activity happens at a single location and 100% data is available for

verification. The data which directly affect emission reduction calculations being "total wastewater flow for treatment' 'COD in and out', 'Total Biogas generation' and 'biogas gainfully used' are monitored through dedicated monitoring equipments and hence 100% verifiable. The data log sheets of all the parameters used in ER calculations were verified 100%. The use of spreadsheets shows the adequate controls related to data updates, version tracking, traceability and security.

(c) During the course of the verification, any individual or aggregate errors, omission or misstatement identified, which resulted in discrepancies have been considered material and requested to be corrected.

RINA confirms that the claimed emission reductions are free from material errors, omissions or misstatements, with a reasonable level of assurance, and proceeds with the verification as defined in the verification plan.

SECTION D. Means of verification

D.1. Desk review

The monitoring report, version 01 of 04/05/2018 and version 04 of 15/08/2018 /**01**/, the emission reduction calculations provided in the form of a spreadsheet (874_TSML_ex-post_ER_Calculation_v01_04052018.xlsx) submitted on 04/05/2018 and '874TSML_ex-post_ER calculation_v02_04Jul18.xlsx' /**02**/ were assessed as part of the verification. In addition the GS Project Design Document (PDD) /**03**/ in particular the baseline estimations and the monitoring plan, the GS passport /**04**/ the GS validation report /**05**/ for the project were reviewed.
The list of all documents reviewed are referenced during the verification is available in Appendix 3 below.

D.2. On-site inspection

On 01/12/2016 and 02/12/2016, RINA visited the project facility TSML distillery at 60/9, Moo 1, Wangkhanai, Subdistrict, Thamuang District, Kanchanaburi Province, Thailand. There were no hindrances or barriers that were faced by the verification team while carrying out the site visits. During the on-site assessment of the project 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 including calibration performance, 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.

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

	Date	Name and Role	Organization	Topic
/a/	01/12/2016 & 02/12/2016	Ladaporn Kat Khunikakorn (Project Manager)	Swiss Carbon Value Ltd.	Project implementation and operation. Technical equipment, calibration and monitoring observation. Management of the electricity meter and data collection. Monitoring plan and monitoring parameters. Preparation of the
/b/		Sirinut Raya (Project Manager)		
/c/		Santosh Kumar Singh (Regional Director, SEA)	South Pole Group	

				Monitoring Report (MR), calculation of the ER.
/d/	01/12/2016 & 02/12/2016	Prasarn Phengphit (QC Maintenance)	Papop Renewable Company Limited	Monitoring plan and monitoring parameters. Management of the meter devices. Technical equipment, calibration and monitoring observation. Information flows for generating, aggregating and reporting the monitoring parameters. Cross-check of information in the monitoring report and data source.
/e/		Manop Saekam (QC Maintenance)		
/f/		Narong Wongju (Head, electrical & technician)		
/g/		Suchai Rattananadhever (Design Engineer)		
/h/	01/12/2016 & 02/12/2016	Charoen Immboon (Local Farmer)	Wangkhanai village	Sustainable development parameters, employment generation, Continuous grievance mechanism, Stakeholder engagement etc.
/i/		Somkate Boonchu (Assistant, Village head)	Wangkhanai village	
/j/		Padung Aumnhongpoh (Head Village security)	Wangkhanai village	

The project is registered as retroactive registration under GS version 2.2 and first monitoring period is from 08/01/2016 to 31/10/2016. Therefore, site visit was done considering GS validation and verification of above monitoring period. The verification contract was signed on 28/10/2016 and therefore eligible to perform the verification under GS version 2.2.

D.3. Sampling approach

>> Not applicable.

D.4. Clarification requests, corrective action requests and forward action requests raised

Areas of verification findings	No. of CR	No. of CAR	No. of FAR
Compliance of the monitoring report with the monitoring report form	-	-	-
Compliance of the project implementation with the registered PDD	-	-	-
Post-registration changes	-	-	-
Compliance of the monitoring plan with the monitoring methodology including applicable tool and standardized baseline	-	-	-
Compliance of monitoring activities with the registered monitoring plan	-	3	-
Compliance with the calibration frequency requirements for measuring instruments	2	-	-
Assessment of data and calculation of emission reductions or net removals	1	1	-
Others (monitoring of GS sustainable development	1	-	-

parameters)			
Total	4	4	0

SECTION E. Verification findings

E.1. Compliance of the monitoring report with the monitoring report form

Means of verification	Comparing the monitoring report /**01**/ with applicable rule of GS.
Findings	N/A
Conclusion	Gold Standard version 2.2 does not provide any specific monitoring report template. PP has used UNFCCC CDM template covering all relevant monitoring parameters. Hence, accepted by RINA.

E.2. Remaining forward action requests from validation and/or previous verification

>> Based on the review of validation report /**05**/ and GS registration review /**06**/, no FAR found raised during the validation.

E.3. Compliance of the project implementation with the registered project design document

Means of verification	**Actual implementation of the registered project activity**: The proposed project activity involves installation of a new Upflow Anaerobic Sludge Blanket ("UASB") for wastewater treatment and biogas recovery at the Thai San Miguel Liquor ("TSML") distillery ("TSML distillery") located in Amphor Tha Muang, Kanchanaburi Province, Thailand. The proposed project activity is being implemented by the Papop Renewable Company Limited ("Papop") as a builder, operator, transfer scheme, which will be handed over to TSML after a period of 9 years as verified from project agreement copy /**12**/. TSML distillery produces alcohol spirits and as a part of the production process generates large amounts of wastewater, which has high organic matter content. In the pre-project scenario, wastewater was treated in an anaerobic lagoon and the anaerobic conditions lead to the production of biogas that is released directly to the atmosphere. The purpose of the proposed project activity is to use the biogas generated by the UASB for heat generation in the TSML boilers and for electricity generation in a newly installed engine. The project wastewater treatment plant got commissioned on 01/05/2010 /**13**/ and the gas engine got commissioned on 21/05/2010 /**14**/. The date of submission to GS (registration action) was 08/01/2018 /06/ and therefore as per GS rule version 2.2 for retroactive projects two years prior to date registration can be considered as start date of crediting period. Hence, the crediting period of the project activity is from 08/01/2016 to 07/01/2023. The verification activity covers the first monitoring period from 08/01/2016 to 31/10/2016. The UASB is designed to treat 1,500 m^3/day of wastewater with a methane generation rate of 0.15 m3/kg of COD /**12**/. The produced biogas is used in two thermal oil boiler of 16 TPH each (S/N: 0387 and S/N: 0388) as verified during site visit. Remaining biogas is used in two gas engine of 952kWe each for electricity generation (S/N: 330,595 and S/N: 330,594) and export to grid. An enclosed flare in installed for flaring in case of emergency. During the site visit the verification team observed that the project is implemented as per the registered design document /**03**/. The project boundary, monitoring arrangements are as per the registered monitoring plan. During the site visit, no changes have been observed or identified which may impact the additionality as there was no change in the effective output

	capacity, no addition of component nor extension of technology, no addition nor removal of project sites since there is only one site of the project activity, no change of values of the actual operational parameter relevant to determination of emission reductions which are within the control of the PP; no change has been observed or identified that may impact the scale of the project activity or applicability of the monitoring methodology ACM0014 version 07 /**11**/. In conclusion, RINA is able to confirm that: the implementation and operation of the project during this monitoring period is consistent with the registered PDD /**03**/ and the information provided in the CDM MR is also in accordance with the description of the registered PDD /**03**/.
Findings	N/A
Conclusion	RINA was able assess all physical features (technology, project equipment, monitoring and metering equipment) are in place during site visit and confirms the implementation and operation of the project during this 1st monitoring period is consistent with the registered PDD; the information provided in the MR is also in accordance with the description of the registered PDD.

E4. Post-registration changes

E4.1. Temporary deviations from the registered monitoring plan, monitoring methodology or standardized baseline

>>N/A

E4.2. Corrections

>>N/A

E4.3. Changes to the start date of the crediting period

>>N/A

E4.4. Inclusion of a monitoring plan to a registered project activity

>>N/A

E4.5. Permanent changes from registered monitoring plan, monitoring methodology or standardized baseline

>>N/A

E4.6. Changes to the project design of a registered project activity

>>N/A

E4.7. Types of changes specific to afforestation and reforestation project activities

>>N/A

E.5. Compliance of monitoring plan with the monitoring methodology including applicable tool and standardized baseline

Means of verification	During this monitoring period, the validated and registered monitoring plan was found to be in accordance with the applied methodology /**11**/.
Findings	N/A
Conclusion	All monitoring parameters, monitoring and calibration procedures follow the methodology requirements. No recommendation was made during this verification.

