

FINAL VALIDATION REPORT OF
CREDITING PERIOD RENEWAL
FOR THE PROJECT TITLE
“WASTEWATER TREATMENT WITH
BIOGAS PRODUCTION (UASB) AND
HEAT UTILIZATION AT GENERAL
STARCH CO.,LTD.”



RINA

Document Prepared By RINA Services SPA

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Summary:

RINA Services S.p.A. (RINA), commissioned by South Pole Carbon Asset Management Ltd., has performed the validation for renewal of crediting period for the VCS project "Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd." in Thailand, VCS Registration Reference N° 82.

The scope of validation of renewal of crediting period is to have an independent evaluation of a project activity by a designated operational entity against the requirements of the VCS Standards, on the basis of the project design document and related project documents in order to confirm that the project designed as documented is sound reasonable and meets the identified criteria.

The validation consisted of the following three phases: (i) document review, (ii) on-site assessment, (iii) the resolution of outstanding issues and the issuance of the final validation report and certification.

In conclusion, it is RINA's opinion that the project meets all the relevant requirements for the renewal of the crediting period.

Hence RINA requests that the renewal of the crediting period of the project activity "Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd" in Thailand.

Table of Contents

1	Introduction.....	4
2	Validation Process	5
3	Validation Findings.....	10
4	Validation Conclusions.....	33

1 INTRODUCTION

1.1 Objective

The objective of the Validation of renewal of crediting period is to have an independent evaluation of the updated PD's compliance with relevant VCS requirements and host Party criteria to confirm that the original project baseline is still valid or has been updated taking into account of new data where applicable. In particular, the project's baseline, monitoring plan and the project's compliance with relevant VCS requirements and host Party criteria are validated in order to confirm the correctness of the application of the approved baseline methodology ACM0014 version 06.0 of 21/02/2014 for the determination of the continued validity of the baseline/or its update, and estimation of the emission reductions for the applicable crediting period from 01/01/2014 to 31/12/2023 reported for the "Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd " project in Thailand.

1.2 Scope and Criteria

The validation scope is to review the updated VCS PD against the UNFCCC criteria and VCS requirements.

This validation opinion is also to be seen in conjunction with the validation report at the time of requesting registration of the project (TUV NORD CERT GmbH (A combined report for both validation and verification, Report no. 8000349679-07/63 - V01 of 31/08/2007).

The Validation Opinion 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 project design.

1.3 Level of Assurance

The validation has been carried out by reviewing the VCS-PD /01/, emission reduction sheet and supporting documents (refer below section 2.2) made available to the RINA assessment team and information collected through performing interviews and document review. Based on review of above mentioned documents, the assessment team is of the opinion that level of assurance is reasonable and that the GHG assertions are free of material errors, omissions and misrepresentations. The validation opinion is assured provided the credibility of all above document. All the revisions of the validation report before being submitted to the client were subjected to an independent internal technical review to confirm that all validation activities had been completed according to the pertinent RINA instructions.

The technical review was performed by a technical reviewer(s) qualified in accordance with RINA's qualification scheme VCS VER validation and verification. The validation team and the technical reviewers consist of the following personnel:

Role/Qualification	Last Name	First Name	Country
VCS Team Leader, VCS Validator and Technical Expert	Rekha	Menon	India
VCS Validator and Technical Expert	Arokiasamy	Cyril	India
Technical Reviewer	Timuroglu	Isil	Turkey

1.4 Summary Description of the Project

The project activity involves installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) technology, at a starch manufacturing plant that has been in operation since 1995.

The first phase of the project (UASB 1) was implemented at General Starch Co., Ltd. in 2003 with start up of operations in January 2004 and the second phase of the project (UASB 2) in 2005 with start up of operations in January of 2006 (already verified and reported in previous verification reports) /16/.

2 VALIDATION PROCESS

2.1 Method and Criteria

Validation was conducted using RINA procedures in line with the requirements specified in the Rules for the Use of the VCS Standards and applying standard auditing techniques. The validation consisted of the following three phases:

- Document review;
- Follow-up actions (field visit)
- The resolution of outstanding and the issuance of the final validation report.

The following sections outline each step in more detail.

2.2 Document Review

The updated PDD, version 01 submitted on 01/10/2015 version 03 of 03/12/2015, version 04 of 21/06/2016 and version 05 of 04/07/2016 /01/, in particular the applicability of the methodology, the baseline determination, the emission reduction calculations provided in the form of a spreadsheet (044_GSL_ER Ex-ante_rev01.xlsx) version 01 submitted on 01/10/2015 and (044_GSL_ER Ex-ante_rev02_n1.xlsx) version 02 of 03/12/2015, version 03 of 22/04/2016, version 04 of 21/06/2016 and version 05 of 04/07/2016, and the documents listed in the table below, were reviewed during the validation.

/01/	South Pole Carbon Asset Management Ltd : VCS-PD for project activity “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.Ltd., version 0.0 submitted on 01/10/2015. South Pole Carbon Asset Management Ltd : VCS-PD for project activity “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.Ltd., version 3.0 of 03/12/2015. South Pole Carbon Asset Management Ltd : VCS-PD for project activity “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.Ltd., version 4.0 of 22/04/2016. South Pole Carbon Asset Management Ltd : VCS-PD for project activity “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.Ltd., version 5.0 of 04/07/2016.
/02/	Verified Carbon Standard: VCS Program Guide v3.5 of 08/10/2013
/03/	Verified Carbon Standard: VCS Standard v3.5 of 25/03/2015
/04/	Verified Carbon Standard: Validation report template, v3.3 of 08/10/2013
/05/	CDM Executive Board: Large scale consolidated Methodology “ treatment of wastewater”, ACM0014, version 06.0 of 21/02/2014
/06/	CDM Executive Board: Tool to calculate baseline , project and/or leakage emissions from electricity consumption and monitoring of electricity generation , version 02.0 of 27/11/2015
/07/	CDM Executive Board: Tool for the demonstration and assessment of additionality , version 07.0.0 of 23/11/2012
/08/	CDM Executive Board: Tool to calculate the emission factor for an electricity system , version 04.0 of 04/10/2013
/09/	CDM Executive Board: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period , version 03.0.1 of 02/03/2012
/10/	CDM Executive Board: Tool to determine the baseline efficiency of thermal or electricity generation system , version 01 of 17/07/2009
/11/	PAPOP Envir Innovation: Open flare specifications for 750m ³ /h
/12/	Verified Emission Reduction Transfer agreement between South Pole Carbon Asset Management Ltd and Papop Renewable Co.Ltd, dated 30/09/2008
/13/	General Starch Co Limited: VER Benefit Share agreement with PAPOP Renewable Co Ltd, dated 24/04/2007.
/14/	TUV NORD CERT GmbH: A combined report for both validation and verification , Report no. 8000349679-07/63 - V01 of 31/08/2007

/15/	South Pole Carbon Asset Management Limited: ER spread sheets ((044_GSL_ER Ex-ante_rev01.xlsx) version 01 submitted on 01/10/2015 South Pole Carbon Asset Management Limited: ER spread sheets ((044_GSL_ER Ex-ante_rev02_nl.xlsx) version 02 submitted on 03/12/2015 South Pole Carbon Asset Management Limited: ER spread sheets ((044_GSL_ER Ex-ante_rev02_nl.xlsx) version 03 submitted on 22/04/2016 South Pole Carbon Asset Management Limited: ER spread sheets ((044_GSL_ER Ex-ante_rev04_210616.xlsx) version 04 submitted on 21/06/2016 South Pole Carbon Asset Management Limited: ER spread sheets ((044_GSL_ER Ex-ante_rev04_210616.xlsx) version 05 submitted on 04/07/2016
/16/	VCS related project documents:http://www.vcsprojectdatabase.org/#/project_details/82, English website, last accessed on 14/12/2015
/17/	General Starch Co Limited: As built drawing for 34 open lagoons, dated 13/01/2003.
/18/	Meteorological Department , Ministry of Information and Communication Technology :http://www.e-report.energy.go.th/weather.html: The annual average temperature at Chok Chai Station is compiled by Statistical Forecasting Bureau , National Statistical Office: Thai Language, Last accessed on 03/12/2015
/19/	CDM Executive Board: Project and leakage emissions from anaerobic digesters, version 01.0.0, dated 02/03/2012
/20/	BOT contract between GSL and Papop Co Ltd, dated 04/01/2005
/21/	Wastewater Stabilization Ponds (WSP) For Wastewater Treatment - Table 1, : http://www.eolss.net/sample-chapters/c07/e6-144-12.pdf, English Language: last accessed on 03/12/2015
/22/	South Pole Carbon Asset Management Ltd : VCS-PD for project activity "Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.Ltd., version 1.0 submitted on 19/06/2007.
/23/	ALS laboratory Group: COD analysis Test report, dated 26/04/2008, 30/05/2009, 10/05/2010, 23/04/2011,13/05/2012, 18/04/2013
/24/	NCV of methane: The Engineering tool box: http://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html, English Language, last accessed on 14/12/2015
/25/	CDM Executive Board: Tool to determine project emissions from flaring gases containing methane", version 02.00 of 20/07/2012

/26/	2006 IPCC guidelines for national green house gas inventories Global warming potentials derived from IPCC second assessment report http://ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20(Feb%2016%202016).pdf
/27/	CDM Executive Board: Tool to determine the mass flow of greenhouse gas in as gaseous stream" version 03.0 of 27/11/2015
/28/	LOVIBOND Water testing: http://dl.lovibond.com/instructions/cod/ins_md200_00386324_cod_multi_lovi.pdf , photometer system, MD200, dated 09/2013.
/29/	Department of Factory Control, Dept. of Industrial Work: Operational License of the factory, dated 25/05/1993 and extended to dated 13/10/2015
/30/	Ministry of Energy: Thailand Energy Statistic Report from DEDE http://www.dede.go.th/download/state_58/sit_57_58/Thailand%20Energy%20Efficiency%20Situation%202014.pdf , last accessed on 15/12/2015
/31/	Korat waste to Energy Project, Thailand: https://cdm.unfccc.int/methodologies/PAMethodologies/pnm/byref/NM0041-rev2 , last accessed on 15/12/2015
/32/	Standard Methods for 5220 Chemical Oxygen Demand: http://www.standardmethods.org/store/ProductView.cfm?ProductID=37 , Last accessed on 15/12/2015
/33/	PAPOP Renewable Co Ltd :VCU-PD"Wastewater Treatment with Biogas production (UASB) and heat utilization at General Starch Co. Ltd, Version 1,0 of 19/06/2007
/34/	Thailand Greenhouse Gas Management Organization: http://tver.tgo.or.th/2015/thai/news_detail.php?id=53 , Thai language, last accessed on 22/04/2016.

2.3 Interviews

On 06/10/2015, RINA visited the project site located on Ratchasima-Chokchai Road , Amphur Kornburi in Nakorn Ratchasima Province in the northeast of Thailand to resolve questions and issues identified during the document review of the updated PDD related to the renewable crediting period 01/01/2014 to 31/12/2023.

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

	Date	Name and Role	Organization	Topic
/a/	06/10/2015	Ms. Nattaya Lonawan (Project Manager)	South Pole Carbon Asset Management Ltd	Baseline, Additionality, ER calculation and project description
/b/		Mr. Krittapak Srisook (Supervisor)	GSL	Project Implementation status, Operation and Maintenance, project boundary, baseline , Data storage and Archiving procedures, Trainings
/c/		Mr. Meksuwan Khakhanmalee (Biogas Officer)	GSL	
/d/		Mr. Somkiert Korkaew (Forman officer)	GSL	
/e/		Mr. Suchai Rattananadhekul (Engineering Design Manager)	Papop Co Ltd	Technology involved, UASB and flare specification, steps involved in waste water treatment and disposal of sludge

2.4 Site Inspections

The audit team performed an on-site inspection of the project area on the dates 06/10/2015. The main activities undertaken by the audit team were as follows:

- Interview with project personnel (see Section 1.7 above) to gather information regarding the project design;
- Review of records (see Section 1.6 above) to ensure the appropriate design of the project;
- Conduct of a visit to the project area to confirm the accuracy of the claims made in the PDD.

2.5 Resolution of Findings

The objective of this phase of the validation is to resolve any outstanding issues which need to be clarified for RINA's positive conclusion on the monitoring report and emission reductions.

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 validation protocol consists of two tables and it 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 (CL) is raised if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met.

A forward action request (FAR) is raised during verification for actions if the monitoring and reporting require attention and/or adjustment for the next monitoring period.

