



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



Document Prepared By Swiss Carbon Value Ltd.
Technoparkstrasse 1, 8005 Zurich Switzerland
Phone +41 43 501 35 50 Fax +41 43 501 35 99
info@southpole.com www.southpole.com

Project Title	P.S.C Starch Wastewater Treatment and Biogas Utilization Project
Version	02
Report ID	01
Date of Issue	09-June-2020
Project ID	417
Monitoring Period	01-January-2019 to 30-November-2019
Prepared By	Swiss Carbon Value Ltd.
Contact	Technoparkstrasse 1, 8005, Zurich, Switzerland Email: registration@southpole.com Website: www.southpole.com

CONTENTS

1	PROJECT DETAILS.....	3
1.1	Summary Description of the Implementation Status of the Project.....	3
1.2	Sectoral Scope and Project Type	4
1.3	Project Proponent	4
1.4	Other Entities Involved in the Project	5
1.5	Project Start Date	5
1.6	Project Crediting Period	5
1.7	Project Location	5
1.8	Title and Reference of Methodology	6
1.9	Participation under other GHG Programs.....	6
1.10	Other Forms of Credit	6
1.11	Sustainable Development	7
2	SAFEGUARDS	8
2.1	No Net Harm.....	8
2.2	Local Stakeholder Consultation	8
2.3	AFOLU-Specific Safeguards	10
3	IMPLEMENTATION STATUS	10
3.1	Implementation Status of the Project Activity	10
3.2	Deviations	10
3.3	Grouped Projects.....	11
4	DATA AND PARAMETERS.....	14
4.1	Data and Parameters Available at Validation	14
4.2	Data and Parameters Monitored	20
4.3	Monitoring Plan	28
5	QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS.....	30
5.1	Baseline Emissions.....	30
5.2	Project Emissions.....	33
5.3	Leakage	38
5.4	Net GHG Emission Reductions and Removals.....	38

1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

P.S.C. Starch Products wastewater treatment and biogas utilization project, hereafter the project activity, involves biogas recovery and its utilization as a fuel in hot oil boiler and steam boilers. The project involves wastewater generation from two different manufacturing units turning out three products (i.e. starch, sweetener and ethanol).

The project was implemented at P.S.C Starch Products Public Company Limited on 28/04/2005 (project start date). In the starch unit, raw tapioca is fed into the processes to produce wet starch. For further processing, the wet starch is then separated into two parts, namely native tapioca starch and starch sugar. These two products are manufactured using different procedures. This process generates wastewater which is generated irrespective whether the wet starch is converted to native tapioca starch or is used as raw material for sweetener products. The production capacity of the starch factory is 200 metric tons of dry starch equivalent products per day, and 240 metric tons of sweetener products per day.

The Upflow Anaerobic Sludge Blanket (UASB) reactor was the first system to be implemented in April 2005. The UASBs are assigned to treat wastewater from starch factory. During the early stage of operation, the UASBs reactor could not reach expected performance and the project owner decided to install a covered lagoon (CL1) in order to pre-treat the wastewater before feeding it to UASBs. By 2006, a covered sheet was installed over the existing first open anaerobic lagoon to collect the biogas generated. Then covered lagoon 2 (CL2) was designed to receive wastewater from sweetener factory together with the effluent from the UASBs reactor. In October 2009, an ethanol plant started operation in line with these existing facilities, the project activity involved the construction of a new covered lagoon (CL3) with biogas recovery. The wastewater from ethanol plant has been taken into a covered lagoon 3 (CL3). In the absence of the project activity, the wastewater from the ethanol plant would have been treated in an open pond anaerobic system.

The biogas generated by the overall system (UASB + CL1 + CL2 + CL3) is being used at sweetener plant (steam boilers), starch plant (hot oil boiler) and sweetener plant (electricity generation). It was mentioned during the project validation that due to unsteady fuel mixture of biomass and coal, the components of electricity production and fuel replacement have not been claimed for emission reduction. Only biomass has been used as additional fuel in this monitoring period of project activity.

This monitoring report is for the fifth verification of this project. The project activity can achieve 59,738 tCO₂e in this monitoring period. The monitoring period starts from 01/01/2019 to 30/11/2019. Further background information on this project activity can be found on the VCS website: <https://registry.terra.org/app/projectDetail/VCS/417>