E.6. Compliance of monitoring activities with the registered monitoring plan

E.6.1. Data and parameters fixed ex ante or at renewal of crediting period

Means of verification

	Data/parameter	Unit	Value applied	Assessment
1	Inlet wastewater COD concentration ($COD_{in,x}$)	ton/year	47,980	Historical COD concentration (0.1279 tCOD/m3) is used for wastewater flow of 1250 m3/day is used in line with applied methodology /**11**/.
2	Outlet wastewater COD concentration ($COD_{out,x}$)	ton/year	15,007	Historical COD concentration (0.0400 tCOD/m3) is used for wastewater flow of 1250 m3/day is used in line with applied methodology /**11**/.
3	Discount factor for historical information (ρ)	Factor	1	Default value as per ACM0014 /**11**/.
4	Maximum methane producing capacity (Bo)	ton CH_4/ton COD	0.25	Default value as per ACM0014 /11/.
5	Average depth of the lagoon (D)	m	3	The average depth of the lagoon is more than 3 m. This is verified from the lay out diagram **/15/, /16/**.
6	Factor expressing the influence of the depth of the lagoon on methane generation (f_d)	percentage	70%	The value applied is 70% as the depth of the baseline open lagoon is determined to be more than 2m. This is verified from the lay out diagram /**10/, /26**/.

		7	Grid emission factor in the year y ($EF_{grid,y}$)	tCO_2/MWh	0.5897	Country specific grid emission factor is considered as per publicly available report for Thailand **/21/** and which is in line with grid emission factor tool /**22**/.
		8	CO_2 emission factor of the fossil fuel (HFO); $EF_{CO2,FF,boiler}$	tCO_2/GJ	0.0774	IPCC default value /**17**/.
		9	Efficiency of the boiler ($\eta_{BL,boiler}$)	%	85%	Default value as per Tool to determine the baseline efficiency of thermal or electric energy generation systems /**18**/.
		10	Global warming potential for CH_4 (GWP_{CH4})	Default value	25	Default value as per UNFCCC /**19**/.
		11	N2O emission factor for nitrogen from sludge applied to land ($EF_{N2O,LA,sludge}$)	t N_2O/t N	0.016	Default value in line with the methodology **/11/**.
		12	Methane conversion factor for the application of sludge to lands ($MCF_{sludge,LA}$)	Default value	0.05	Default value in line with the methodology **/11/**.
		13	Global warming potential for N_2O (GWP_{N2O})	Default value	298	Default value as per UNFCCC /**19**/.
		14	Factor representing the remaining CH4 production capacity of liquid digestate ($F_{ww,CH4,default}$)	Fraction	0.15	Default value in line with the methodology **/11/**.
		15	Low heating value (LHV_{CH4})	MJ/kg	50.4	IPCC default value /**17**/.
		16	Fraction of biogas that leaks from the digester ($EF_{CH4,default}$)	m^3 biogas leaked / m^3 biogas produced	0.05	The project participant selects the default leak factor of 0.05 m3 biogas leaked per m3 of biogas produced. The methodology **/11/** has been checked and this is found to be acceptable.
		17	Universal ideal gases constant (Ru)	Pa.m3/kmol.K	8,314	Default in line with the tool 'Tool to determine the mass flow of a

					greenhouse gas in a gaseous stream' /**20**/.
	18	Molecular mass of greenhouse gas *i* (CH_4)	kg/kmol	16.04	Default in line with the tool 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream' **/20/**.
	19	Total pressure at normal conditions (P_n)	Pa	101,325	Default in line with the tool 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream' **/20/**.
	20	Temperature at normal conditions (T_n)	K	273.15	Default in line with the tool 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream' **/20/**.
	21	Manufacturer's flare specifications for temperature and flow rate ($SPEC_{flare}$)	Temperature - ºC Flow rate or heat flux – kg/h or m3/h	Flow rate: Minimum 500 maximum 750 Temperature: Min= 800 deg C Max= 1000 dec C	Verified from specifications provided by manufacturer /**23**/
	22	Representative historical reference period (x)	Number of years	1	Fixed ex-ante in the registered PDD in line with the applied methodology.
	23	T1	K	303.16 K (273.16 K + 30 K)	Default as per theapplied methodolgy.
Findings	N/A				
Conclusion	RINA is able to confirm that the Data and parameters fixed ex ante have been implemented in full compliance with the registered monitoring plan				

E.6.2. Data and parameters monitored

Means of verification		
	Data/Parameter	**$F_{PJ,dig,m}$**
	Data Unit	m^3/month
	Description	Quantity of wastewater treated in month '*m*' entering the cooling pond and entering the digester
	Source of data to be used	Plant record as per flow meter measurement

Value of monitored parameter for the monitoring period	317,792 (for the entire monitoring period; i.e. from 08/01/2016 to 31/10/2016). The daily recording of wastewater flow was cross checked from the log book records and confirm to be correct /**33**/.
Monitoring equipment	The monitoring equipment is flow meter located at the inlet of anaerobic reactor, detailed information of the meter are listed in the following table: Meter: Magnetic Flow meter Manufacturer: Endress+Hauser Model: FM MAG6000 SN: C5023920000 Accuracy: ±0.20%
Accuracy of the monitoring equipment	The accuracy of the meters is ±0.20% and in compliance with the registered PDD /**03**/
Measuring/Reading/Recording frequency	The parameter is continuously monitored, hourly recorded and summarized daily. This is in accordance with the methodology ACM0014 version 07 /**11**/ and the registered PDD /**03**/.
Calcualtion method (if applicable)	Not applicable

Data/Parameter	**$COD_{dig,m}$**
Data Unit	$tCOD/m^3$
Description	Chemical oxygen demand of wastewater wastewater that is treated in the anaerobic digester
Source of data to be used	Plant record as per on-site laboratory test reports
Value of monitored parameter for the monitoring period	1.04 (Average for the monitoring period). The daily recording vales were cross checked from the log book records and confirm to be correct/**34**/.
Monitoring equipment	The COD content was analysed in comply with colorimetric method which is international standard method. Detailed information of the Colorimeter are listed in the following table: Equipment: Colorimeter Manufacturer: HACH SN: 081290C71533 Maximum permissible error: +/- 0.24 %
Accuracy of the monitoring equipment	The maximum permissible error of the Colorimeter is ±0.24% as per specification of the instrument.
Measuring/Reading/Recording frequency	The parameter is measured daily basis and also recorded Daily. Monthly average value is reported. This is in accordance with the registered PDD. The methodology requirement is to measure monthly. Hence, measuring and recording frequency is met.

Calcualtion method (if applicable)	Not applicable

Data/Parameter	**$F_{biogas,y}/V_{t,b}$**
Data Unit	Nm^3 in year 'y'
Description	Total amount of biogas collected at the outlet of the digester tanks
Source of data to be used	Plant record as per flow meter measurement
Value of monitored parameter for the monitoring period	9,286,959
Monitoring equipment	Not applicable.
Accuracy of the monitoring equipment	Not applicable
Measuring/Reading/Recording frequency	Not applicable
Calcualtion method (if applicable)	The value is the summation of total biogas utilized in power generation ($F_{biogas, genset,y}$), boiler ($F_{biogas, boilers,y}$) and flaring ($F_{biogas, FLARE,y}$)

Data/Parameter	**$F_{biogas,boilers,y}$**
Data Unit	Nm^3 in year 'y'
Description	Volumetric flow of biogas to the boilers
Source of data to be used	Plant record as per flow meter measurement
Value of monitored parameter for the monitoring period	7,225,361 (for the entire monitoring period; i.e. from 08/01/2016 to 31/10/2016). The daily recordings of biogas flow to boiler were cross checked from the log book records and confirm to be correct /**37**/.
Monitoring equipment	Equipment: Mass flow meter Manufacturer: Endress+Hauser SN: C20C7B02000 Maximum permissible error: +/- 1.5 %
Accuracy of the monitoring equipment	The accuracy of the flow meter is as per specification of the instrument.
Measuring/Reading/Recording frequency	Continuous monitoring with hourly measurement. Daily measured value is recorded for emission reduction calculation.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	**$F_{biogas,genset,y}$**
Data Unit	Nm^3 in year 'y'