CARs, CLs and FARs identified are included in the validation protocol in Appendix A of this report Validation Findings.

2.6 Forward Action Requests

No Forward Action Request raised.

3 VALIDATION FINDINGS

3.1 Project Details

The project activity involves installation of an anaerobic wastewater treatment facility, based on Upflow Anaerobic Sludge Blanket (UASB) technology, at a starch manufacturing plant that has been in operation since 1995 /14/.

The first phase of the project (UASB 1) was implemented at General Starch Co., Ltd. in 2003 with start-up of operations in January 2004 and the second phase of the project (UASB 2) in 2005 with start-up of operations in January of 2006.

The starch plant has a total production capacity of 600 tonnes of native starch per day, generating an average of 5,000 m³ of wastewater every production day /14/. As a normal practice, the wastewater in the plant is treated through cascading lagoons with a retention time of more than a year. The minimum depth of these ponds is about 10 meters for the first two lagoons and more than 3 m from the water surface for the remaining lagoons /17/. The average atmospheric temperature in the region is 28 degree Celsius and the waste water has a temperature of between 25 and 35 degree Celsius at all times /18/.

These conditions result in anaerobic environment within the ponds, resulting in methane generation from the organic content (characterized by chemical oxygen demand or COD) of the wastewater which is released into the atmosphere.

The use of UASB to treat the wastewater generated in the plant enable the capture of methane produced in the process as well as to meet the effluent standards. This will help reduce the emission of GHG.

The project utilizes the captured methane as fuel in existing heat generating devices in the plant replacing heavy fuel oil, and the surplus methane, if any, is flared in an open flare.

During the site visit , it was noted that the project involves (covered lagoon 3,4) as additional units from the previous version of the registered PD. The new wastewater and biogas flow meters are installed at each unit in order to separate the wastewater and biogas volume from the project activity. From the emission reduction spread sheets /15/, it was confirmed that the emissions from the same are not included in the ER calculations and the covered lagoons are not part of the project boundary.

RINA was able to verify all the documented evidence listed above during the validation process and can confirm that data and considerations are complete and accurate.

RINA confirms that the description of the proposed VCS project activity, as contained in the VCS-PD sufficiently covers all relevant elements, is accurate and complete and that it provides the reader with a clear understanding of the nature of the proposed VCS project activity.

3.2 Application of Methodology

3.2.1 Title and Reference

The project applies the approved consolidated baseline and monitoring methodology ACM0014 : Large-scale Consolidated Methodology , Treatment of wastewater (Version 06.0) /05/.

Also, following tools have been applied as referred by the Methodology /05/

- Tool for the demonstration and assessment of additionality , version 07.0.0 /07/;
- Tool to calculate baseline , project and/or leakage emissions from electricity consumption, version 01 /06/;
- Tool to calculate the emission factor for an electricity system , version 04.0 /08/
- Tool to determine the baseline efficiency of thermal or electricity generation system , version 01 /10/ ;
- Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period , version 03.0.1 /09/ ;
- Project and leakage emissions from anaerobic digesters, version 01.0.0 /19/.

3.2.2 Applicability

The proposed project meets scenario 1 of table-2.

In baseline scenario the wastewater discharged from starch plant is directed to an existing cascade open lagoon system under anaerobic condition /17/. The project activity involves, installation of new anaerobic digesters. The biogas extracted from the anaerobic digesters is used to generate heat and the excess of biogas is flared, which mainly occur in times when the starch production process is not in operation /14. Further, the treated wastewater will be reused internally in starch factory ; washing of cassava roots and plantation.

The project meets the following applicability conditions:

1. Depth of the baseline anaerobic open lagoons is more than 1m. The same was checked against open lagoon layout plan and confirmed /17/.
2. It was noted that the residence time of the organic matter in the open lagoon system is more than 30 days. The same was checked from the open lagoon layout plan and further confirmed by means of interviews with plant personnel /17/.
3. The solid materials are not separated before directing to the open lagoon system in baseline situation. The solid materials are separated by the rotating screen installed for the UASB system in the project scenarios. Noted that the separated solid materials will be dried on the sand drying bed and will be used as fertilizer for palm oil plantation within the factory. Thus, the criteria is not applicable. Therefore, this criterion is not applicable.
4. The excess sludge (granular) from UASBs is owned and copyright by technology provider which will be only used as seeding material for start up the new UASBs. The same was checked with the BOT contract between GSL and Papop Co Ltd, dated 04/01/2005 /20/.

RINA hereby confirms that the selected baseline and monitoring methodology has been previously approved by the CDM Executive Board, and is applicable to the Project, which complies with all the applicability conditions therein.

3.2.3 Project Boundary

The project boundary is clearly defined in accordance with the applied approved methodology, ACM0014 /05/. The spatial extent of the project boundary includes:

- The site where the wastewater is treated in both the baseline and the project scenario;
- On-site facilities to generate heat that is used by the wastewater treatment systems;
- The anaerobic digester, the heat generation equipment and/or the flare installed under the project activity;

Emissions sources included in the project boundary are shown in the table below and found to be consistent with the applied methodology /05/:

Source		Gas	Included?	Justification/Explanation
Baseline	Wastewater treatment processes or sludge disposal	CO ₂	No	CO ₂ emissions from the decomposition of organic waste are not accounted for
		CH ₄	Yes	Main source of emissions
		N ₂ O	No	Excluded for simplification
	Electricity consumption / generation	CO ₂	Yes	Electricity may be consumed for the operation of the wastewater or sludge treatment system in the baseline scenario
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
	Thermal energy consumption	CO ₂	Yes	On-site thermal energy generation could be displaced by the project activity
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
Project	Wastewater treatment process or sludge disposal	CO ₂	No	CO ₂ emissions from the decomposition of organic waste are not accounted for
		CH ₄	Yes	Main source of emissions
		N ₂ O	Yes	In case of projects that involve land application of sludge

Source		Gas	Included?	Justification/Explanation
	On-site Electricity use	CO ₂	Yes	May be an important emission source
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
	On-site fossil fuel consumption	CO ₂	Yes	May be an important emission source
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification

3.2.4 Baseline Scenario

As per clause 16 and 17 of the methodology ACM0014, version 06.0 /05/, the project participants shall identify realistic and credible alternatives with regard to the possible scenarios that would occur in the absence of the project activity.

To identify the most plausible baseline scenario, the PP has chosen the following steps as per the methodology /05/.

STEP 1: Identification of alternative scenarios

The following plausible alternative scenarios for the treatment of wastewater (W) is determined:

- W1: The use of open lagoons for the treatment of the wastewater;
- W2: Direct release of wastewater to a nearby water body;
- W3: Aerobic wastewater treatment facilities (e.g. activated sludge or filter bed type treatment);
- W4: Anaerobic digester with methane recovery and flaring;
- W5: Anaerobic digester with methane recovery and utilization for electricity or heat generation;
- W6: Wastewater is directed to land application without dewatering;
- W7: Wastewater is dewatered and directed to land application/used as fuel in energy applications.

As discussed in section 2.22 of the applicability conditions, the project activity is not applicable to scenario 2. Hence, the plausible alternative scenarios for the treatment of sludge /19/ (S1-S6) are not considered /14/.

Further, the project does not generate electricity. Thus, the plausible alternative scenarios for the electricity generation (E1-E3) is also not considered/14/.

The following plausible alternative scenarios for the generation of heat is determined.

- H1: Co-generation of heat using fossil fuels in a captive cogeneration power plant;
- H2: Heat generation using fossil fuels in a boiler;
- H3: Heat generation using renewable sources.

H1 and H3: The removal of the existing boilers and replacement with a cogeneration system or biomass based boiler would require amount of modifications and additional training of the

operators. In addition, the introduction of new equipment, and operating requirements, would introduce additional risk to the stability and reliability of the heat supply at the starch factory. As the starch factory relies on thermal energy supply to starch production process, this additional risk is not warranted without substantial gains such as a financial return, or increases in efficiency. Therefore, these alternatives are eliminated. While in the pre-project scenario only heavy fuel oil is utilized. Hence the alternative H2 is selected as baseline scenario. The alternative H1 and H3 are excluded from further consideration.

There is no solid material treatment in the pre-project scenario and project activity. The solid material is not separated in the pre-project scenario. However, the solid materials separated in the project scenario will be dried on the sand drying bed and will be used as fertilizer for palm oil plantation within the factory. Thereby, the plausible alternative scenarios for the treatment of solid materials (SM1-SM4) are not considered.

STEP 2: Eliminate alternatives that are not complying with applicable laws and regulations.

As required by the applied methodology , sub-step 1b from the latest version of “*Tool for the demonstration and assessment of additionality*” version 07.0.0 , is applied to eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements.

Regulations in Thailand prohibit the direct discharge of untreated wastewater into water bodies such as rivers and lakes, primarily through the Enhancement and Conservation of National Environmental Quality Act of 1992. Therefore, alternative W2 is not in compliance with local laws and regulations and is not further considered.

According to the operation permit of General Starch Ltd. /29/, issued by the Department of Industrial Works, (DIW) : Conditions for factory operation permission ;

“ 1.4 Do not allow to discharge effluent outside the factory

1.5 To dispose the sludge from wastewater treatment by using the appropriate method which not create the hazard to public” /29/.

Therefore, alternative W2 (Direct release of wastewater to a nearby water body) and W6 (wastewater is directed to land application) are eliminated. Similarly alternative W7 involves dewatering and redirection to land application would not be in accordance with guidelines, as it would involve discharge of un-treated wastewater for land use. Thereby alternative W7 is ruled out.

Alternatives W1, W3, W4 and W5 and are in compliance with host country regulations and remain as possible alternatives.

Further in the absence of project activity, the fuel oil is used as the main heat energy source for starch drying process. There is no regulatory in Thailand concerned with the alternatives H1, H2 and H3 for heat generation, and thus remain as possible alternatives.

STEP 3: Eliminate alternatives that face prohibitive barriers

As required by the ACM0014 version 06.0 /05/, Step 3 (Barrier Analysis) from the “*Tool for the demonstration and assessment of additionality*” (version 07.0.0) is applied to eliminate alternatives that face prohibitive barriers. The following barriers are considered in the analysis:

- a) Investment barriers
- b) Technological barriers such as complex operation
- c) Barriers due to prevailing practice
- d) Other barriers – non-availability of fuel, grid electricity etc.

a) Investment barriers

Alternative W1 creates acceptable operational costs to achieve compliance with domestic effluent regulation. The anaerobic open lagoon technology is well-established technology. Open anaerobic lagoons require very low investment and have lower operation and maintenance costs /21/ as compared to alternative systems such as anaerobic reactors and aerobic systems. Given the significantly lower investment cost, it is clear that *Alternative W1* does not face significant financial barriers and represents a plausible baseline scenario /21/.

Alternative W3 entails high investment and very high O&M costs /21/ in comparison to alternatives *W1* and *W5*. The major reason for high O&M costs for treating wastewater with high organic content in aerobic systems is the very high electricity demand for forced aeration and high costs associated to sludge disposal as compared to anaerobic treatment systems. Due to high investment and O&M costs and the lack of commercial returns from energy production, it is clear that *Alternative W3* would face similar or even stronger access-to-finance barriers as the project activity (see Section B.5 for more details). Therefore, the alternative can be excluded from further analysis.

Alternative W4, anaerobic digester with methane recovery and flaring, also entails high investment and O&M costs and no returns as the produced biogas is destroyed without use. There will be no expected revenue generation from the project activity and therefore, this alternative is not considered a practical option because it would face even greater access-to-finance barriers as the project activity. Therefore, the alternative is excluded from further analysis.

Alternative W5, anaerobic digester with methane recovery and utilization, also involves substantial capital investment but also has economic returns for biogas usage for energy generation. Therefore, the alternative is further analysed in the next step.

In addition, the above mentioned alternatives, except *W1* Also faces barriers, which already exists to the implementation of different kind of project technologies. The relevant implementation barriers that must be overcome to establish sustainable energy technologies in Thailand are shown in table 4 of the literature titled “waste water Stabilization Ponds (WSP) for waste water /21/. The table states that the implementation of sustainable energy technologies in Thailand, faces barriers i.e. lack of knowledge to operate and manage new technologies and limited availability of spare parts and maintenance expertise. Thus being non-profitability and facing with many technical barriers, it is excluded from the plausible alternative scenarios. The same was accepted by RINA.

Thus , the scenarios analysis demonstrate that the baseline scenario corresponds to Scenario 1.