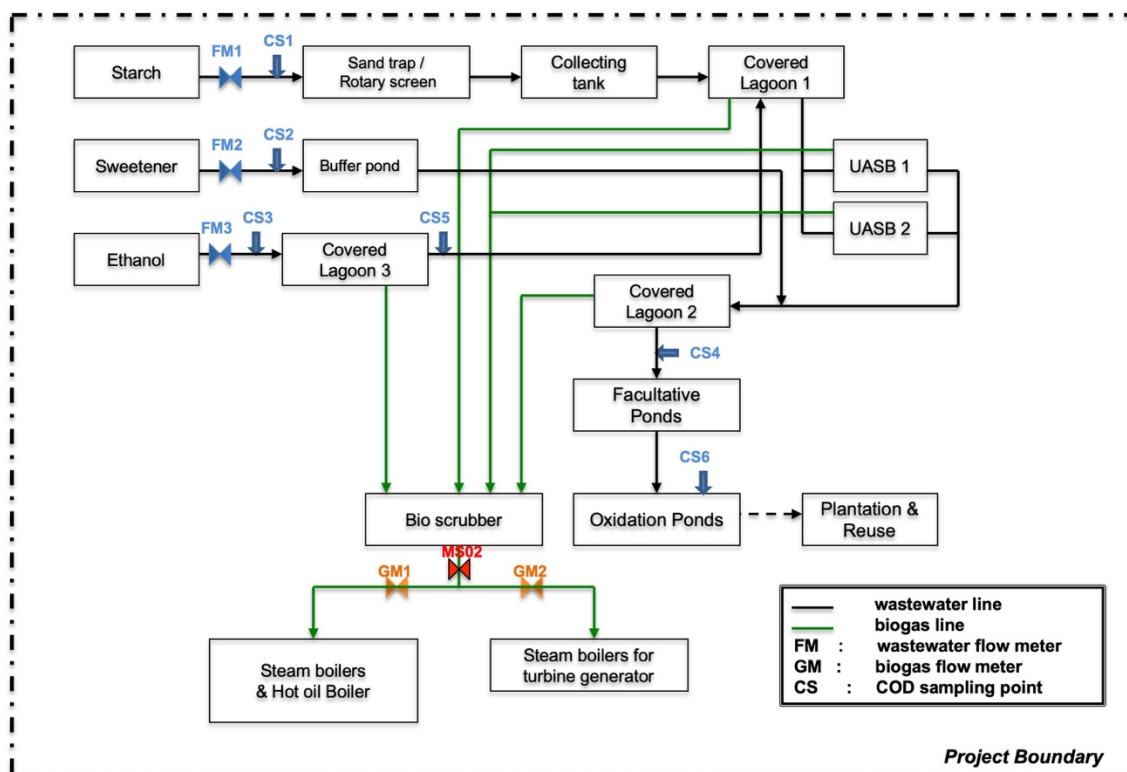


Figure 1 The project flow diagram

1.2 Sectoral Scope and Project Type

The approved CDM methodology has been applied to this project activity. According to Appendix B of the *Simplified Modalities and Procedures for Small-Scale CDM Project Activities*, the project type and category are defined as follows:

First Crediting Period

Methane destruction component

Category III.H Version: 13.0: Methane Recovery in Wastewater Treatment

Type of GHG emission mitigation action: Destruction of methane emission

Sectoral Scope: 13 Waste Handling and Disposal

The project is not a grouped project and not an AFOLU project.

1.3 Project Proponent

Organization name	P.S.C Starch Products Public Company Limited (Project owner: Responsible for implementation and operation of the project activity)
-------------------	---

Contact person	Mr. Sereethoranakul Sarun
Title	President
Address	999 Moo.5 Nongyai, Chonburi, Thailand
Telephone	+66 38 219 730 - 4
Email	n/a

1.4 Other Entities Involved in the Project

Organization name	Swiss Carbon Value Ltd. (Project developer: Responsible for development of emission reduction through the Voluntary Carbon Standard)
Contact person	Mr. Heuberger Renat
Title	CEO
Address	Technoparkstrasse 1, Zurich 8005 Switzerland
Telephone	+41 43 501 35 50
Email	registration@southpole.com

1.5 Project Start Date

According to version 3.1 of the VCS PD, the project start date was defined on 28/04/2005 based on the date when emissions reduction began (section 1.6 in the registered PD).

1.6 Project Crediting Period

The crediting period of this project activity is ten years renewable. The first crediting period ran from period start date 01/12/2009 to 30/11/2019 (in accordance with the installation of monitoring equipment). The monitoring period under this report covers the period of 01/01/2019 to 30/11/2019. It is the fifth monitoring report.