Description	Volumetric flow of biogas to the generators
Source of data to be used	Plant record as per flow meter measurement
Value of monitored parameter for the monitoring period	2,043,403 (for the entire monitoring period; i.e. from 08/01/2016 to 31/10/2016). The daily recordings of biogas flow to genset were cross checked from the log book records and confirm to be correct /**37**/.
Monitoring equipment	Equipment: Mass flow meter Manufacturer: Endress+Hauser SN: C20C8902000 Maximum permissible error: +/- 1.5 %
Accuracy of the monitoring equipment	The accuracy of the flow meter is as per specification of the instrument
Measuring/Reading/Recording frequency	Continuous monitoring with hourly measurement. Daily measured value is recorded for emission reduction calculation.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$F_{biogas,flare,y}/V_{RG,m}$
Data Unit	Nm^3 in year 'y'
Description	Volumetric flow of biogas to flare
Source of data to be used	Plant record as per flow meter measurement
Value of monitored parameter for the monitoring period	18,583 (higher value considering error factor for delay calibration) 17,807 (lower value higher value considering error factor for delay calibration) The daily recordings of biogas flow to flare were cross checked from the log book records and confirm to be correct /**37**/.
Monitoring equipment	Equipment: Mass flow meter Manufacturer: Endress+Hauser SN: C20C8B02000 Maximum permissible error: +/- 1.5 %
Accuracy of the monitoring equipment	The accuracy of the flow meter is as per specification of the instrument.
Measuring/Reading/Recording frequency	Continuous monitoring with hourly measurement. Daily measured value is recorded for emission reduction calculation.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$W_{CH4,biogas,y}$ $V_{i,t,db}$
Data Unit	kg CH4/m3 , m3 CH4/ m3 biogas
Description	Concentration of methane in the total biogas supply, Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis
Source of data to be used	Plant record as per gas analyzer measurement
Value of monitored parameter for the monitoring period	59.06% (lower value considering error factor for delay calibration) 59.48% (higher value considering error factor for delay calibration) Daily measurement of methane concentration values were cross checked from log book records and DOE confirms to be correct /**37**/.
Monitoring equipment	Equipment: Gas analyzer Manufacturer: Geotech SN: BM13285 Maximum permissible error: +/- 0.5 %
Accuracy of the monitoring equipment	The accuracy of the analyzer is as per specification of the instrument.
Measuring/Reading/Recording frequency	Daily measurement is done with a portable analyzer ensuring 90/10 confidence level as per methodology requirement.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$T_{2,m}$
Data Unit	K
Description	Average temperature at the project site in month m
Source of data to be used	Thai Meteorological Department
Value of monitored parameter for the monitoring period	302.96 (average monthly value over the monitoring period)
Monitoring equipment	Not applicable. Publicly available data from thai meteorological department is taken /**38**/.
Accuracy of the monitoring equipment	Not applicable
Measuring/Reading/Recording frequency	Monthly
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$T_{flare,m}$
Data Unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in minute m
Source of data to be used	Plant record
Value of monitored parameter for the monitoring period	Not available. The records are not available for the monitoring period and hence as per the 'flaring tool' zero flare efficiency is taken. This is consistent with the flaring tool and conservative.
Monitoring equipment	Thermocouple Model: Type N Serial Number: 07610001701-58
Accuracy of the monitoring equipment	Accuracy of the thermocouple is not specified. Since, there was no record available for flare temperature, the non-availability of accuracy during the monitoring period is accepted.
Measuring/Reading/Recording frequency	Measured once per minute. However, during the monitoring period no data records available.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$Flame_m$
Data Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Source of data to be used	Plant record
Value of monitored parameter for the monitoring period	Not available. The records are not available for the monitoring period and hence as per the 'flaring tool' zero flare efficiency is taken. This is consistent with the flaring tool and conservative.
Monitoring equipment	BKE flame Ionization detector
Accuracy of the monitoring equipment	Accuracy of the flame detector is not specified. Since, there was no record available for flare temperature, the non-availability of accuracy during the monitoring period is accepted.
Measuring/Reading/Recording frequency	Continuously monitored and recorded as in when flame is detected. However, during the monitoring period no data records available.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	$EG_{PJ,y}$
Data Unit	MWh/year
Description	Net quantity of electricity generated in year y with biogas from the new anaerobic digester

Source of data to be used	Power meter reading reports
Value of monitored parameter for the monitoring period	2,436 (For the entire monitoring period). The monthly values are cross checked from PEA monthly records /**39**/.
Monitoring equipment	Equipment: Energy meter Manufacturer: EDMI SN: 206501201 Maximum permissible error: +/- 0.5 %
Accuracy of the monitoring equipment	The accuracy of the energy meter is as per the specification of the equipment.
Measuring/Reading/Recording frequency	Continuously measured and monthly recorded by PEA.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	**$EC_{PJ,y}$**
Data Unit	MWh/year
Description	Net quantity of grid electricity consumed by the project in year y
Source of data to be used	Power meter reading reports
Value of monitored parameter for the monitoring period	435 (For the entire monitoring period). The monthly values are cross checked from PEA monthly records /**39**/.
Monitoring equipment	Equipment: Energy meter Manufacturer: EDMI SN: 212309924 Maximum permissible error: +/- 0.5 %
Accuracy of the monitoring equipment	The accuracy of the energy meter is as per the specification of the equipment.
Measuring/Reading/Recording frequency	Continuously measured and monthly recorded by PEA.
Calcualtion method (if applicable)	Not applicable.

Data/Parameter	**$HG_{PJ,y}$**
Data Unit	GJ/year
Description	Net quantity of heat generated in year y by the biogas from proposed project activity combusted in the TSML boilers
Source of data to be used	Plant records

Value of monitored parameter for the monitoring period	260,737 (For the entire monitoring period). The value is calculated considering monitored value of biogas used in boiler ($F_{biogas,boilers,y}$), methane content of biogas (W_{CH4}), NCV of methane and efficiency of boiler.
Monitoring equipment	Not applicable. Calculated value.
Accuracy of the monitoring equipment	Not applicable. Calculated value.
Measuring/Reading/Recording frequency	Relevant parameters are monitoring, measured and recorded as per defined monitoring plan. Therefore, the parameter is calculated as per required monitoring period.
Calcualtion method (if applicable)	Calculated based on the monitoring volume of biogas used for heat generation (Fbiogas, boilers,y) multiplied with the monitored methane content in biogas (wCH4, biogas,y), NCV of methane (NCVCH4) and the efficiency of the boilers.

Data/Parameter	**$FC_{k,y}$**
Data Unit	Liter/year
Description	Quantity of fossil fuel type k combusted in the boilers
Source of data to be used	Plant records
Value of monitored parameter for the monitoring period	519,054 (For the entire monitoring period). The value is cross checked from the log book records of daily consumption and DOE confirms the values are consistent /**40**/.
Monitoring equipment	Oil Meter. It is to be noted that monitoring of HFO consumption to account project emission is not needed as per the project scenario. The project is replacing HFO consumption partially and baseline emissions are accounted for the replaced HFO which is calculated based on biogas utilized in boilers. The remaining HFO consumed in boiler is part of baseline situation which would anyway been consumed as part of the pre-project scenario and is not happening as part of the project implementation. Therefore, accounting project emission for HFO consumption in the boiler is not necessary. Although, PP is accounting the same as part of proposed monitoring plan which is highly conservative and hence specific details of the oil meter and calibration details are not necessary to maintain in DOE's opinion.
Accuracy of the monitoring equipment	Not available and not necessary as explained in above.
Measuring/Reading/Recording frequency	Continuous monitoring and daily recording.