W1: The use of open lagoons for the treatment of the wastewater

H2: Heat generation using fossil fuels in a boiler.

The baseline scenario is the continuation of the current situation (continued use of open lagoons for the treatment of wastewater and heat generation by means of fossil fuels in a boiler). charcoal and fuel wood in inefficient stoves).

RINA confirms that the project baseline scenario in the updated VCS-PD is the same as in the registered PDD version 1.0 of 19/06/2007 /33/ and is deemed to be applicable for the next crediting period.

3.2.5 Additionality

As per section 3.8.5 of VCS Standard, Version 3.5, dated 25/03/2015 /02/, a full reassessment of additionality is not required when renewing the project crediting period. As per the validation report, Report No: 8000349679-07/63 - V01, dated 31/08/2007 the additionality test is demonstrated based on VCS Criteria 10 - option A /14/.

It is further checked that the proposed project is not mandated by any law, statute or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute or other regulatory framework.

RINA can confirm that all data, rationales, assumptions, justifications, and documentation provided by the project participants to support demonstration of additionality are credible and reliable, which was checked and verified at the time previous validation /22/ /14/.

By assessing the previous validation report /14/ and cross-checking the information contained in, RINA considers the reasoning for the proposed project additionality demonstration is credible and reasonable i.e. the proposed project has the ability to reduce anthropogenic emissions of greenhouse gases by sources below those that would have occurred in the absence of the registered VCS project activity.

3.2.6 Quantification of GHG Emission Reductions and Removals

The emission reduction E_{Ry} by the proposed project activity during the crediting period is the difference between baseline emissions (BE_y), project emission (PE_y). Justification of the values chosen is available in 3.2.8 of this report.

Baseline Emissions:

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH_4,y} + BE_{EL,y} + BE_{HG,y} \quad (1)$$

Where:

Parameter	Details
BE_y	Baseline emissions in year y (tCO ₂ e / yr)
$BE_{CH_4,y}$	Methane emissions from anaerobic treatment of the wastewater in open lagoons in the absence of the project activity in year y(tCO ₂ e / yr)
$BE_{EL,y}$	CO ₂ emissions associated with electricity generation that is displaced by the project activity and / or electricity consumption in the absence of the project

	activity in year y (tCO ₂ e / yr)
$BE_{HG,y}$	CO ₂ emissions associated with fossil fuel consumption for heating equipment that is displaced by the project in year y (tCO ₂ e / yr)

The project will only claim emission reductions from the methane avoidance due to the installation of a new, closed, anaerobic, wastewater-treatment system. Heat generated from the project activity will replace the heat generated from heavy fuel oil that would be occurred in the absence of project activity.

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater or sludge

The methodology proposes to use the minimum value between the methane produced after the implementation of the project activity and methane conversion factor method for the estimation of methane emissions from open lagoons in case of the waste water lagoons.

$$BE_{CH_4,y} = \min \{ Q_{CH_4,y} ; BE_{CH_4,MCF,y} \}$$

Results to 53, 077.5 tCO₂e.

$Q_{CH_4,y}$ is measured using the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream “. Since the project is largescale project, option 1 of the tool is applied i.e. the procedure using monitored data.

The baseline methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) are estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon in the absence of the project activity ($COD_{BL,y}$), the maximum methane producing capacity (B_0) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH_4,MCF,y} = GWP_{CH_4} * MCF_{BL,y} * B_0 * COD_{BL,y} \quad (2)$$

Where:

Parameter	Details
$BE_{CH_4,MCF,y}$	Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) or the anaerobic treatment of sludge in sludge pits (Scenario 2) in the absence of the project activity in year y (tCO ₂ e/yr)
GWP_{CH_4}	Global Warming Potential of methane, GWPs derived from the IPCC's Second Assessment Report, (tCO ₂ e/tCH ₄), 21

$MCF_{BL,y}$	Average baseline methane conversion factor (fraction) in year y, representing the fraction of ($COD_{PJ,y} \times B_0$) that would be degraded to CH_4 in the absence of the project activity, 0.595
B_0	Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand ($tCH_4/tCOD$), 0.25
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year y ($tCOD/yr$), 2,03,915

Determination of $COD_{BL,y}$

The baseline chemical oxygen demand ($COD_{BL,y}$) is equal to the chemical oxygen demand that is treated under the project activity ($COD_{PJ,y}$), unless there would have been effluent from the lagoons (Scenario 1) in the baseline, in this case the COD_{PJ} should be adjusted by an adjustment factor which relates the COD supplied to the lagoon or sludge pit with the COD in the effluent.

$$COD_{BL,y} = \rho \left[1 - \frac{COD_{out,x}}{COD_{in,x}} \right] * COD_{PJ,y} \quad (3)$$

Where:

Parameter	Details
$COD_{BL,y}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year y ($tCOD/yr$)
ρ	Discount factor for historical information
$COD_{out,x}$	COD of the effluent in the period x ($tCOD$)
$COD_{in,x}$	COD directed to the open lagoons (Scenario 1) or in sludge pits (Scenario 2) in the period x ($tCOD$)
x	Representative historical reference period
$COD_{PJ,y}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year y ($tCOD/yr$)

It is noted that $COD_{out,x}$: Calculated from $COD_{in,x}$ with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% and $COD_{in,x}$: From operating data of 2006, already validated and as per the registered previous PD. As per the COD test by external laboratory (once a year) during 2008 to 2013, the COD reduction efficiency by lagoon is above 90% /23/ which is higher than the estimated value, 87.88%. Hence the same was accepted.

$COD_{PJ,y}$ is determined as follows:

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} * COD_{dig,m} \quad (4)$$

Where:

Parameter	Details
$COD_{PJ,y}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year y (t COD/yr)
$F_{PJ,dig,m}$	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (m ³ /month)
$COD_{dig,m}$	Chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (t COD / m ³)
m	Months of year y of the crediting period

The values for $F_{PJ,dig,m}$ and $COD_{dig,m}$ is referred in appendix 2 of the PD, which is further sourced from page 16 of the 1st monitoring report, already verified and registered. Thus, the same is accepted by RINA.

Determination of $MCF_{BL,y}$

The quantity of methane generated from COD disposed to the open lagoon (Scenario 1) depends mainly on the temperature and the depth of the lagoon or sludge pit. Accordingly, the methane conversion factor is calculated based on a factor f_d , expressing the influence of the depth of the lagoon or sludge pit on methane generation, and a factor $f_{T,y}$ expressing the influence of the temperature on the methane generation. In addition, a conservativeness factor of 0.89 is applied to account for the considerable uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

$$MCF_{BL,y} = f_d * f_{T,y} * 0.89 \quad (5)$$

Where:

Parameter	Details
$MCF_{BL,y}$	Average baseline methane conversion factor (fraction) in year y , representing the fraction of ($COD_{PJ,y} \times B_o$) that would be degraded to CH ₄ in the absence of the project activity
f_d	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
$f_{T,y}$	Factor expressing the influence of the temperature on the methane generation in year y
0.89	Conservativeness factor

Determination of f_d

f_d represents the influence of the average depth of the lagoons or sludge pit on methane generation.

$$f_d = \begin{cases} 0 ; & \text{if } D < 1m \\ 0.5 ; & \text{if } 1m \leq D < 2m \\ 0.7 ; & \text{if } D \geq 2m \end{cases} \quad (6)$$

Where:

Parameter	Details
f_d	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
D	Average depth of the lagoons or sludge pits (m)

Determination of $f_{T,y}$

An increase in temperature in the lagoon has several benefits to generate more methane, including an increasing solubility of the organic compounds, enhanced biological and chemical reaction rates. The factor $f_{T,y}$ is calculated using a monthly stock change model which aims at assessing how much COD degrades in each month.

For each month m , the quantity of wastewater directed to the lagoon or sludge directed to a pit, the quantity of organic compounds that decay and the quantity of any effluent water from the lagoon is balanced, giving the quantity of COD that is available for degradation in the next month: the amount of organic matter available for degradation to methane ($COD_{available,m}$) is assumed to be equal to the amount of organic matter directed to the open lagoon or sludge pit, less any effluent, plus the COD that may have remained in the lagoon or sludge pit from previous months, as follows:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m-1}) * COD_{available,m-1} \quad \text{with} \quad (8)$$

$$COD_{BL,m} = \left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) * COD_{PJ,m} \quad \text{and} \quad (9)$$

$$COD_{PJ,m} = F_{PJ,dig,m} * COD_{dig,m} \quad (10)$$

Where:

Parameter	Details
$COD_{available,m}$	Quantity of chemical oxygen demand available for degradation in the open lagoon in month m (t COD/month)
$COD_{BL,m}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month m (t COD/month)
$COD_{PJ,m}$	Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (t COD/month)
$F_{PJ,dig,m}$	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (m ³ /month)
$COD_{dig,m}$	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (t COD/m ³)
$f_{T,m-1}$	Factor expressing the influence of the temperature on the methane generation in month m
m	Months of year y of the crediting period
$COD_{in,x}$	COD of the effluent in the period x (t COD)
$COD_{out,x}$	COD directed to the open lagoons (Scenario 1) or in sludge pits (Scenario 2) in the period x (t COD)
x	Representative historical reference period

In case of emptying the lagoon, the accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero. The monthly factor to account for the influence of the temperature on methane generation is calculated based on the following “van’t Hoff – Arrhenius” approach:

$$f_{T,m} = \begin{cases} 0 ; & \text{if } T_{2,m} < 278 \text{ K} \\ e^{\frac{E \cdot (T_{2,m} - T_1)}{R \cdot T_1 \cdot T_{2,m}}} ; & \text{if } 278 \text{ K} \leq T_{2,m} \leq 302.5 \text{ K} \\ 0.95 ; & \text{if } T_{2,m} > 302.5 \text{ K} \end{cases} \quad (11)$$

Where:

Parameter	Details
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month m
e	Activation energy constant (15,175 cal/mol)
$T_{2,m}$	Average temperature at the project site in month m (K)
T_1	303.16 K (273.16 K + 30 K)
R	Ideal gas constant (1.987 cal/K mol)
m	Months of year y of the crediting period

The annual value $f_{T,y}$ is calculated as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} * COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}} \quad (12)$$

Where:

Parameter	Details
$f_{T,y}$	Factor expressing the influence of the temperature on the methane generation in year y
$f_{T,m}$	Factor expressing the influence of the temperature on the methane generation in month m
$COD_{available,m}$	Quantity of chemical oxygen demand available for degradation in the open lagoon or sludge pit in month m (t COD/month)
$COD_{BL,m}$	Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) or in sludge pits (Scenario 2) in the absence of the project activity in month m (t COD/month)
m	Months of year y of the crediting period

Baseline under a suppressed demand scenario

Suppressed demand scenario may only be applied if the procedure to determine the baseline scenario identifies W2, W6 and/or W8 as the scenario for the treatment of at least 50 per cent of

the domestic wastewater in the project boundary. This scenario is not applicable for this project activity.

Step 2: Baseline emissions from generation and/or consumption of electricity

In this step, baseline emissions from consumption of electricity associated with the treatment of wastewater (Scenario 1) are estimated. Since the project activity does not generate the electricity from biogas, the baseline emission from generation and/or consumption of electricity is considered as 0.

Step 3: Baseline emissions from the generation of heat

This step is applicable if the biogas captured from the new anaerobic digester is utilized in the project scenario for heat generation. In this case, for the application of the baseline Scenarios H2, fossil fuels from the generation of heat in boilers are displaced and baseline emissions are calculated as follows:

$$BE_{HG,y} = \frac{HG_{PJ,y} * EF_{CO2,FF,boiler}}{\eta_{BL,boiler}} \quad (14)$$

Where:

Parameter	Details
$BE_{HG,y}$	CO ₂ emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO ₂ /yr)
$HG_{PJ,y}$	Net quantity of heat generated in year y with biogas from the new anaerobic digester (GJ), 16, 237
$EF_{CO2,FF,boiler}$	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), 0.0774
$\eta_{BL,boiler}$	Efficiency of the boiler that would be used for heat generation in the absence of the project activity, 90%

Determination of $EF_{CO2,FF,boiler}$

The heavy fuel oil was used in the industrial facility that generates the wastewater for heating purposes before the implementation of the project activity. A value of 0.0774 tCO₂/GJ is used as per the IPCC default values /26/.