Calcualtion method (if applicable)	Not applicable

Data/Parameter	$TDL_{j,y}$
Data Unit	%
Description	Average technical transmission and distribution losses for providing electricity to the project activity (electricity import)
Source of data to be used	Publicly available data
Value of monitored parameter for the monitoring period	6.073%. The value is as per publicly available data published by World Bank /**26**/.
Monitoring equipment	Not applicable
Accuracy of the monitoring equipment	Not applicable.
Measuring/Reading/Recording frequency	Annually or most recent figures should be used, but not older than 5 years.
Calcualtion method (if applicable)	Not applicable

Data/Parameter	$S_{LA,m}$
Data Unit	Ton/month
Description	Amount of sludge applied to land in month m
Source of data to be used	Plant record
Value of monitored parameter for the monitoring period	0. No sludge generated which were applied to land.
Monitoring equipment	Not applicable
Accuracy of the monitoring equipment	Not applicable.
Measuring/Reading/Recording frequency	Monthly
Calcualtion method (if applicable)	Not applicable

Data/Parameter	$EF_{CO2,k,y}$
Data Unit	CO_2/TJ
Description	CO_2 emission factor of fossil fuel type k combusted in the boiler
Source of data to be used	IPCC value
Value of monitored parameter for the monitoring period	77.4

Monitoring equipment	Not applicable
Accuracy of the monitoring equipment	Not applicable.
Measuring/Reading/Recording frequency	Annually
Calcualtion method (if applicable)	Not applicable

Data/Parameter	**$NCV_{i,y}$**
Data Unit	GJ/l
Description	Net calorific value of fossil fuel type k combusted in the boiler
Source of data to be used	IPCC value
Value of monitored parameter for the monitoring period	0.0323
Monitoring equipment	Not applicable
Accuracy of the monitoring equipment	Not applicable.
Measuring/Reading/Recording frequency	Annually
Calcualtion method (if applicable)	Not applicable

Findings	CR 01 was raised to provide accuracy details of colorimeter which has been provided with supporting document and details found consistent with site visit observations. Hence, CR was closed. CR 02 was raised to provide sample copies of monthly PEA records of electricity export and import which PP has provided and details are found confirmed. In summary, CARs and CRs are closed as discussed in Appendix 4 of this report.
Conclusion	RINA is able to confirm that the monitoring has been implemented in full compliance with the registered monitoring plan and all the parameters listed in the registered monitoring plan have been completely monitored.

E.6.3. Implementation of sampling plan

Means of verification	N/A
Findings	N/A
Conclusion	N/A

E.7. Compliance with the calibration frequency requirements for measuring instruments

Means of verification

Calibration details of monitoring equipments are provided below:

Instrument and Sl.No	Accuracy	Calibration date	Validity till	Calibration agency
Magnetic flow meter; C5023920000	±0.20%	07/08/2015 10/05/201	06/08/2016 09/05/2017	Endress+Hauser /**27**/

			6		
	Colorimeter; 081290C71533	±0.24%	07/01/2015 12/01/2016	06/01/2016 11/01/2017	EnviScience Company Limited /**28**/
	Flowmeter; C20C7B02000	±1.5%	10/10/2015 10/05/2016	09/10/2016 09/05/2017	Endress+Hauser /**29**/
	Flowmeter; C20C8902000	±1.5%	07/08/2015 10/05/2016	06/08/2016 09/05/2017	Endress+Hauser /**30**/
	Flowmeter; C20C8B02000	±1.5%	18/01/2017	17/01/2018	Endress+Hauser /**31**/
	Gas Analyzer; BM13285	±0.5%	07/10/2015 24/03/2016	06/10/2016 23/03/2017	Geotech /**32**/
	Energy meter: 206501201	±0.5%	14/09/2015 22/09/2016	13/09/2016 21/09/2017	PEA

Calibration frequency as per registered monitoring plan is once in a year /01/. Calibration frequency is maintained during the monitoring period. However, there has been delay in calibration of colorimeter (081290C71533) from 07/01/2016 to 12/01/2016, however during that period there was no monitoring of COD and hence calibration delay has no impact. Further, monthly average value is taken for COD as per the registered monitoring plan and hence non availability of COD values in some days of the month is accepted. For the flow meter (C20C8B02000) for monitoring biogas to flare is delayed for the entire monitoring period. Therefore, PP has taken the maximum error (2.13%) of the instrument as per the latest calibration result and applied over the measured value following paragraph 369 of CDM VVS, version 01. Although the energy meter (206501201) for monitoring net electricity export is maintained and calibrated by PEA and meter is under the control of PEA, PP on a conservative side has applied calibration delay from 13/09/2016 to 22/09/2016 considering maximum error of the meter over the measured value. Therefore, calibration frequency is respected by PP as per the registered monitoring plan and wherever delay has happened appropriate conservative approach has been applied by PP to account emission reductions. Further, calibrations are been done by accredited agencies.

Findings	CR 03 was raised to provide calibration certificate copies of all monitoring equipments which PP has provided and details are found to be correct and consistent with records. Hence, CR is closed.
Conclusion	RINA confirms that the calibration confirms the proper functioning of the monitoring equipment and is valid for the whole verification monitoring period. According to clause 341 (b), and 376 of VVS version 01.0, verification team has checked calibration records to confirm that the frequency of calibration is carried out as specified in the registered monitoring plan (clause 361, 364, and 368 of VVS, version 01.0).

E.8. Assessment of data and calculation of emission reductions or net removals

E.8.1. Calculation of baseline GHG emissions or baseline net GHG removals by sinks

Means of verification	**Baseline emissions**: As per ACM0014 Version 07, the baseline emissions are calculated in three components, (i) baseline missions from anaerobic treatment of the wastewater (BE_{CH4}), (ii) baseline emissions from generation and consumption of electricity ($BE_{EL,y}$) and (iii) baseline emissions from heat generation ($BE_{HG,y}$). The calculation is as follows: $$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y}$$ **Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater** ($BE_{CH4,y}$): In line with the methodology, project proponent shall use minimum value between methane produced after implementation of the project activity ($Q_{CH4,y}$) and methane conversion factor method ($BE_{CH4,MCF,y}$) for the estimation of methane emissions from open lagoons. $$BE_{CH4,y} = \min\{Q_{CH4,y} \quad ; \quad BE_{CH4,MCF,y}\}$$ **Methane produced ($BE_{CH4,y}$):** In line with applied methodology ACM0014, version 07, step 1 of tool 'Project and leakage emissions from anaerobic digesters' /**24**/ is applied for quantification of $BE_{CH4,y}$. Being large scale project activity, option 1 of the tool is applied as below: The project proponent choose the measurement option A on a dry basis as per table 2 (measurement options) of the tool. The mass flow of methane ($F_{CH4,t}$) is determined following below equation: $F_{CH4,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t}$ Where: $F_{CH4,t}$ Mass flow of greenhouse gas CH_4 in the gaseous stream in time interval t (kg/h) $V_{t,db}$ Volumetric flow of CH4 in time interval t on a dry basis (Nm3/h). The amount of biogas produced is monitored in three usage point (genset, boiler and flaring). Sum of the three usage volume for the monitoring period is 9,286,571 Nm3. $V_{CH4,t,db}$ Volumetric fraction of the greenhouse gas CH4 in the gaseous stream in time interval t on a dry basis (m3 CH4/m3 dry gas). The fraction of methane in biogas is monitored and average value for the monitoring period is 59.06%. $P_{CH4,t}$ Density of greenhouse gas CH4 in the gaseous stream in minute m (0.716 kg/m3) at reference conditions. Therefore, $Q_{CH4,y}$ for the monitoring period is 98,169 tCO_2. **Methane Conversion factor method ($BE_{CH4,MCF,y}$)**: $$BE_{CH4,MCF,y} = GWP_{CH4} \times MCF_{BL,y} \times B_o \times COD_{BL,y}$$

The quantity of baseline chemical oxygen demand ($COD_{BL,y}$) that would be treated in open lagoons is equal to the chemical oxygen demand ($COD_{PJ,y}$) of the project activity (unless there would have been effluent from the lagoons) is determined using equation 4 of ACM0014 version 07 **/11/** and as follows:

$$COD_{BL,y} = \rho\left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) \times COD_{PJ,y}$$

Considering one year historical data, discount factor for historical information (ρ) is considered as 1 in line with the methodology **/11/**. COD of the effluent in the period x ($COD_{out,x}$) is considered as 15007 ton/year (fixed ex-ante) and COD directed to the open lagoons ($COD_{in,x}$) (scenario 1 for this project activity) is taken as 47,980 ton/year as per one year historical data and fixed ex-ante.

As per equation 5 of the methodology **/11/**, Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity ($COD_{PJ,y}$) in year y (tCOD/yr) is determined as follows:

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} \times COD_{dig,m}$$

Quantity of wastewater that is treated in the anaerobic digester in the project activity ($F_{PJ,dig,m}$) in month m (m^3/month) is monitored *ex-post* and total amount during the monitoring period is 317,792 m^3 as per log book records **/33/**.

Chemical oxygen demand in the wastewater that is treated in the anaerobic digester ($COD_{dig,m}$) in the project activity in month *m* is monitored *ex-post*, and average value for the monitoring period is 0.104 ton/m^3 has been considered as per log book records /**34**/.

Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity ($MCF_{BL,y}$) is determined as per equation 6 of the methodology **/11/** and as follows:

$$MCF_{BL,y} = f_d \times f_{T,y} \times 0.89$$

Since the depth of the baseline lagoon is 3 m as per drawings of open lagoon **/15/**, the Factor expressing the influence of the depth of the lagoon (f_d) is taken as 70% in line with the methodology **/11/**.

Factor expressing the influence of the temperature on the methane generation in year *y* ($f_{T,y}$) shall be calculated following equation 12 of the methodology as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}}$$

Factor expressing the influence of the temperature on the methane generation

in month *m* ($f_{T,m}$) is estimated *ex-post* based on monitoring average temperature at the project site ($T_{2,m}$) in month *m* (K) following the equation 11 of the methodology as below:

$$f_{T,m} = \begin{cases} 0 & if \quad T_{2,m} < 278K \\ e^{\left(\frac{E*(T_{2,m}-T_1)}{R*T_1*T_{2,m}}\right)} & if \quad 278K \le T_{2,m} \le 302.5K \\ 0.95 & if \quad T_{2,m} > 302.5K \end{cases}$$

Where, activation energy constant E as 15,175 cal/mol, T_1 as 303.16 K (273.16 K + 30 K) and ideal gas constal (R) as 1.987 cal/K mol) considered as default in line with the methodology **/11/**.

Accordingly, **$BE_{CH4,MCF,y}$** is calculated for the monitoring period is 86,724 tCO_2.

Step 2: Baseline emissions from generation of electricity/or consumption of electricity:
In line with applied methodology the baseline emissions from the generation and/or consumption of electricity are calculated as follows:

$BE_{EL,y} = (EC_{BL} * EF_{BL,EL,y}) + (EG_{PJ,y} * EF_{PJ,EL,y})$

Annual quantity of electricity that would be consumed in the absence of the project activity for the treatment of the wastewater (Scenario 1) (MWh/yr) is considered zero on a conservative side.

Net quantity of electricity generated in year *y* with biogas ($EG_{PJ,y}$) from the new anaerobic biodigester (MWh/yr) is monitored ex-post and total value is 2436 MWh for the entire monitoring period as per monthly PEA records /**35**/. Baseline emission factor for electricity generated by the project activity in year y (tCO_2/MWh) is fixed ex-ante to be 0.5897 tCO_2/MWh /**03**/.
Therefore, $BE_{EL,y}$ during the monitoring period is 1,436 tCO_2.

Step 3: Baseline emissions from the generation of heat:
The project activity involves heat generation utilizing the recovered biogas in boiler. In line with the methodology, baseline emissions from hear generation is calculated as:

$$BE_{HG,y} = \frac{HG_{PJ,y} \times EF_{CO2,FF,boiler}}{\eta_{BL,boilder}}$$

Net quantity of heat generated in year y with biogas from the new anaerobic digester (GJ) is calculated considering monitored biogas utilized in boilers ($Q_{biogas,boiler,y}$) multiplied with density of methane (0.716 kg/Nm3) and NCV of methane (50.4 MJ/kg). Accordingly, $HG_{PJ,y}$ is calcaulted to be 260,737 GJ for the monitoring period. The efficiency of boiler ($\eta_{BL,boiler}$) considered 85% default as per Tool to determine the baseline efficiency of thermal or electric energy generation systems /**03**/. CO_2 emission factor of the fossil fuel type used in the boiler for heat generation in the absence of the project activity (tCO_2/GJ) is as per IPCC default value 0.0774 /**03**/. Accordingly, $BE_{HG,y}$ is estimated to be 17,154 tCO_2e.

Therefore, total Baseline Emissions for the monitoring period (08/01/2016 to

	31/10/2016) is 105,314 tCO_2.
Findings	CAR 04 was raised to correct the $COD_{PJ,y}$ in the emission reduction worksheet and reporting error of some values in emission reduction worksheet. The same found corrected in the revised documents and hence CAR is closed.
Conclusion	RINA confirms that baseline emissions have been appropriately calculated and are consistent with site visit observations, the applied methodology and registered PDD **/01/, /02/, /03/, /05/, /11/.**

E.8.2. Calculation of project GHG emissions or actual net GHG removals by sinks

Means of verification	**Project Emissions:** Sources of project emissions have been identified and they are in accordance with the adopted methodology **/11/**. Total estimated project emissions as per ACM0014 version 07.0 are the sum of the below calculated in line with the tool 'Project and leakage emissions from anaerobic digesters':- i) Project emissions associated with the anaerobic digester ($PE_{CH4,y}$); ii) Project emissions from flaring of biogas ($PE_{flare,y}$); and iii) CO_2 emissions from consumption of electricity ($PE_{EC,y}$) and/or fossil fuels ($PE_{FC,y}$) **Project emissions from physical leakage of methane from the anaerobic digester ($PE_{CH4,y}$):** In line with the tool 'Project and leakage emissions from anaerobic digesters'. $PE_{CH4,y}$ is calculated as: $PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y}$ Following steps are followed in line with the tool: **Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)**: Following option 1 as per "tool to determine the mass flow of a greenhouse gas in a gaseous stream" the monitored quantity of biogas produced is 9,287,347 Nm^3. **Step 2: Determination of project emissions from electricity consumption ($PE_{EC,y}$)**: Electricity consumed from grid is monitored in dedicated energy meter and the total 435 MWh is consumed as per monthly PEA bills /**35**/. The grid emission factor is fixed ex-ante to be 0.5897 tCO2/MWh and as per latest data the transmission and distribution loss is 6.07% /**26**/. Therefore, project emissions from electricity consumption is 272 tCO_2. **Step 3: Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$):** In case, fossil fuel is consumed, project emissions shall be calculated as below: $PE_{FC,y} = FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y}$ It is to be noted that monitoring of HFO consumption to account project emission is not needed as per the project scenario. The project is replacing HFO consumption partially and baseline emissions are accounted for the replaced HFO which is calculated based on biogas utilized in boilers. The remaining HFO consumed in boiler is part of baseline situation which would anyway been consumed as part of the pre-project scenario and is not happening as part of the project implementation. Therefore, accounting project emission for HFO

	consumption in the boiler is not necessary. Although, PP is accounting the same as part of proposed monitoring plan which is highly conservative. Total HFO consumption during the monitoring period is 519,054 liter as verified from daily monitored HFO consumption log book records /**36**/. CO2 emission factor of HFO is as per IPCC default value 0.0774 tCO2/GJ and NCV of HFO is 0.032 GJ/liter. Accordingly, project emissions from fossil fuel consumption for the monitoring period is 1,298 tCO_2. **Step 4: Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)**: Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH4,default}$), as follows: $PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4}$ Quantity of biogas generation is monitored ex-post is 9,287,347 Nm3 resulting to 3,955 ton and emission factor is fixed ex-ante to be 0.05 and GWP of CH4 is 25. Accordingly, $PE_{CH4,y}$ for the monitoring period is 4,944 tCO2. **Step 5: Determination of project emissions from flaring of biogas ($PE_{flare,y}$):** Enclosed flare is installed for flaring. In line with tool "project emissions from flaring" $PE_{flare,y}$ is determined as below: $F_{CH4,RG,m} = V_{m,db} * v_{CH4,m,db} * \rho_{CH4,m}$ Biogas flow for flaring is monitored and total volume is 18,583 Nm3 (corrected value) during the monitoring period as verified from the log book records **/37/**. Fraction of methane is in biogas is monitored and resulted average value over the monitoring period 59.06% is considered. Density of methane is taken default 0.716 kg/Nm3 as per tool. Since, parameters for flaring efficiency was not monitored during the monitoring period the efficiency is taken as zero efficiency as per the flaring tool. Accordingly, project emissions from flaring is accounted as 196 tCO2. Total project emissions over the monitoring period comes to 6,711 tCO2.
Findings	NA
Conclusion	RINA confirms that project emissions have been appropriately calculated and are consistent with site visit observations, the applied methodology and registered PDD **/01/, /02/, /03/, /05/, /11/.**