Determination of $\eta_{BL,boiler}$

The heating combustion efficiency is 90%, default value for the new oil fired boiler as the tool “tool to determine the baseline efficiency of thermal or electricity generation system”, version 01./10/

Determination of $HG_{PJ,y}$

In order to calculate the quantity of fuel that is displaced by biogas, the two fuels are substituted on the basis of equivalent delivered energy. The following energy densities are used:

- The NCV of CH₄ is 39820 kJ/Nm³ or 39.82 MJ/Nm³ and 39.77 MJ/litre for fuel oil /24/ (Thailand Energy Statistic Report from DEDE)/30/
 - Combustion efficiency on HFO as well as biogas is considered to be 90 %.
- Therefore : $HG_{PJ,y}$ (GJ) = $F_{biogas,boiler,y}$ (Nm³) * NCV_{CH₄} (MJ/Nm³) * W_{CH₄,biogas,y} * 90% / 1,000

Results in 16,756.1 tCO₂e.

Project Emissions

Since the project activity introduces an anaerobic digester for the treatment of wastewater. The tool “*Project and leakage emissions from anaerobic digesters version 01.0.0*” is applied to calculate project and leakage emissions.

The following sources of project emissions are accounted for in this tool:

- (a) CO₂ emissions from consumption of electricity associated with the operation of the anaerobic digester;
- (b) CO₂ emissions from consumption of fossil fuels associated with the operation of the anaerobic digester;
- (c) CH₄ emissions from the digester (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); and
- (d) CH₄ emissions from flaring of biogas.

The project emissions associated with the anaerobic digester (PE_{AD,y}) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y} \quad (1)$$

Where:

Parameter	Details
$PE_{AD,y}$	Project emissions associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{EC,y}$	Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{FC,y}$	Project emissions from fossil fuel consumption associated with the

	anaerobic digester in year y (t CO ₂ e)
$PE_{CH_4,y}$	Project emissions of methane from the anaerobic digester in year y (t CO ₂ e)
$PE_{flaring,y}$	Project emissions from flaring of biogas in year y (t CO ₂ e)

These parameters are determined through the steps outlined below.

Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH_4,y}$)

The project activity is large scale project. The Option 1 is used to determine the quantity of methane produced in the digester in year y ($Q_{CH_4,y}$).

Option 1: Procedure using monitored data

$Q_{CH_4,y}$ shall be measured using the *Tool to determine the mass flow of a greenhouse gas in a gaseous stream*.

Follow the same calculating step for Option C in baseline emission calculation step1.

Step 2: Determination of project emissions from electricity consumption ($PE_{EC,y}$)

The project activity consumes the electricity supplied from grid. The Option 2 is used for $PE_{EC,y}$ calculation.

Option 2 : Procedure using a default value

Project emissions from electricity consumption associated with the anaerobic digester are calculated as follows:

$$PE_{EC,y} = Q_{CH_4} * F_{EC,default} * EF_{EL,default} \quad (3)$$

Where :

Parameter	Details
$PE_{EC,y}$	Project emissions from electricity consumption in year y (t CO ₂ e)
Q_{CH_4}	Quantity of methane produced in the anaerobic digester in year y (t CH ₄), 5, 075
$F_{EC,default}$	Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated (MWh / t CH ₄), 0.01

$EF_{EL,default}$	Default emission factor for the electricity consumed in year y (t CO ₂ / MWh). 0.5897
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The value estimated is 66 tCO₂e. ER spread checked and the same is found to be acceptable.

Step 3: Determination of project emissions from fossil fuel consumption ($PE_{FC,y}$)

Where the anaerobic digester facility uses fossil fuels, project participants shall calculate $PE_{FC,y}$ using the “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”. The project emission source j referred to in the tool is fossil fuel consumption associated with the anaerobic digestion facility (not including fossil fuels consumed for transportation of feed material and digester or any other on-site transportation). The $PE_{FC,y}$ is 0 for this project activity. The same was crosschecked during the site visit and found to be satisfactory.

Step 4: Determination of project emissions of methane from the anaerobic digester ($PE_{CH_4,y}$)

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 ($EF_{CH_4,default}$), as follows:

$$PE_{CH_4,y} = Q_{CH_4,y} * EF_{CH_4,default} * GWP_{CH_4} \quad (4)$$

Where :

Parameter	Details
$PE_{CH_4,y}$	Project emissions of methane from the anaerobic digester in year y (t CO ₂ e)
$Q_{CH_4,y}$	Quantity of methane produced in the anaerobic digester in year y (tCH ₄), 5,075
$EF_{CH_4,default}$	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester (fraction), 0.05
GWP_{CH_4}	Global warming potential for CH ₄ (t CO ₂ / t CH ₄), 21

The value estimated is 5, 329 tCO₂e. ER spread checked and the same is found to be acceptable.

Step 5: Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the “Tool to determine project emissions from flaring gases containing methane” version 02.0.0/25/. The following applies:

- The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

The calculation procedure in this tool determines the project emissions from flaring the residual gas ($PE_{\text{flare},y}$) based on the flare efficiency ($\eta_{\text{flare},m}$) and the mass flow of methane to the flare ($F_{\text{CH}_4,\text{RG},m}$). The flare efficiency is determined for each minute m of year y based either on monitored data or default values.

The project emission calculation procedure is given in the following steps:

Step 1: Determination of the methane mass flow in the residual gas

The “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” shall be used to determine the following parameter:

Parameter	Details
$F_{\text{CH}_4,m}$	Mass flow of methane in the residual gaseous stream in the minute m (kg)

The following requirements apply:

- The gaseous stream tool shall be applied to the residual gas;
- The flow of the gaseous stream shall be measured continuously;
- CH_4 is the greenhouse gas i for which the mass flow should be determined;
- The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
- The time interval t for which mass flow should be calculated is every minute m .

$F_{\text{CH}_4,m}$, which is measured as the mass flow during minute m , shall then be used to determine the mass of methane in kilograms fed to the flare in minute m ($F_{\text{CH}_4,\text{RG},m}$). $F_{\text{CH}_4,m}$ shall be determined on a dry basis.

Step 2: Determination of flare efficiency

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. For open flares a default value must be applied.

Open flare

In the case of open flares, the flare efficiency in the minute m ($\eta_{\text{flare},m}$) is 50% when the flame is detected in the minute m (Flame_m), otherwise $\eta_{\text{flare},m}$ is 0%.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y , based on the methane mass flow in the residual gas ($F_{\text{CH}_4,\text{RG},m}$) and the flare efficiency ($\eta_{\text{flare},m}$), as follows:

$$PE_{\text{flare},y} = GWP_{\text{CH}_4} * \sum_{m=1}^{525600} F_{\text{CH}_4,\text{RG},m} * (1 - \eta_{\text{flare},m}) * 10^{-3} \quad (15)$$

Where:

Parameter	Details
$PE_{flare,y}$	Project emission from flaring of the residual gas stream in year y (tCO ₂ e)
GWP_{CH_4}	Global warming potential of methane valid for the commitment period (tCO ₂ e/tCH ₄)
$F_{CH_4, RG, m}$	Mass flow of methane in the residual gas in the minute m (kg), is calculated value of 1,191
$\eta_{flare, m}$	Flare efficiency in minute m , 0%

Project emissions due to flare is estimated to be 25, 027 tCO₂e. Checked the values provided in the ER spread sheets and found to be satisfactory.

Leakage

The project activity introduces an anaerobic digester for the treatment of wastewater , the latest approved version of the tool “*Project and leakage emissions from anaerobic digesters*” is applied to calculate leakage emissions.

However , according to ACM0014 version 06.0.0 “*Additionally leakage emissions are calculated for Scenario 1 type projects that include the treatment of solid materials in the digester in the project activity*”. Since there is no treatment of solid materials , there is no leakage applicable to the project activity.

Net GHG Emission Reductions and Removals

Emission reductions for any given year of the crediting period are obtained by subtracting project emissions from baseline emissions:

$$ER_y = BE_y - PE_y - LE_y \quad (24)$$

Where:

Parameter	Details
ER_y	Emissions reductions of the project activity in year y (tCO ₂ e/year)
BE_y	Baseline emissions in year y , 69, 834 (tCO ₂ e/year)
PE_y	Project emissions in year y , 30, 421 (tCO ₂ e/year)
LE_y	Leakage emissions in year y , 0 (tCO ₂ e/year)

The annual emission reductions generated by the project activity is calculated to be 39,411tCO₂e/year over the selected 10 years renewable crediting period.

The estimation of the emission reductions can be replicated using the data and parameter values provided in the VCS-PD /1/ and supporting files /14/ /15/. The data sources mentioned have been verified by RINA and confirms that the GHG emissions reduction calculation is complete and transparent, and the data accuracy has been verified.

3.2.7 Methodology Deviations

Not applicable

3.2.8 Monitoring Plan

The monitoring plan is in accordance with the approved baseline and monitoring Methodology ACM0014, *Large-scale Consolidated Methodology, Treatment of wastewater (Version 06.0) /05/*; the monitoring plan will give opportunity for real measurement of achieved emission reductions.

RINA has checked all the parameters presented in the monitoring plan against the requirements of the methodology; no deviations relevant to the project activity have been found in the plan.

RINA confirms that the monitoring arrangements described in the monitoring plan are feasible within the project design, and the means of implementation of the monitoring plan are sufficient to ensure the emission reductions achieved by/resulting from the proposed VCS project activity can be reported ex-post and verified.

Parameters Determined Ex-ante

The ex-ante parameters that are mentioned in the methodology are included in the VCS PD and are provided in compliance with the methodology:

	Data / Parameter	Unit	Value applied	Assessment
1	COD _{out,x} COD _{in,x} (COD of the effluent in the period x COD directed to the open lagoons (Scenario 1) in the period x)	t COD	COD _{out,x} 2,674.52 COD _{in,x} 22,066.99	Sourced from COD _{out,x} : Calculated from COD _{in,x} with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% /31/. COD _{in,x} : From operating data of 2006 /22/ As per the COD test by external laboratory (once a year) during 2008 to 2013 , the COD

				reduction efficiency by lagoon is above 90% /23/ which is higher than the estimated value , 87.88%. The same was accepted since its conservative.
2	X Representative historical reference period	Time	1 year	Taken as per the previous registered PD /22/.
3	ρ Discount factor for historical information		0.89	The value of 0.89 for the case where there is no one year historical data is to account for the uncertainty range (of 30% to 50%) associated with this approach as compared to one-year historical data. The values are taken as per the methodology and the same is accepted.
4	B_0 Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (COD).	$tCH_4/tCOD$	0.25	2006 IPCC Guidelines/26/. The same is as per the methodology. Hence accepted.
5	D	m	5.32	Sourced from

	Average depth of the lagoons			the design of baseline lagoon system. RINA checked the lagoon layout design and the same is accepted /17/.
6	EC _{BL} 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	0	The open lagoon system is designed for gravity flow. There is no electricity consumed equipment installed in the absence of project activity. The same was checked during the site visit and accepted /17/.
7	EF _{CO₂,FF,boiler} 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	0.0774	IPCC default values used from the most recent version of IPCC Guidelines for National Greenhouse Gas Inventories/26/. The same is as per the methodology. Hence accepted.
8	GWP _{CH₄} Global warming potential for CH ₄	tCO ₂ e/tCH ₄	21	IPCC default value /26/. GWPs derived from the IPCC's Second Assessment Report,
9	R _u	Pa.m ³ /kmol.K	8,314	Taken as per

	Universal ideal gases constant					“Tool to determine the mass flow of greenhouse gas in as gaseous stream” version 03.0 /27/
10	MM _i molecular mass of greenhouse gas i	kg/kmol	Compound	Structure	Molecular mass (kg / kmol)	Taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous stream” version 03.0 /27/
			Carbon dioxide	CO ₂	44.1	determine the
			Methane	CH ₄	16.04	mass flow of
			Nitrous oxide	N ₂ O	44.02	greenhouse gas
			Sulfur hexafluoride	SF ₆	146.06	in as gaseous
			Perfluoromethane	CF ₄	88.00	stream” version
			Perfluoroethane	C ₂ F ₆	138.01	03.0 /27/
			Perfluoropropane	C ₃ F ₈	188.02	
			Perfluorobutane	C ₄ F ₁₀	238.03	
			Perfluorocyclobutane	c-C ₄ F ₈	200.03	
			Perfluoropentane	C ₅ F ₁₂	288.03	
			Perfluorohexane	C ₆ F ₁₄	338.04	
			11	P _n Total pressure at normal condition	Pa	101,325
12	T _n Temperature at normal condition	K	273.15			Taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous team” version 03.0 /27/
13	ρ _{CH4} Density of methane at normal condition	t CH ₄ / Nm ³ CH ₄	0.00067			Default value. Taken as per the methodological tool “Project

				and leakage emissions from anaerobic digesters” version 01.0.0 /19/
14	$EF_{CH_4, default}$ Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester	t CH ₄ leaked / t CH ₄ produced	0.05	IPCC default values for UASB type digesters taken as per the methodology /05/.
15	$F_{EC, default}$ Default factor for the electricity consumption associated with the anaerobic digester per ton of CH ₄ generated	MWh / t CH ₄ produced	0.01	Default values for UASB, taken as per the methodological tool “Project and leakage emissions from anaerobic digesters” version 01.0.0 /19/
16	$EF_{EL, default}$ Default emission factor for the electricity consumed in year y	t CO ₂ / MWh	0.5897	Methodological tool ; Baseline , project and/or leakage emissions from electricity consumption and monitoring of electricity generation /06/. The scenario A : Electricity consumption from the grid is chosen scenario in this case. PP has chosen the published combined grid emission actor values from Thailand