E.8.3. Calculation of leakage GHG emissions

Means of verification	**Leakage Emissions:** In line with the methodology leakage emissions are discussed as per tool 'Project and leakage emissions from anaerobic digesters'. Option 2 of the tool (equation no. 7) is used as follows: $LE_{AD} = LE_{storage} = F_{ww,CH4,default} \times Q_{CH4,y} \times GWP_{CH4}$ Quantity of methane produced ($Q_{CH4,y}$) is monitored ex-post and accounted to be 3,955 tCO_2. $F_{ww,CH4,default}$ (Default factor representing the remaining methane production capacity of liquid digestate (fraction)) is 0.150 as per the

	tool /0**3**/ and GWP of methane is 25 as per UNFCCC. Therefore, $LE_{storage}$ is accounted for the monitoring period is 14,833 tCO_2.
Findings	NA
Conclusion	RINA confirms that leakage emissions have been appropriately calculated and are consistent with site visit observations, the applied methodology and registered PDD **/01/, /02/, /03/, /05/, /11/.**

E.8.4. Summary of calculation of GHG emission reductions or net anthropogenic GHG removals by sinks

Means of verification	The net emission reduction is calculated as the difference of baseline emissions, project emissions and leakage emissions. The baseline emissions from the project activity during the monitoring period is 105,314 tCO2 as discussed in section E.8.1. Project emissions from the project activity during the monitoring period is 6,711 tCO2 as discussed in section E.8.2 and leakage emissions from the project activity during the monitoring period is 14,833 tCO2 as discussed in section E.8.3 above. Therefore, net emission reductions from the project activity during the monitoring period is 83,770 tCO_2e.
Findings	NA
Conclusion	RINA confirms that net emission reductions have been appropriately calculated and are consistent with site visit observations, the applied methodology and registered PDD **/01/, /02/, /03/, /05/, /11/.**

E.8.5. Comparison of actual GHG emission reductions or net anthropogenic GHG removals by sinks with estimates in registered PDD

Means of verification	The emission reductions from the project for the monitoring period as reported in the monitoring report revision 4.0 of 15/08/2018 /**01**/ is equivalent to 83,770 tCO_{2e}. The reported emission reductions are 14% higher than the estimated emission reduction of 73,325 tCO_{2e} for the period as per the registered PDD /**03**/. The higher emission reduction is due to higher methane concentration in biogas than considered at the time of registration of the project activity. The design methane concentration was taken as 55% whereas, the actual realization was average 59.17% during the monitoring period. The methane concentration of biogas is a monitoring parameter and may vary depending of wastewater quality. Therefore, the parameter is not under the control of PP. The increase emission reduction is thus accepted.
Findings	NA
Conclusion	The emission reduction calculations provided in the spreadsheet /**02**/ have been verified to be correct and in line with the registered PDD /**03/.**

E.8.6. Remarks on difference from estimated value in registered PDD

Means of verification	The emission reductions achieved during the monitoring period is higher than estimated in the registered PDD. The higher emission reduction is due to higher methane concentration in biogas than considered at the time of registration of the project activity. The design methane concentration was taken as 55% whereas, the actual realization was average 59.17% during the monitoring period. The methane concentration of biogas is a monitoring parameter and may vary depending of wastewater quality. Therefore, the parameter is not under the control of PP. The increase emission reduction is thus accepted.
Findings	NA
Conclusion	The emission reduction calculations provided in the spreadsheet /**02**/ have

	been verified to be correct and in line with the registered PDD /**03/.**

E.8.7. Actual GHG emission reductions or net anthropogenic GHG removals by sinks during the first commitment period and the period from 1 January 2013 onwards

Means of verification	GHG emission reductions or net GHG removals by sinks reported up to 31 December 2012	GHG emission reductions or net GHG removals by sinks reported from 1 January 2013 onwards
	NA	83,770 tCO_2e
Findings	NA	
Conclusion	The actual monitoring period does not fall into the first commitment period.	

E.8.8. Assessment of the sustainability parameters

Means of verification

Data variable	**Source of Data**	**Reported value for the project period**
Air Quality	Laboratory analysis reports /41/	

Period	Parameters	Results (ppm)			
		Generator 1		Generator 2	
22/06/16 to 14 07/16	SOx	22.69	34.52	18.69	23.32
	NOx	26.80	40.77	32.75	40.88
	CO	227.60	346.23	23.10	28.83

Assessment

Air quality of at the exhaust of generator is monitored to maintain below industrial norms. Due to the implementation of the project activity the SOx, NOx and CO of exhaust gases from electricity generators are at much lower than the industrial norms. The results of third party analysis /**41**/ were checked by the verification team and details found consistent. Hence, desired results are achieved.

Data variable	**Source of Data**	**Reported value for the project period**
Water Quality	Laboratory analysis reports /34/	0.032 ton/m3

Assessment

COD of wastewater entering the digester and after digester is analysed daily and results are recorded. Results show that COD leaving the digester is lower than the initial value /34/. Hence, compared to baseline scenario, where higher COD in wastewater would have resulted higher water pollution the project activity reduces the same utilizing the wastewater in digester. Hence, desired results are achieved.

Data variable	**Source of Data**	**Reported value for the project period**

	Quantitative employment and Income generation	List of employee and payment details /42/.	As per the employee list, 17 persons have been employed PP.
	Assessment		
	List of employees and payment details were checked /42/. It is confirmed that 17 employment has been generated for the project activity and minimum monthly salary found to be 8,370 THB/month and highest salary 37,322 THB/month which is higher than baseline scenario (4,896 THB/month). Hence, the desired results are achieved for the monitoring period.		
	Data variable	**Source of Data**	**Reported value for the project period**
	Quality of employment	Training records /43/.	Trainings provided to employees.
	Assessment		
	Trainings related to biogas generation system, First aid, operation and maintenance of biogas plants, quality management system (ISO 9001:2008) etc. were provided to project employees which results in quality of employment and knowledge in technology transfer /43/. Training records were verified. Hence, the desired results are achieved for the monitoring period.		
Findings	CR 04 was raised to provide copies of records against all monitoring results of sustainable development parameters to which PP has provided the same. Results in records are consistent with the details provided in the MR. Hence, CR was closed.		
Conclusion	RINA confirms that monitoring of all the sustainable development monitoring parameters during this monitoring period is in line with registered monitoring plan and are consistent with site visit observations **/01/, /04/, /05/.**		

SECTION F. Internal quality control

The draft final verification report before being submitted to the client is subjected to an independent technical review to confirm that all validation activities has been completed according to the pertinent RINA's procedures. The technical review is performed by a technical reviewer(s) qualified in accordance with the RINA's qualification procedure.

SECTION G. Verification opinion

RINA Services Spa (RINA) has performed verification of the emission reductions reported for the project activity 'Papop Biogas and Renewable Energy Project in Thailand', GS Registration Reference No. 3992 for the period 08/01/2016 to 31/10/2016, with regard to the relevant GS requirements and principles. The project participants are responsible for the preparation for the collection of data in accordance with the monitoring plan and the reporting emission reductions from the project. It is RINA's responsibility to express an independent verification opinion on the reported emission reductions from the project and does not express any opinion on the selected baseline scenario or on the validated and registered PDD. Based on documented evidences and corroborated by an on-site assessment RINA can confirm that: (i) the project has been implemented and operated as per the registered PDD; (ii) the monitoring report and other supporting documents provided are complete and verifiable and in accordance with the applicable GS requirements and principles; (iii) the monitoring is in place as per the applied baseline and monitoring methodology; (iv) the monitoring complies with the registered monitoring plan; (v) the monitoring plan in the registered PDD is as per the applied baseline and monitoring methodology.

SECTION H. Certification statement

It is RINA's opinion that the GHG emission reductions stated in the monitoring report version 4.0 of 15/08/2018 for the project activity 'Papop Biogas and Renewable Energy Project in Thailand' in Thailand, for the period 08/01/2016 to 31/10/2016 are fairly stated. The GHG emission reductions were calculated correctly on the basis of the approved monitoring methodology ACM0014, version 107, 'Treatment of wastewater'. Hence RINA is able to certify that the emission reductions from the project during the monitoring period 08/01/2016 to 31/10/2016 amount to 83,770 tCO_2e.

Appendix 1. 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_2e	Carbon dioxide equivalent
CRT	Coordination and Technical Control Staff
DCI	Certification Division of RINA Services Spa
DNA	Designated National Authority
DOE	Designated Operational Entity
EB	Executive Board
ER	Emission Reductions
FAR	Forward Action Request
GHG(s)	Greenhouse gas(es)
GS	Gold Standard
GWP	Global Warming Potential
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
PP(s)	Project Participant(s)
Ref.	Document Reference
RINA	RINA Services Spa
SS(s)	Sectoral Scope(s)
TA(s)	Technical Area(s)
UNFCCC	United Nations Framework Convention on Climate Change
VVS	Validation and Verification Standard

Appendix 2. Competence of team members and technical reviewers

RINA SERVICES
classification, certification, inspection & testing

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

*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

RINA Services S.p.A. è accreditato/riconosciuto da
RINA Services S.p.A. is accredited /recognized by

UNFCCC	quale Entità Operativa Designata (DOE), per condurre la Validazione e la Verifica di Progetti CDM *as Designated Operational Entity (DOE), to carry out Validation and Verification of CDM Projects*
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*

GHG_QUAL_CERT_EN_07_16 Voluntary(Certificate) Page 1 of 1

RINA SERVICES
classification, certification, inspection & testing

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, ITR, Local Expert

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)
1	11/07/2017	Qualification update

Responsabile di schema
Scheme Leader
Laura SEVERINO

*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: Indipendent technical reviewer

RINA Services S.p.A. è accreditato/riconosciuto da
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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*

RINA SERVICES
classification, certification, inspection & testing

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:

Fulya Ekinci Ozen

è qualificato come:
is qualified as:

TEC, VAL, VER, LOCAL EXPERT, TL, ITRP

AREE TECNICHE *TECHNICAL AREAS*	DESCRIZIONE DELL'AREA TECNICA *TECHNICAL AREA DESCRIPTION*	SCOPO SETTORIALE *SECTORAL SCOPE*
1.2	Renewables	1
13.1	Solid waste and wastewater	13

REVISIONE *REVISION*	DATA *DATE*	MOTIVAZIONI PER LA REVISIONE *REASON FOR THE REVISION*
0	27/01/2017	First issue
5	06/12/2017	Update qualification as VAL

Head of QPT
Laura Severino

*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

RINA Services S.p.A. è accreditato/riconosciuto da
RINA Services S.p.A. Is accredited /recognized by

UNFCCC	quale Entità Operativa Designata (DOE), per condurre la Validazione e la Verifica di Progetti CDM *as Designated Operational Entity (DOE), to carry out Validation and Verification of CDM Projects*
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*
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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*

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Appendix 3. Documents reviewed or referenced

No.	Author	Title	References to the document	Provider
1	Swiss Carbon Value Limited	Monitoring report for project activity "Papop Biogas and Renewable Energy Project in Thailand" in Thailand	Version 1.0 of 04/05/2018 and version 04 of 15/08/2018	PP
2	Swiss Carbon Value Limited	Emission reduction calculation spreadsheet (874_TSML_ex-post_ER_Calculation_v01_0405 2018.xlsx) & '874TSML_ex-post_ER calculation_v02_04Jul18.xlsx'	Submitted on 04/05/2018 and submitted on 04/07/2018	PP
3	Swiss Carbon Value Limited	Registered GS PDD for project activity 'Papop Biogas and Renewable Energy Project in Thailand'	Version 04 of 16/02/2018	PP
4	Swiss Carbon Value Limited	GS passport for the project 'Papop Biogas and Renewable Energy Project in Thailand'	Version 03 of 16/02/2018	PP
5	RINA	GS validation report (for the project activity ''Papop Biogas and Renewable Energy Project in Thailand'	Revision 2.0 Aa of 05/04/2018	DOE
6	Gold Standard	6-week Registration Review Period under GS Version 2.2VER-GS 3992	Final review document	PP
7	The Gold Standard	Gold Standard Requirements	version 2.2 of 01/06/2012	Publicly available
8	The Gold Standard	Gold Standard Toolkit	version 2.2 of 01/06/2012	Publicly available
9	CDM Executive Board	Clean Development Mechanism Project Standard	Version 01.0 of 03/03/2017	Publicly available
10	CDM Executive Board	Clean Development Mechanism validation and verification standard	Version 01.0 of 03/03/2017	Publicly available
11	CDM Executive Board	Large scale consolidated methodology "ACM0014", "Treatment of wastewater",	Version 07 of 04/11/2016	Publicly available
12	Thai San Miguel Liquor Company Limited and	Agreement between Thai San Miguel Liquor Company Limited and Papop Renewable Company Limited for construction,	Agreement dated 22 August 2008	PP

	Papop Renewable Company Limited	commission and operation of wastewater anaerobic treatment and biogas capture at its distillery plant (Thai San Miguel Liquor Company Limited)		
13	Papop Co. Ltd.	Commissioning certificate of biogas and wastewater treatment system	Dated 01/05/2010	PP
14	Guascor	Commissioning certificate of 1.904 MW (Serial no. 330595 and serial no. 330594) biogas fired generator	Commissioning report dated 21/05/2010	PP
15	Papop Renewable Company Limited	Drawing of open lagoons	TS-WP-03	PP
16	Gamma Engineering Co. Ltd.	Lay out plan of anaerobic pond	Layout drawing dated 14/07/2007	PP
17	IPCC	2006 IPCC Guidelines for National Greenhouse Gas Inventories	Volume 2: Energy	Publicly available
18	UNFCCC	Tool: Determining the baseline efficiency of thermal or electric energy generation systems	Version 02 of 27/11/2015	Publicly available
19	CDM Executive Board	Standard for the application of the global warming potentials to clean development mechanism project activities and programme of activities for the second commitment period of the Kyoto Protocol	version 1, Annex 3 of EB 69 dated 13/09/2012	Publicly available
20	UNFCCC	Tool to determine the mass flow of a greenhouse gas in a gaseous stream	Version 03 of 27/11/2015	Publicly available
21	Bureau of Analysis and Evaluation	Study of greenhouse gas emissions from the power generation of Thailand in 2014	http://tver.tgo.or.th/2015/file/download/Grid_Emission_Factor_124.pdf	Publicly available
22	UNFCCC	Tool to calculate the emission factor for an electricity system	Version 05 of 27/11/2015	Publicly available
23	BKE Combustion Controls Co. Ltd.	Flare specification	Dated 31/07/2009	PP
24	UNFCCC	Project and leakage emissions from anaerobic digesters	Version 01	Publicly available
25	Thai Meteorological Department	Monthly average temperature of project site from January 2016 to October 2016	https://www.tmd.go.th/en/climate.php?FileID=4	Publicly available
26	The World Bank	Electric power transmission and distribution losses	https://data.worldbank.org/indicator/EG.ELC.LOSS.ZS?locations=TH	Publicly available
27	Endress+Hause	Calibration report for flow meter	Calibration certificate	PP

	r	(C5023920000) dated 07/08/2015 and on 10/05/2016		
28	EnviScience Company Limited	Calibration certificate of colorimeter (081290C71533) dated 07/01/2015 and on 12/01/2016	Calibration certificate	PP
29	Endress+Hauser	Calibration report for flow meter (C20C7B02000) dated 10/10/2015 and on 10/05/2016	Calibration certificate	PP
30	Endress+Hauser	Calibration report for flow meter (C20C8902000) dated 07/08/2015 and on 10/05/2016	Calibration certificate	PP
31	Endress+Hauser	Calibration report for flow meter (C20C8B02000) dated 18/01/2017	Calibration certificate	PP
32	Geotech	Calibration certificate of gas analyser (BM13285) dated 07/10/2015 and 24/03/2016	Calibration certificate	PP
33	Papop Renewable Company Limited	Log book record of wastewater flow into the digester from 01/01/2016 to 31/10/2016	Log book record	PP
34	Papop Renewable Company Limited	Log book record of COD in wastewater flowing into the digester and leaving the digester from 01/01/2016 to 31/10/2016	Log book record	PP
35	PEA	Monthly net electricity exported and imported by Papop Renewable energy from January 2016 to October 2016	Monthly electricity export-import records	PP
36	Papop Renewable Company Limited	Log book record of HFO consumption in boilers from 01/01/2016 to 31/10/2016	Log book records	PP
37	Papop Renewable Company Limited	Log book record of biogas flow into boilers, genset, flare and methane concentration in biogas from 01/01/2016 to 31/10/2016	Log book record	PP
38	Thai Meteorological Department	Monthly average temperature of project site from January 2016 to October 2016	https://www.tmd.go.th/en/climate.php?FileID=4	Publicly available
39	PEA	Monthly net export to grid from the project activity from January 2016 to October 2016	Monthly net export records	PP
40	Thai San Miguel Liquor	Daily consumption records of HFO in TSML boilers	Log book record	PP
41	Vcare Environment Services Co., Ltd.	SOx, NOx and CO monitoring at the generator points	Laboratory analysis reports	PP
42	Papop Renewable Company	List of employees in the project activity with payment records from the year 2015 to 2016	Employment records	PP

	Limited			
43	Papop Renewable Company Limited	Training records provided to project employees in the year 2016	Training records	PP

Appendix 4. Clarification requests, corrective action requests and forward action requests

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

No FAR to be addressed.