				Greenhouse Gas Management Organization. The data chosen is for the year 2012 to 2014 /34/. This approach is in line with the condition identified in clause 19 : option A1 of the methodological tool and accepted by RINA.
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Parameters Monitored Ex-post

The ex-post parameters that are mentioned in the methodology are included in the VCS-PD and are provided in compliance with the methodology, and they will be monitored during the crediting period:

	Parameter	Description/Assessment
1	$F_{PJ,dig,m}$ (m ³ /month)	Quantity of wastewater that is treated in the anaerobic digester in the project activity in month m . Measured continuously by flow meters installed at the inlet of UASB no.1 and 2. Flow meters will undergo maintenance / calibration subject to appropriate industry standards, at least once every 3 years. The approach used in the project activity is consistent with the methodology applied /05/, hence accepted.
2	$COD_{dig,m}$ (t COD / m ³)	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m . The COD is measured by means of Spectrophotometer for Colorimetric analysis, USEPA approved for wastewater analysis (standard method 5220 D). The same is accepted as its an international standard /32/. If COD is measured more than once per month, the average value of the measurements should be used. The spectrophotometer is calibrated once in every three years, which is as per the previous registered PD. RINA further checked the manufacturer specifications for Lovibond MD 200 /28/, noted that the measurement device require no maintenance.
3	$T_{2,m}$ (K)	Average temperature at the project site in month m . Taken as per the " National published report"; the monthly average

		temperature of Nakornratchasima province /18/. The same was accepted. Monitored continuously, aggregated in monthly average values
4	$HG_{PJ,y}$ (GJ/year)	Net quantity of heat generated in year y with biogas from the new anaerobic digester. Measured from the heat received by the heated process; else: calculated on the basis of measurement of the volume of biogas captured and used for heat generation multiplied by methane content of biogas, NCV of methane /24/, and the efficiency of the boiler during the project (i.e. with biogas). The biogas flowmeters of thermal mass type with temperature and pressure measuring for display in Nm^3 are installed. Flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years.
5	$F_{biogas,y}$ (Nm^3/yr)	Total amount of biogas collected in the outlet of the new digester in year y. The biogas flow meters are installed at the outlet of biogas from UASB no.1 and 2. Parameter monitored continuously but aggregated annually for calculations. Flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years.
6	$W_{CH_4,biogas,y}$ ($kg\ CH_4 / m^3$)	Concentration of methane in the total biogas supply in the outlet of the new digester. Is measured by means of calibrated continuous gas analyzer or alternatively with periodical measurement at 95% confidence level. Gas analyzer will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years.
7	$V_{RG,y}$ (Nm^3/yr)	Volumetric flow of the residual gas on a dry basis at reference conditions. Measured by means of the biogas flow meters installed at the flare. Parameter monitored continuously but aggregated annually for calculations. Flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years.

3.3 Non-Permanence Risk Analysis

Validation did not reveal any non-permanence risk for the project activity.

3.4 Environmental Impact

Not applicable since this is validation for renewal of crediting period.

3.5 Comments by Stakeholders

Not applicable since this is validation for renewal of crediting period.

4 VALIDATION CONCLUSION

RINA Service Spa (RINA) has performed validation of the updated VCS PD for the project activity “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd.” in Thailand, VCS Registration Reference N° 82. The validation of the updated VCS PD is performed for the 02nd renewal crediting period (from 01/01/2014 to 31/12/2023) and is based on the information made available to us.

RINA has performed this validation in accordance with VCS Standard V3.5 of 25/03/2015 and included an assessment of:

- An impact of new relevant national and/or sectoral policies and circumstances on the baseline taking into account relevant guidance from the Board with regard to renewal of the crediting period at the time of requesting renewal of crediting period:
- The correctness of the application of an approved baseline methodology for the determination of the continued validity of the baseline or its update, and the estimation of emission reductions for the applicable crediting period.

The review of the VCS- PD version 05 and the subsequent follow-up interviews have provided RINA with sufficient evidence to determine the validity of the original baseline scenario. The project correctly applies the baseline and monitoring methodology ACM0014 version 06.0 “Large scale consolidated Methodology “treatment of wastewater”.

It is RINA’s opinion that the project “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd” in Thailand, meets all the relevant requirements for the renewal of the crediting period. Hence, RINA requests the renewal of the crediting period of the project activity.

APPENDIX-A

VALIDATION PROTOCOL

TABLE 1 REQUIREMENTS CHECKLIST

Checklist Question		Reference	MoV ¹	Comments	Conclusion
A Description of Project Activity					
A.1 Title of the project activity					
A.1.1.	Does the used project title clearly enable the reader to identify the unique VCS activity? Is there an indication of a revision number and the date of the revision.	/01/	DR/C C	The title of the project is “Wastewater treatment with biogas production (UASB) and heat utilization at General Starch Co.,Ltd”. The title clearly enables the reader to identify the unique VCS activity. The PD is of version 01. However, the date of the document is not transparent.	~~CL-1~~ OK
A.1.2	Does the project comply with the applicable requirements for completing the PDs (latest version available)?	/01/ /03/ /04/ /05/	DR/C C	Yes, the project complies with the requirements of latest template of version v3.2, dated 08/10/2013	OK
A.1.3	Does the PD comply with the template available (latest version)?	/01/ /03/ /04/ /05/	DR/C C	Yes, the project complies with the latest template of version v3.2, dated 08/10/2013	OK
B. Baseline and monitoring methodology					
B.1 Methodology applied					
B.1.1	Does the project activity apply an approved methodology and the correct version thereof?	/01/ /05/	DR/C C	Yes, the project applies a CDM methodology, ACM0014, Large scale consolidated methodology, “treatment of waste water”, version 06.0 , dated 21/02/2014.	OK
B.1.2	Is there any specific guidance, including the methodological tools provided by EB and has these guidance been applied?	/01/ /05//06//07/ 08/09/	DR/C C	Yes, the following methodological tools have been applied: • Tool for the demonstration and assessment of additionality , version 07.0.0 ; • Tool to calculate baseline , project and/or leakage emissions from electricity	OK

¹ MoV: DR document review, I interview, CC cross checking

Checklist Question		Reference	MoV ¹	Comments	Conclusion						
				consumption , version 01 ; • Tool to calculate the emission factor for an electricity system , version 04.0 ; • Tool to determine the baseline efficiency of thermal or electricity generation system , version 01 ; • Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period , version 03.0.1 ; • Project and leakage emissions from anaerobic digesters , version 01.0.0 .							
B.1.3	How was it validated that the project activity complies with the applicability criteria?	/01/ /05/	DR/C	<table><tr><th>Applicability criteria</th><th>Project activity</th><th>Criteria is met?</th></tr><tr><td>Project participants should document in the CDM-PDD which scenario applies and clearly describe the situation before and after the start of implementation of the project activity, preferably by providing similar diagrams as contained in the appendix, which provides an example for application of Scenario 2</td><td>The PP has documented in the PD section 2.2 that the project applied scenario 1. In baseline scenario the wastewater discharged from starch plant is directed to an existing cascade open lagoon system under anaerobic condition. As part of the project activity, the new anaerobic digesters were installed. Flaring of excess biogas will only occur in times when the starch production process is not in operation. The treated wastewater will be reused internally in starch factory , washing of cassava roots and plantation.</td><td>PP is requested to clarify the cases where solid materials are separated before directing the waste water to the open lagoons. The treatment of solid material is not clear.</td></tr></table>	Applicability criteria	Project activity	Criteria is met?	Project participants should document in the CDM-PDD which scenario applies and clearly describe the situation before and after the start of implementation of the project activity, preferably by providing similar diagrams as contained in the appendix, which provides an example for application of Scenario 2	The PP has documented in the PD section 2.2 that the project applied scenario 1. In baseline scenario the wastewater discharged from starch plant is directed to an existing cascade open lagoon system under anaerobic condition. As part of the project activity, the new anaerobic digesters were installed. Flaring of excess biogas will only occur in times when the starch production process is not in operation. The treated wastewater will be reused internally in starch factory , washing of cassava roots and plantation.	PP is requested to clarify the cases where solid materials are separated before directing the waste water to the open lagoons. The treatment of solid material is not clear.	CAR-1 OK
Applicability criteria	Project activity	Criteria is met?									
Project participants should document in the CDM-PDD which scenario applies and clearly describe the situation before and after the start of implementation of the project activity, preferably by providing similar diagrams as contained in the appendix, which provides an example for application of Scenario 2	The PP has documented in the PD section 2.2 that the project applied scenario 1. In baseline scenario the wastewater discharged from starch plant is directed to an existing cascade open lagoon system under anaerobic condition. As part of the project activity, the new anaerobic digesters were installed. Flaring of excess biogas will only occur in times when the starch production process is not in operation. The treated wastewater will be reused internally in starch factory , washing of cassava roots and plantation.	PP is requested to clarify the cases where solid materials are separated before directing the waste water to the open lagoons. The treatment of solid material is not clear.									

Checklist Question	Reference	MoV ¹	Comments	Conclusion
			The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1m; Depth of the baseline anaerobic open lagoons is approximately 10 m. and always greater than 1 m. Therefore, the project is satisfied for this applicability condition.	pp is requested to provide evidences for the depth of the lagoons.
			The residence time of the organic matter in the open lagoon or sludge pit system should be at least 30 days. As per the baseline lagoon design, the retention time of the cascade lagoon system is more than a year. Therefore, the project is satisfied for this applicability condition.	pp is requested to provide evidences for the design of the baseline lagoon system.
			Inclusion of solid materials in the project activity is only applicable where: (i) Such solid materials are generated by the industrial facility producing the wastewater; and (ii) The solid materials would be generated both in the project and in the baseline scenario Before and after the implementation of project activity, the solid materials are generated in the open lagoons. In normal situation, the sludge will not be removed from lagoons, it will be naturally decay at the bottom of lagoons. Therefore, the project is satisfied for this applicability condition.	The justification provided by the PP is not for the generation of solid materials but for the sludge generation. Please justify for the solid materials and support the same with evidences.
			The sludge produced during the implementation of the project activity is not stored onsite before land application to avoid any possible methane emissions from anaerobic The excess sludge from UASB reactors will be pumped out via sludge drainage system at the bottom of the reactors. The drainage pipe will be connected to the	pp is requested to clarify , how this will not lead to methane emissions

Checklist Question		Reference	MoV ¹	Comments			Conclusion
				degradation.	truck/tanker and transferred from project site without storage.	else where. Justify the same with evidences.	
B.1.4	Is the selected baseline one of the baseline(s) described in the methodology and this hence confirms the applicability of the methodology?	/01/ /05/	DR/C C	Yes, it is one of the baseline described in the methodology. However, please refer section B.1.3			~~CAR 1~~ OK
B.2 Project boundary							
B.2.1	Is the project boundary are clearly defined and in accordance with the applied methodology?	/01/ /05/	DR/C	The project boundary is clearly defined and is in accordance to the applied methodology. However, during the site visit, it was noted that covered lagoon 3 and 4 were added to the project boundary, which were not part of the project boundary as per the registered PDD, Further 5 more new boilers have been installed to generate heat from the biogas generated. PP is requested to clarify , if there is design change in the quantity of waste water flow and starch production, we has led to installation of 2 covered lagoons and 5 more boilers. Please support the same with evidences and confirm that it doesn't impact the ER calculations.			CL 2 OK
B.2.2	What are the project's system boundaries (components and facilities used to mitigate GHGs)?	/01/ /05/	DR/C	The spatial extent of the project boundary includes: • The site where the wastewater is treated in both the baseline and the project scenario; • Any on-site facilities to generate heat that is used by the wastewater treatment systems; • Also, the anaerobic digester, the heat generation equipment and/or the flare installed under the project activity; PP is requested to provide the operational license of the plant, clarify if an overhaul was carried out for the boilers , also provide the boiler inspection certificates, an updated ERPA and UASB specifications.			CL 3 OK
B.2.3	Which sources are identified for the project? Does the	/01/ /05/	DR/C	Please refer section B.2.1			CL 2

Checklist Question	Reference	MoV ¹	Comments	Conclusion
				OK
B.2.4	/01/ /05/	DR/C	Not applicable, since the PP has used the tool “ project and leakage emissions from anaerobic digesters” for electricity consumption calculation.	OK
B.2.5	/01/ /05/	DR/C	The validation did not reveal other emissions sources not foreseen by the methodologies that may question the applicability of the methodology nor sources that may contribute more than 1% to the estimated emission reductions of the project.	OK
B.3 Identification of the Baseline Scenario				
B.3.1	/01/ /05/	DR/C	PP has tried to identify the most plausible baseline scenario as per the steps provided in the methodology AM0014, version 06.0. Noted that in identifying the scenarios, PP has not considered sludge, since the project applies only to scenario 1 of table-2, Electricity generation is not considered since the captured biogas will be utilized in the co-fired boiler along with heavy fuel oil to generate steam and hot air for the starch plant, while in the pre-project scenario only heavy fuel oil is utilized. However, it is not clear on what basis the treatment of solid materials have been eliminated from the identification of plausible alternative. PP is requested to provide copies of the applicable laws, which do not allow to discharge effluent outside the factory, to dispose the sludge from wastewater treatment by using the appropriate method which does not create the hazard to public. Further as per the methodology prohibitive barriers needs to be eliminated by applying step-3 of the latest version of the “tool for the demonstration and assessment of additionality”. The same is not transparent in the PD. PP	CAR-2 OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
				is requested to justify the same with supporting evidences. It is also noted that the Step-4 of “compare economic attractiveness of remaining alternatives is not justified as per the parameters mentioned in step-4 of the methodology.	
B.3.2	How have the other baseline scenarios been eliminated in order to determine the baseline?	/01/ /05/	DR/C	Please refer section B.3.1	~~CAR-2~~ OK
B.3.3	What is the baseline scenario? Is the determination of the baseline scenario in accordance with the guidance in the methodology?	/01/ /05/	DR/C	Please refer section B.3.1	~~CAR-2~~ OK
B.3.4	Has the baseline scenario been determined using conservative assumptions? Does the baseline scenario sufficiently take into account relevant national and/or sectoral policies (E+ / E-), macro-economic trends and political aspirations?	/01/ /05/	DR/C	Please refer section B.3.1	~~CAR-2~~ OK
B.4 Algorithms and/or formulae used to determine emission reductions					
B.4.1 Baseline emissions					
B.4.1.1	Are the steps and equations applied to calculate the baseline emissions in compliance with the requirements of selected baseline and monitoring methodology?	/01/ /05/ /15/	DR/C C	1. It is noted that $COD_{out,x}$: Calculated from $COD_{in,x}$ with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% and $COD_{in,x}$: From operating data of 2006. PP is requested to clarify, how these measurements are as per measurement methods provided in para 78 of the methodology. 2. PP to clarify on, how the value 1 is applicable to the parameters “discount factor for historical	~~GL-4~~ OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
				information”. 3. Provide evidences to support the average depth of the lagoons. 4. PP is request to clarify on how the value used for $\eta_{BL, boiler}$ is as per the “ tool to determine the baseline efficiency of thermal or electricity generation system, version 01. 5. Please provide evidences for the values $F_{PJ, dig, m}$, UASB no.1 : 41,289 and UASB no.2 : 68,700 6. Please provide evidences for the values used in COD entering the project and COD leaving the project. 7. PP is requested to clarify, if the volume of biogas sent to the boilers is the volume of biogas combusted, which nothing but the volume is used to heat generation. As per the ER calculations the volume of biogas sent to the boilers is monitored at GM4 and GM5. During the site visit as well as from the project boundary diagram, it is understood that GM4 and GM5 measures the biogas sent to the boilers, however, it is not clear on how the biogas combusted in boilers for heat generation is measured or monitored. Further PP is requested to clarify on why the NCV of methane is not used in the calculations of $HG_{PJ, y}$. 8. Please provide evidences for the values used for $F_{biogas, flare, y}$. 9. Please provide evidences for the values used for $W_{CH4, biogas, y}$ in percentage.	
B.4.1.2	Have conservative assumptions been used when calculating the baseline emissions and are the	/01/ /15/	/05/ C	Please refer section B.4.1.1	CL-4

Checklist Question		Reference	MoV ¹	Comments	Conclusion
	uncertainty estimates properly addressed? Are all the values used in the PDD considered reasonable in the context of the proposed project activity?				OK
B.4.1.3	Baseline Emissions estimated (in case of different components applied please make them transparent).	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~ OK
B.4.2 Project emissions					
B.4.2.1	Are the steps and equations applied to calculate the project emissions in compliance with the requirements of selected baseline and monitoring methodology? Are all the values used in the PDD considered reasonable in the context of the proposed project activity?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~ OK
B.4.2.2	Have conservative assumptions been used when calculating the project emissions and are the uncertainty estimates properly addressed?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~ OK
B.4.2.3	Project emissions estimated	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~ OK
B.4.3 Leakage					
B.4.3.1	Are the steps and equations applied to calculate the leakage in compliance with the requirements of selected baseline and monitoring methodology? Are all the values used in the PDD considered reasonable in the context of the proposed project activity?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~ OK
B.4.3.2	Have conservative assumptions been used when calculating the leakage and are the uncertainty	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~GL-4~~

Checklist Question		Reference	MoV ¹	Comments	Conclusion
	estimates properly addressed?				OK
B.4.3.3	Leakage estimated	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~CL-4~~ OK
B.4.4 Emission reductions					
B.4.4.1	Has the methodology been correctly applied to calculate the emission reductions and can this be replicated by the data provided in the PDD and supporting files to be submitted for registration?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~CL-4~~ OK
B.4.4.2	Are all the assumptions and data used by the project participants listed in the PDD including their references and sources?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~CL-4~~ OK
B.4.4.3	Is all the documentation used by the project participants as the basis for assumptions and source of data quoted and interpreted in the PDD?	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~CL-4~~ OK
B.4.4.4	Emission Reductions estimated	/01/ /15/	/05/ C	DR/C C Please refer section B.4.1.1	~~CL-4~~ OK
B.5 Monitoring plan					
B.5.1 Parameters ex-ante					
B.5.1.1	Does the monitoring plan contain the list of all parameters required by the approved methodology and by the applicable methodological tool?	/01/ /05/	DR/C C	Yes, the monitoring plan contains the list of all parameters required by the approved methodology and also as per the applicable methodological tools.	OK

Checklist Question	Reference	MoV ¹	Comments	Conclusion
B.5.1.2 How were the parameters available at validation verified?	/01/ /05/	DR/C C	Following are the parameters available at the validation. 1. $COD_{out,x}$ and $COD_{in,x}$: Calculated from $COD_{in,x}$ with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% and $COD_{in,x}$: From operating data of 2006. PP is requested to clarify, how these measurements are as per measurement methods provided in para 78 of the methodology. 2. PP to clarify what on basis the value of X is chosen as one year. 3. PP to clarify on, how the value 1 is applicable to the parameters “discount factor for historical information”. 4. B_o : 0.21 is taken as per 2006 IPCC Guidelines. However, PP to clarify on why a value of 0.25 is not used. 5. $EF_{CO2,FF,boiler}$: PP is requested to clarify why an actual measured or local data or regional data is not used. 6. GWP considered is 25, which is as per IPCC, the same is accepted as it is as per the 2nd commitment period. 7. Universal ideal gases constant: 8314 Pa.m³/kmol.K, taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous team “, version 02. 8. Molecular mass of greenhouse gas I, taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous team “, version 02. 9. P_n, 101,325 Pa taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous team “, version 02. 10. T_n, 273.15 K taken as per “Tool to determine the mass flow of greenhouse gas in as gaseous	~~CL5~~ OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
				team “, version 02. 11. ρ_{CH_4}, :.00067 t CH₄ / Nm³ CH₄ taken as per tool “Project and leakage emissions from anaerobic digesters” version 01.0.0 12. $EF_{CH_4, default}$: :0.5 UASB type digesters, floating gas holders with no external water seal; taken as per IPCC 2006 guidelines. 13. $F_{EC, default}$: 0.01 - UASB / filter bed reactor for wastewater / fluidized bed reactor as per “Project and leakage emissions from anaerobic digesters” version 01.0.0 14. $EF_{EL, default}$: A value of 1.3 tCO₂ / MWh is applied as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. However, PP is requested to justify on the selection of value 1.33 tCO₂ / MWh.	
B.5.1.3	Which default data have been selected and applied?	/01/ /05/	DR/C C	Please refer section B.5.1.2	~~CL5~~ OK
B.5.1.4	Are all the values used in the PDD considered reasonable in the context of the proposed project activity?	/01/ /05/	DR/C C	Please refer section B.5.1.2	~~CL5~~ OK
B.5.2 Parameters ex-post					
B.5.2.1	Does the monitoring plan described in the PDD comply with the requirements of the methodology and the applicable methodological tool?	/01/ /05/	DR/C C	Please refer section B.4.1.1	~~CL4~~ OK
B.5.2.2	Does the monitoring plan contain all necessary	/01/ /05/	DR/C	Please refer section B.4.1.1	~~CL4~~

Checklist Question	Reference	MoV ¹	Comments	Conclusion
parameters and are they clearly described?		C		OK
B.5.2.3 Is the measurement equipment described? Is the accuracy of the measurement equipment addressed and deemed appropriate? Are the requirements for maintenance and calibration of measurement equipment described and deemed appropriate?	/01/ /05/	DR/C C	The following are the measuring equipment's: 1. Quantity of waste water that is treated in the anaerobic digester in the project activity in month <i>m</i> : is measured by means of flow meters FM3 and FM4. Two flow meters installed each for UASB1 and UASB2. The calibration of the flowmeters will be carried out once in three years, which is as per the industry standards. The Parameter is monitored continuously, aggregated monthly and reported annually for calculations. 2. Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month <i>m</i> is measured by means of Spectrophotometer for Colorimetric analysis ,which as per the USEPA approved for wastewater analysis (standard method 5220 D).<i>The calibration of spectrophotometer will be carried out once in three years. PP is requested to clarify, this is as per, which standard and provide evidence of the same.</i> The parameter is measured three times in a day and average monthly values are taken. 3. Average temperature at the project site in month <i>m</i>: <i>is taken as per the national published report. PP is requested to clarify on how it ensures that the parameter is continuously monitored.</i> 4. Net quantity of heat generated in year <i>y</i> with biogas from the new anaerobic digester: As per the PD, biogas flowmeters GM4 and GM5 is used in measuring the biogas sent to the boilers. However, it is not clear , if this is the same quantity of biogas that is combusted in the boilers. Thus not clear on what is the biogas combusted in each boiler. Moreover, GM4 and GM5 also measures the biogas capture from covered lagoon 3 and 4 , which is not part of the boundary.	CL6 OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
				5. The parameters associated with sludge are not monitored since there is no sludge generated and treated in the project boundary. 6. Total amount of biogas collected in the outlet of the new digester in year y: measured by means of biogas flow meters GM1 and GM2. The calibrations of the same will be performed once in three years as per the industry standards. <i>The Parameter will be monitored continuously and aggregated monthly and reported annually for calculations. PP is requested to make the same transparent in the PD.</i> 7. Concentration of methane in the total biogas supply in the outlet of the new digester: measured using continuous gas analyzer. <i>The calibration of the gas analyzer will be performed once in three years, as per the industry standard. PP is requested to provide copy of the same.</i> The measuring frequency is either with continuous analyzer or alternatively with periodical measurement at 95% confidence level. 8. Volumetric flow of the residual gas on a dry basis at reference conditions: measured by biogas flow meters (GM6) installed at the flare. Flow meters will undergo maintenance/calibration subject to appropriate industry standards, at least once every 3 years. This Parameter is monitored continuously but aggregated annually for calculations.	
B.5.2.4	Is the monitoring and recording frequency adequate for all monitoring parameters? Is it in line with the monitoring methodology?	/01/ /05/	DR/C C	Please refer section B.5.2.3	CL6 OK
B.5.2.6	How has it been assessed that the monitoring arrangements described in the monitoring plan are feasible within the project design? Please confirm the	/01/ /05/	DR/C C	Please refer section B.5.2.3	CL6 OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
	ability of the project participants to implement the described monitoring plant.				
B.5.3 Management/Quality Assurance/Quality Control					
B.5.3.1	Are procedures identified for day-to-day records handling (including what records to keep, storage area of records and how to process performance documentation)?	/01/ /05/	DR/C C	The plant operator carries out the daily operation recording and laboratory analysis. The monitored data is collected and recorded in the excel spread sheet by chief of biogas operator. The report will be checked and approved by the plant supervisor. The summary reports are submitted to management on daily basis. The same was also checked during the site visit and found to be acceptable.	OK
B.5.3.2	Are the data management and quality assurance and quality control procedures sufficient to ensure that the emission reductions achieved by/resulting from the project can be reported ex post and verified?	/01/ /05/	DR/C C	Noted that all equipment calibrations are controlled by the biogas plant supervisor. All documents are managed according to the requirements of ISO14001. PP is requested to provide the latest certificate of ISO 14001. Further, during the site visit it was also noted that the PP is having the following data storage and back up. • The original log sheets are collected and stored at biogas plant office by Chief of biogas operator. • The data in excel format is stored at two computers at biogas plant. The backup of hard disk is done by IT department on monthly basis. • The data submitted to consultant is stored and backup via consultant's internal server on monthly basis.	OK