Table 2. CR from this verification

CR ID	01	**Section no.**	E.6.2	**Date:** 07/06/2018
Description of CR				
The supporting document for accuracy of colorimeter is not provided. Also provide supporting documents for accuracy of all monitoring equipments.				
Project participant response				**Date:** 11/06/2018
The supporting documents for accuracy of monitoring equipment are provided as in folder Att-01				
Documentation provided by project participant				
Att-01Equipment_Accuracy				
DOE assessment				**Date:** 27/08/2018
PP has provided supporting document for accuracy of colorimeter and also updated accuracy details of all monitoring equipments in the MR. Details are found consistent with actual site visit observations. Hence response is accepted and CR is closed.				

CR ID	02	**Section no.**	E.6.2	**Date:** 07/06/2018
Description of CR				
Kindly provide the copies of PEA invoice/monthly bill for the values of $EG_{PJ,y}$ and $EC_{PJ,y}$.				
Project participant response				**Date:** 11/06/2018
The monthly invoices from PEA are provided as Att-02, with some translation				
Documentation provided by project participant				
Att-02PEA Invoices_2016				
DOE assessment				**Date:** 27/08/2018
The PEA monthly export and import records are provided for the entire monitoring period. Data found consistent with the records. Hence, CR is closed.				

CR ID	03	**Section no.**	E.7	**Date:** 07/06/2018
Description of CR				
Kindly provide the copies of calibration certificates of all monitoring equipments covering the monitoring period.				
Project participant response				**Date:** 11/06/2018
The calibration certificates of equipment are provided with some translation. The provided calibration certificates covers the monitoring period as found in folder Att-03.				
Documentation provided by project participant				
Att-03Calibration_1stMR				

DOE assessment	Date: 27/08/2018
PP has provided copies of calibration certificates of all monitoring equipments applicable for the monitoring period. Details reported in MR is consistent with records. Hence, CR is closed.	

CR ID	04	Section no.	E.8.8	Date: 07/06/2018
Description of CR				
Kindly provide the supporting documents for monitored values of SO2, NO2 in gen sets. Also provide supporting documents for employment and income generation, copies of training records.				
Project participant response				**Date:** 22/06/2018
As per the environmental report, the sampling points of SO2, NO2 are at the Generator1 and Generator2. The shown results of SO2 and NO2 are under the Thai standard for industrial stack emission. The supportive documents are provided as Att-04.1-Att-04.2. *Employee agreement and income generation are provided with some translation as Att-04.3 to Att-04.4* *Papop Renewable had provided the internal training courses for their employees. Though some of the employee had gone for external courses. The supportive evidences can be found with translation as Att-04.5.*				
Documentation provided by project participant				
Att-04.1NO2-SO2 monitoring *Att-04.2TH_Stack Emission_standard* *Att-04.3Employee agreement* *Att-04.4Income Generation* *Att-04.5Training Records*				
DOE assessment				**Date:** 27/08/2018
PP has provided copies of monitoring results of all sustainable development parameters. Results presented in MR is found consistent with records of monitoring. Hence, CR is closed.				

Table 3. CAR from this verification

CAR ID	01	Section no.	E.6.2	Date: 07/06/2018
Description of CAR				
As per PDD, the total biogas generation ($F_{biogas,y}$) and methane concentration ($W_{CH4,biogas,\ y}$ $V_{i,t,db}$) of total biogas supply is monitored at the outlet of digester. Please clarify how this requirement is met. Also, please clarify whether the gas analyzer used for monitoring is a portable gas analyzer or continuous gas analyzer. In case of portable analyzer how it is ensured the measurement meets 95/10 confidence/precision level.				
Project participant response				**Date:** 21/06/2018
As per the project activity, three gas meters have been implemented at the outlet of digester where methane concentration was also being sampled. The gas meters are measuring biogas to boilers(GM2), biogas to generator(GM3) and biogas to flare(GM4). The summation of the three monitoring points was used for total biogas generation ($F_{biogas,y}$). The diagram of the current implementation of project activity in MR would provide support to these monitoring points. All requirement as written in PDD have been met. *In this monitoring period, the gas analyzer brand – Geotech was used. The equipment information was shown in the monitoring report. The equipment is a portable kind which can be crossed check with Att-01. The confidence/precision level of 90/10 was applied to the calculation and the amount is complied with the PDD.*				
Documentation provided by project participant				
Att-01Methane Analyzer-portable_accuracy				
DOE assessment				**Date:** 27/08/2018

As per applied methodology, total amount of biogas gainfully used needs to monitor for emission reduction calculation. PP is monitoring biogas gainfully used at three locations, at boiler, at generator and at flaring. Total summarized value of three used points are considered as total biogas generation which is consistent with the methodology. In addition, the methane fraction of biogas is monitored using a portable analyser and samples are taken before the usage point. The monitoring and measurement procedure is consistent with applied methodology and registered PDD. Hence, response is accepted and CAR is closed.

CAR ID	02	**Section no.**	E.6.2	**Date:** 07/06/2018
Description of CAR				
Kindly provide the source based on which the temperature of project site ($T_{2,m}$) is considered.				
Project participant response				**Date:** 13/06/2018
The temperature of the project site is based on Thai Meteorological Department(TMD) monthly published reports. The average monthly temperature of Kanchanaburi province was selected for the temperature of project site ($T_{2,m}$). The supportive documents are provided as Att-06.				
Documentation provided by project participant				
Att-06Temperature of project site				
DOE assessment				**Date:** 27/08/2018
PP has transparently provided the source from which the temperature of project site taken. The method is consistent with registered monitoring plan. The values are found consistent with source information. Hence, CAR is closed.				

CAR ID	03	**Section no.**	E.6.2	**Date:** 07/06/2018
Description of CAR				
The measuring and recording method described in MR for $EG_{PJ,y}$ is not consistent with registered PDD. The oil meter (used for monitoring $FC_{k,y}$) specifications are not provided.				
Project participant response				**Date:** 15/06/2018
As per the registered PDD, the amount of electricity consumption and generation are based on PEA invoices. The amount of $EG_{PJ,y}$ *as well as* $EC_{PJ,j,y}$ *in emission reduction worksheet and the measuring - recording method in MR have been revised. The equipment information had also been updated in the monitoring report. The supporting documents are prepared with translation as Att-02.* *Oil meter specification is provided now.*				
Documentation provided by project participant				
Att-02PEA Invoices_2016-CL *Att-07Oil Meter*				
DOE assessment				**Date:** 27/08/2018
The measuring and recording method is made consistent in MR with PDD. In practice also $EG_{PJ,y}$ is continuously monitored and monthly recorded. For oil meter details are provided. Response is accepted and CAR is closed.				

CAR ID	04	**Section no.**	E.8.1	**Date:** 07/06/2018
Description of CAR				
The calculation of $COD_{PJ,y}$ found incorrect in the emission reduction worksheet. Please clarify the use of value 283 and 303 in the calculation of $f_{T,m}$ in cell number Q43-Q52 sheet 2016.				
Project participant response				**Date:** 14/06/2018
The emission reduction worksheet has been revised. The number of value 283 and 303 is replaced by 278 and 302.5 as per ACM0014, version07. The calculation is now complied with the methodology and PDD.				
Documentation provided by project participant				
874TSML_ex-post_ER calculation_V02_20062018_revised				
DOE assessment				**Date:** 27/08/2018

Necessary corrected to calculate $COD_{PJ,y}$ is done in the updated emission reduction worksheet. The method is now consistent with registered PDD and applied methodology. Hence, CAR is closed.

Table 4. FAR from this verification

No FAR raised.

- - - - -

Document information

Version	*Date*	*Description*
01.0	10/06/2016	Initial publication.