Checklist Question		Reference	MoV ¹	Comments	Conclusion
B.5.3.3	Will all monitored data required for verification and issuance be kept for two years after the end of the crediting period or the last issuance of VERs, for this project activity, whichever occurs later?	/01/ /05/	DR/C C	Yes, all monitored data required for verification and issuance be kept for two years after the end of the crediting period or the last issuance of VERs, for this project activity, whichever occurs later	OK
C.1 Crediting period					
C.1.1	What is the expected crediting starting date of the proposed project activity?	/01/ /05/	DR/C C	The project initially had renewable crediting period for 7 years from 1st January 2004 to 31st December 2010 (as per the registered VCS PD). As per the VCS standard version 3.22 'The Project Crediting Period for the VCS version 1 shall be the same as for the VCS 2007.1 commencing at the specific Project Crediting Period Start Date'. The crediting period for a VCS version 1 project is 10 years, twice renewable, starting at the beginning of the original project crediting. Thus, the first crediting period was updated from 1st January 2004 to 31st December 2023 for this project activity. The same was accepted since , a verification has already been performed for the MP 2013 and also the report is available in VCS website. The revised PD, the second crediting period is from 1st January 2014 to 31st December 2023. The same was accepted by RINA.	OK
C.1.2	What is the length of the crediting period? Is it clearly defined and reasonable?	/01/ /05/	DR/C C	Yes, please refer section C.1.1	OK

TABLE 2 RESOLUTION OF CORRECTIVE ACTION REQUESTS AND CLARIFICATION REQUESTS

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
CAR 1 1. PP is requested to clarify the cases where solid materials are separated before directing the waste water to the open lagoons. The treatment of solid material is not clear. 2. PP is requested to provide evidences for the depth of the lagoons. 3. PP is requested to provide evidences for the design of the baseline lagoon system. 4. The justification provided by the PP is not for the generation of solid materials but for the sludge generation. Please justify for the solid materials and support the same with evidences. 5. PP is requested to clarify , how this will not lead to methane emissions else where. Justify the same with evidences.	B.1.3, B.1.4	1. The justification for solid materials separation is provided in section 2.2 of the PD. 2. The layout of open lagoons with depth is submitted. 3. The baseline information is added in appendix 2 of the PD. The main source is from the operating data 2006 , referred to page 16 of the 1st monitoring report². 4. The justification for solid materials separation is provided in section 2.2 of the PD. Item d) of table 2 in section 2.2 of PD is revised.	1 and 4. Accepted. 2 and 3. checked, the as built drawing, dated 13/01/2013. 5. It is checked that the excess sludge (granular) from UASBs is owned and copyright by technology provider which will be only used as seeding material for start up the new UASBs. The same was checked with the BOT contract for biogas plant General Starch Company Limited , dated 4th January 2005. CAR 1 is closed.
CAR 2 PP has tried to identify the most plausible baseline scenario as per the steps provided in the methodology AM0014, version 06.0. Noted that in identifying the scenarios, PP has not considered sludge, since the project applies only to scenario 1 of table-2, Electricity generation is not considered since the captured biogas will be	B.3.1, B.3.2, B.3.3,	- The justification for solid materials separation is provided in section 2.2 of the PD. - The operating license with attachment is submitted. The description in step 3 and step 4 of the baseline scenario is revised.	-Accepted. -The operating license with attachment is submitted. -Step 3 and step 4 has been demonstrated with the evidences. The same checked and accepted. CAR 2 is closed.

² http://www.vcsprojectdatabase.org/#/project_details/82

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
utilized in the co-fired boiler along with heavy fuel oil to generate steam and hot air for the starch plant, while in the pre-project scenario only heavy fuel oil is utilized. However, it is not clear on what basis the treatment of solid materials have been eliminated from the identification of plausible alternative. PP is requested to provide copies of the applicable laws, which do not allow to discharge effluent outside the factory, to dispose the sludge from wastewater treatment by using the appropriate method which does not create the hazard to public. Further as per the methodology prohibitive barriers needs to be eliminated by applying step-3 of the latest version of the “tool for the demonstration and assessment of additionality”. The same is not transparent in the PD. PP is requested to justify the same with supporting evidences. It is also noted that the Step-4 of “compare economic attractiveness of remaining alternatives is not justified as per the parameters mentioned in step-4 of the methodology.			
CL 1 The PD is of version 01. However, the date of the document is not transparent.	A.1.1.	The date of PD issued in updated.	The date is updated as 03/12/2015. The same is accepted. CL1 is closed.
CL 2 The project boundary is clearly defined and is in accordance to the applied methodology. However, during the site visit, it was noted that covered lagoon 3 and 4 were added to the project boundary, which were not part of the project boundary as per the registered PDD, Further 5	B.2.1, B.2.3	- The new covered lagoons and the new additional boilers are from the increment of starch production capacity. However, the new flow meters have been installed for measuring the amount of wastewater and biogas at both cover lagoon. The ER calculation will consider only 2 UASBs	RINA accepts the justification provided by the PP. During the site visit and as per the ER spread sheets, though the project involves construction on two covered lagoons CL3 and CL4, the biogas captured from the same is not accounted in the ER calculations.

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
more new boilers have been installed to generate heat from the biogas generated. PP is requested to clarify , if there is design change in the quantity of waste water flow and starch production, we has led to installation of 2 covered lagoons and 5 more boilers. Please support the same with evidences and confirm that it doesn't impact the ER calculations.		which are not changed in design and configuration since the implementation. The capacity and efficiency of UASB system is the remained the same as previous. - The summary of production data from the verified monitoring reports (4th, 5th and 6th)³ showing that ; a) The annual average starch production capacity is still lower than 600 t/d , by assuming factory did not shutdown. b) The wastewater factor treated by UASB has been reduced after the installation of CL3 in Sep-13 , only half from the start-up period (10.65 to 4.64 m3/t). c) The CL3 and CL4 have been installed in order to treat the additional wastewater which over the capacity of two UASBs. The main wastewater treatment has been shifted to CL3 and CL4 (in future). d) In can be concluded that the capacity increment of starch plant does not impact the amount of wastewater and biogas at UASB , as well as the amount of achieved emission reductions.	RINA further checked the GSL: Summary production data from the verified monitoring reports and confirms that the annual average starch production capacity is lower than 600 t/d and also the intake of waste water treated in UASB has been reduced. Thus RINA accepts the justification provided by the PP and confirms that the increase in the starch production and waste water doesn't impact the ER calculations. CL 2 is closed.
CL 3 PP is requested to provide the operational license	B.2.2	- Referring to the Announce of Department of Industrial Works ⁴ about	RINA checked the boiler inspection certificates of all the 12 boilers and

³ The summary production data is spreadsheet format is submitted. Which can be cross-checked with the verified MRs.

⁴ http://php.diw.go.th/safety_en/wp-content/uploads/2014/12/Rules2012.pdf

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
of the plant, clarify if an overhaul was carried out for the boilers , also provide the boiler inspection certificates, an updated ERPA and UASB specifications.		Rules and procedures for the approval of the boiler , for liquid of gas fuel boiler must be inspected and reported within a maximum period of 5 years. Additionally , as per the conditions determined in the 5th extension as the attachment of operation license , item 1.5 : The factory has to conduct and report the safety inspection for boilers every year. During the inspection , the boiler must be stop and cool down. The overhaul will be done in the same time. The plan and record of maintenance activity will be attached with the annual inspection report submitted to DIW. - The ERPA between South Pole and Papop is submitted. The specification of UASB is described in the proposal by Papop	confirms that the boilers are in good condition and can be in operation also for the next crediting period. -RINA checked the ERPA , dated 25/09/2007 and also the specifications of UASB as provided in the technical proposal provided by Papop t GSL. The same is accepted and CL3 is closed.
CL 4 1. It is noted that $COD_{out,x}$: Calculated from $COD_{in,x}$ with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% and $COD_{in,x}$: From operating data of 2006. PP is requested to clarify, how these measurements are as per measurement methods provided in para 78 of the methodology.	B.4.1.2, B.4.1.3, B.4.2.1, B.4.2.2, B.4.2.3, B.4.3.1, B.4.3.2, B.4.3.3, B.4.4.1, B.4.4.2, B.4.4.3, B.4.4.4,	1. The removal ratio of 87.88% is from NM0041-rev02 : New Methodology Baseline from Korat Waste To Energy Project Thailand⁵ which is the Normative Reference for this applied methodology , ACM0014. This figure is the fraction of COD likely biodegraded in the open pond system for wastewater from starch production in Thailand. Which is the same baseline situation as this project activity. As per the information from the project	1. $COD_{in,x}$ is taken from the operating data of 2006 and a removal ratio of 87.88% is from NM0041-rev02 : New Methodology Baseline from Korat Waste To Energy Project Thailand⁸ which is the Normative Reference for this applied methodology , ACM0014. This figure is the fraction of COD likely biodegraded in the open pond system for wastewater from starch production in Thailand. Which is the same baseline situation as this project activity. As per the COD test

⁵ <https://cdm.unfccc.int/methodologies/PAmethodologies/pnm/byref/NM0041-rev2>

⁸ Table 6 , page 26 of https://cdm.unfccc.int/filestorage/F/S/ /FS_558183733/ESL%2C%20KWTE%20NMB%2C%20Mar%2005%20v3.pdf?t=Wnh8bng4YXMwfdBANDgYp3hu86aW6mlgsV5C

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
2. PP to clarify on, how the value 1 is applicable to the parameters “discount factor for historical information”. 3. Provide evidences to support the average depth of the lagoons. 4. PP is request to clarify on how the value used for $\eta_{BL,boiler}$ is as per the “ tool to determine the baseline efficiency of thermal or electricity generation system, version 01. 5. Please provide evidences for the values $F_{PJ,dig,m}$, UASB no.1 : 41,289 and UASB no.2 : 68,700 6. Please provide evidences for the values used in COD entering the project and COD leaving the project. 7. PP is requested to clarify, if the volume of biogas sent to the boilers is the volume of biogas combusted, which nothing but the volume is used to heat generation. As per the ER calculations the volume of biogas sent to the boilers is monitored at GM4 and GM5. During the site visit as well as from the project boundary diagram, it is understood that GM4 and GM5 measures the biogas sent to the boilers, however, it is not clear on how the biogas combusted in boilers for heat generation is measured		owner , most of the treated wastewater to be reused in factory as well as used for plantation will be from open lagoon no.9. This means from open lagoon no.10 onwards is mainly for rain water storage , only little amount of wastewater overflow from lagoon no.9. So the wastewater analysis results from the last open lagoon could not represent the actual $COD_{out,x}$ from the last open lagoon at the time before the implementation of UASB system. As per the COD test by external laboratory (once a year) during 2008 to 2013 , the COD reduction efficiency by lagoon is above 90%⁶ which is higher than the estimated value , 87.88%. Hence this approach is the most conservative and also applied for previous validation of this project activity. 2. As the data for $COD_{in,x}$ is from the operation data in 2006 while the $COD_{out,x}$ is calculated value. The discount factor is revised to 0.89 for conservativeness. 3. The plan of open lagoon is submitted. 4. Since the commission report of the boilers does not clearly mention about the efficiency. So ,referring to table 1 in page 7/7 of tool⁷ , the default baseline efficiency for new oil fired boiler at 90% is applied for ER calculation. 5. The source of information is	by external laboratory (once a year) during 2008 to 2013 , the COD reduction efficiency by lagoon is above 90% which is higher than the estimated value , 87.88%. Thus the value of 87.88% is accepted, which is conservative. 2. The discount factor is revised to 0.89 for conservativeness. The same is accepted. 3. Checked the as built drawing of 34 open lagoons and found to be satisfactory. 4. Default baseline efficiency for new oil fired boiler at 90% is applied for ER calculation, which is as per the tool. 5. The evidences for the values of $F_{PJ,dig,m}$, UASB no.1 : 41,289 and UASB no.2 : 68,700 is taken from appendix 1 of the PD referred from page 16 of the 1st monitoring report. The same is validated and verified , hence accepted. 6,8,9: the source for the input values used in ER calculations are referred from appendix 1 of the PD referred from page 16 of the 1st monitoring report. The same is validated and verified , hence accepted. 7.PP confirms in the PD that the

⁶ The COD test report from ALS laboratory from 2008 to 2013 are submitted.

⁷ <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-09-v1.pdf>

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
or monitored. Further PP is requested to clarify on why the NCV of methane is not used in the calculations of $HG_{PJ,y}$. 8. Please provide evidences for the values used for $F_{biogas,flare,y}$. 9. Please provide evidences for the values used for $W_{CH4,biogas,y}$ in percentage.		presented in appendix 1 of the PD referred from page 16 of the 1st monitoring report. 6. The source of information is presented in appendix 1 of the PD referred from page 16 of the 1st monitoring report. 7. There is procedure available which will be applied to cross-check between the amount of biogas sent to boilers and biogas consumed by boilers. In the boiler consumption report , the biogas consumed at each boiler is calculated as per the actual running hours. The total biogas consumption of all boiler will be calculated and compared with the total biogas supplied , GM4 and GM5. The result is there is no difference between two sources of data. Hence , it can be concluded that , in case of not biogas sent to flare , all the biogas sent from blowers (monitored by GM4 and GM5) will be all burnt at boilers without any leakage. The NCV of methane from http://www.engineeringtoolbox.com/fuels-higher-calorific-values-d_169.html is replaced the NCV of biogas. The calculation description in PD is revised accordingly. 8. The source of information is presented in appendix 1 of the PD referred from page 16 of the 1st monitoring report. The source of information is presented in appendix 1 of the PD referred from page 16 of the 1st monitoring report.	monitoring of biogas combusted will be carried out as per the methodology. CL 4 is closed.
CL 5	B.5.1.2, B.5.1.3,	1. Same as response for CL4.	1, 2, 3 and 4 , justification provided by PP

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
1. COD_{out,x} and COD_{in,x}: Calculated from COD_{in,x} with the removal ratio for lagoon from CDM project no.1040 – Korat Waste To Energy at 87.88% and COD_{in,x} : From operating data of 2006. PP is requested to clarify, how these measurements are as per measurement methods provided in para 78 of the methodology. 2. PP to clarify what on basis the value of X is chosen as one year. 3. PP to clarify on, how the value 1 is applicable to the parameters “discount factor for historical information”. 4. B₀ : 0.21 is taken as per 2006 IPCC Guidelines. However, PP to clarify on why a value of 0.25 is not used. 5. EF_{CO2,FF,boiler}: PP is requested to clarify why an actual measured or local data or regional data is not used. 6. EF_{EL,default} : A value of 1.3 tCO₂ / MWh is applied as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. However, PP is requested to justify on the selection of value 1.33 tCO₂ / MWh.	B.5.1.4	2. Since the COD_{in,x} is from 1-year operation data. The X – one year is chosen. 3. Same as response for CL4. 4. The B₀ is corrected to 0.25 , as per a default value defined by the methodology. 5. Because the actual measure data or local data or regional data is not available. As per the tool , <i>in its absence , IPCC default values can be used.</i> 6. From the defined tool⁹ , the scenario A is selected as the project consumed the electricity from grid. And the default value of 1.3 is applied for the chosen option A2 condition (b) ; <i>Scenario A applies to: both baseline and project (and/or leakage) electricity consumption sources; and the electricity consumption of the project and leakage sources is greater than the electricity consumption of the baseline sources.</i>	is accepted. 5. RINA confirms that since a local or regional data was not available , PP has applied the default value IPCC for EF_{CO2,FF,boiler}. 6. A default value of 1.3 tCO₂ / MWh is applied as per the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. The same is accepted, as project applies scenario A of the tool, since the project consumes electricity from the grid. CL 5 is closed.
CL 6 1. The calibration of spectrophotometer will be carried out once in three years. PP is	B.5.2.3, B.5.2.6	1. The calibration frequency is not recommended by the manufacturer. As per the technical document ¹⁰ says , the entire measurement device required	1. The calibration frequency of once in three years for the spectrophotometer is taken as per the previous validated and registered PD and also confirmed in the

⁹ <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v1.pdf>

¹⁰ <http://www.prowater.nl/General-2013-MD200.pdf-f519>

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
requested to clarify, this is as per, which standard and provide evidence of the same. 2. Average temperature at the project site in month <i>m</i>: <i>is taken as per the national published report. PP is requested to clarify on how it ensures that the parameter is continuously monitored.</i> 3. Net quantity of heat generated in year <i>y</i> with biogas from the new anaerobic digester: As per the PD, biogas flowmeters GM4 and GM5 is used in measuring the biogas sent to the boilers. However, it is not clear, if this is the same quantity of biogas that is combusted in the boilers. Thus not clear on what is the biogas combusted in each boiler. Moreover, GM4 and GM5 also measures the biogas capture from covered lagoon 3 and 4, which is not part of the boundary. 4. Total amount of biogas collected in the outlet of the new digester in year <i>y</i>: measured by means of biogas flow meters GM1 and GM2. The calibrations of the same will be performed once in three years as per the industry standards. <i>The Parameter will be monitored continuously and aggregated monthly and reported annually for calculations. PP is requested to make the same transparent in the PD.</i> 5. The calibration of the gas analyzer will be performed once in three years, as per the industry standard. PP is requested to		absolutely no maintenance and the tests are conducted using either Lovibond tablet reagents with long-term stability and a guaranteed minimum 5 or 10 year shelf life or using liquid reagent. The project owner also use the Lovibond's reagent with Certificate Of Analysis (COA) for COD test. The calibration frequency of once per three years has been set up since the previous crediting period as. With this calibration gap, the occurred error¹¹ always within the defined maximum range at 3.5%¹². 2. The annual average temperature at Chok Chai Station is complied by Statistical Forecasting Bureau, National Statistical Office. The source of data is from Meteorological Department, Ministry of Information and Communication Technology. While the monthly average data is reported by Ministry of Energy from the same data source. Both data sources comply the data from the central unit which can report the real-time temperature. Hence it can be assumed that the temperature presented on both source are from the continuously monitored information. 3. Additional from the response of CL4, the biogas sent from CL3 and CL4 will be deducted from GM4 and GM5 in the monitoring report. The same approach has been used since the 4th verification of	previous verification reports. 2. RINA accepts the justification provided by PP.

¹¹ From calibration report No.560/2013 issued on 24-Aug-2013, the reading is 5,030 mg/l which is within acceptable range of 4,475 – 5,525 mg/l.

¹² http://dl.lovibond.com/instructions/cod/ins_md200_00386324_cod_multi_lovi.pdf

Corrective action and/ or clarification requests	Reference to Table 2	Response by project participants	Validation Conclusion
provide copy of the same.		the 1st crediting period. 4. The monitoring plan for $F_{\text{biogas},y}$ or $Q_{\text{biogas},y}$ (GM1 and GM2) has been described in section 4.2 of PD. The calibration frequency of once per three years has been set up since the previous crediting period. With this calibration gap , the occurred error always within the defined maximum range¹³. The calibration report and technical specification of the gas analyzer is submitted. The calibration frequency is not recommended by manufacturer. The calibration frequency of once per three years has been set up since the previous crediting period. With this calibration gap , the occurred error always within the defined maximum range¹⁴.	3. The approach provided by PP is accepted RINA. 4. The calibration of flow meters will be performed in once in three years, as per the previous registered PD and verified verification reports. CL 6 is closed.

¹³ Referring to the calibration report of GM1 (as example) , issued on 01-Nov-2012 , the maximum error as found is 0.01% which is less than 1.5% of tolerance.

¹⁴ Referring to the calibration report of VISIT gas analyzer issued on 19-Oct-2012 , the average error for CH4 reading is the 0.16% which is less than the tolerance of 2%.



RINA

CERTIFICATO DI QUALIFICA QUALIFICATION CERTIFICATE

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

Rekha Menon

è qualificato come¹:
is qualified as:

CDM-TEC, -VAL, -VER, -TL

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

1.2, 2.1, 13.1, 13.2, 14.1

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

in accordo alle istruzioni della Divisione Certificazione.
in accordance with the instructions of the Certification Division.

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
0	06-03-2008	-
10	22-12-2014	Update qualification according to AS ver.6.0

Il Resp. QPT
Head of QPT

¹ Legend:

VAL: Validator
VER: Verifier
TEC: Technical Expert
TL: Team Leader
FIN-EXP: Financial Expert
DET: Determiner

CDM: Clean Development Mechanism
VCS : Verified Carbon Standard:
GS: Gold Standard
SCS: SocialCarbon Standard
JI: Joint Implementation

RINA Services S.p.A. è accreditato da UNFCCC, quale Entità Operativa Designata (DOE), per condurre la Validazione e la Verifica di Progetti CDM, da VCSA per condurre la Validazione e la Verifica di Progetti VCS, da GS Foundation, per condurre la Validazione e la Verifica di Progetti GS, da Ecologica Institute per condurre la Validazione e la Verifica di rapporti SCS

RINA Services S.p.A. is accredited by the UNFCCC, as Designated Operational Entity (DOE), to carry out Validation and Verification of CDM Projects, by the VCSA, to carry out Validation and Verification of VCS Projects, by the GS Foundation, to carry out Validation and Verification of GS Projects and by the Ecologica Institute, to carry out Validation and Verification of SCS Reports



RINA

CERTIFICATO DI QUALIFICA QUALIFICATION CERTIFICATE

Si attesta che il sig./sig.ra:

Amalorpavanathan Cyril Augustus Arokiasamy

We declare that Mr/Mrs/Ms:

è qualificato come¹:
is qualified as:

CDM-TEC, CDM-VAL, CDM-VER, CDM-TL,

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

1.1, 1.2, 3.1, 5.1, 13.1

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
3.1	Energy Demand	3
5.1	Chemical industry	5
13.1	Solid Waste and wastewater	13

in accordo alle istruzioni della Divisione Certificazione.
in accordance with the instructions of the Certification Division.

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
0	30/06/2010	-
12	22/12/2014	Updated qualification according to AS ver.6.0

Il Resp. QPT
Head of QPT

¹ Legend:

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VER: Verifier
TEC: Technical Expert
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RINA

**CERTIFICATO DI QUALIFICA
QUALIFICATION CERTIFICATE**

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

Isil Timuroglu

è qualificato come¹:
is qualified as:

**GS/VCS/SCS- TEC, VAL, VER, TL
Local expert (Turkish language),**

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

1.2, 13.1

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

in accordo alle istruzioni della Divisione Certificazione.
in accordance with the instructions of the Certification Division.

REVISIONE REVISION	DATA DATE	MOTIVAZIONI PER LA REVISIONE REASON FOR THE REVISION
-	13/02/2012	-
6	08/06/2015	Update qualification according to AS ver.6.0

Il Resp. QPT
Head of QPT

¹ Legend:

VAL: Validator
VER: Verifier
TEC: Technical Expert
TL: Team Leader
FIN-EXP: Financial Expert
DET: Determiner

CDM: Clean Development Mechanism
VCS : Verified Carbon Standard:
GS: Gold Standard
SCS: SocialCarbon Standard
JI: Joint Implementation

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RINA Services S.p.A. is accredited by the UNFCCC, as Designated Operational Entity (DOE), to carry out Validation and Verification of CDM Projects, by the VCSA, to carry out Validation and Verification of VCS Projects, by the GS Foundation, to carry out Validation and Verification of GS Projects and by the Ecologica Institute, to carry out Validation and Verification of SCS Reports