1.7 Project Location

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

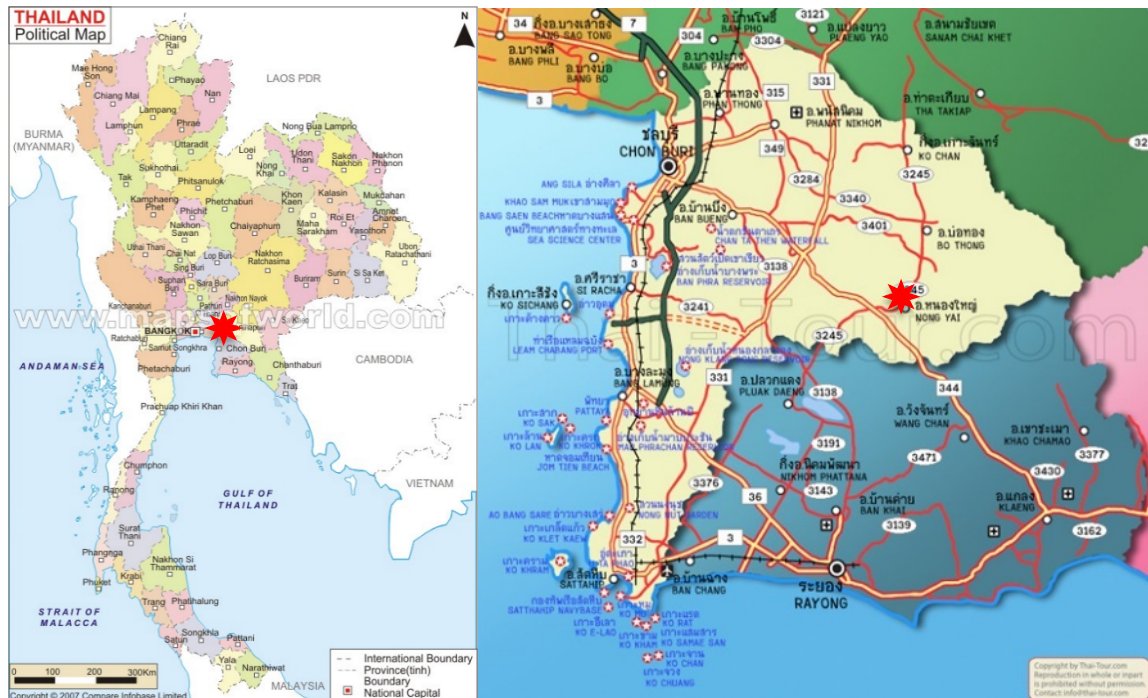


Figure 2 The starch plant location

1.8 Title and Reference of Methodology

Baseline and Monitoring Methodology for the project activity is defined:

First crediting period

AMS-III.H: Methane Recovery in Wastewater Treatment, version 13.0

Tool referenced in the applied methodologies:

AMS-III.H

- “Project emissions from flaring”, version 3.0 (Tool06)
- “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”, version 3.0 (Tool03)
- “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” version 3.0 (Tool05)
- “Tool to calculate the emission factor for an electricity system” version 7.0 (Tool07)

1.9 Participation under other GHG Programs

The project is not registered under any greenhouse gas (GHG) Program.

1.10 Other Forms of Credit

The project does not seek any GHG-related environmental credits.

1.11 Sustainable Development

Economic:

New jobs are created during the construction and operation phases of the biogas reactor system and of the cover lagoons. Furthermore, regional economic development can be fostered through contracts to local firms. In addition, not only partial reimbursement on the vast investment cost can be made through utilization of the captured biogas, and the additional revenue from the sale of Verified Carbon Units (VCUs) has also made the project financially feasible.

Sectoral:

This project is a good example of an effective waste to energy project which in turn improves the long-term sustainability of the Thai starch industry.

Social:

The project activity provides direct and indirect employment to the local community during construction of the project activity and as well as during its operation. During construction, employment was offered to a lot of local unskilled laborers, contributing to their social and economic well-being and economic well-being. The involvement of local employees in the project activity helped to enhance the skills of the laborers in the region by training them in different technical areas. In addition, the close collaboration between external experts and local counterparts is expected to promote long-term sustainable partnerships, benefiting local stakeholders.

The substitution of fuel oil with biogas from the project activity results in the improvement of energy security in the region. The noise, arising from pumps and blowers operating in the biogas plant, is insignificant. No other occupational health issues were identified. The safety aspects of operating the biogas plant have been sufficiently addressed.

Environmental:

Due to increased efficiency and improved process controls, the quality of treated wastewater is expected to improve substantially with the implementation of the project activity. Thus, wastewater leakage is unlikely. It must be mentioned that the project activity has zero discharge to the river or other natural sources such as soils and groundwater. The project has positive impacts on the local environment, improving air quality through reducing odors and cleaner emissions. This, in turn, can improve the standard of living of the local population. The capacity of this technological process to replace fuel oil and generate electricity can also be regarded as a potential for reducing dependency on fossil fuels and for promoting the diversification of energy resources. Ensuring energy security in this way can be seen as a contribution to sustainable development, particularly during this era of growing fuel prices.

Note that wastewater overflow might happen during the rainy season if the precipitation rate is higher than the outflow rate of the final pond for a sustained period of time. Wastewater overflow

can lead to a variety of problems that have significant environmental impacts. Excess nutrients in the wastewater stimulate excessive plant growth which can disrupt the normal functioning of the ecosystem, known as Eutrophication. Such a problem could lead to social conflicts within the community. While wastewater can overflow from any ponds in the old anaerobic lagoon, the overflow can only happen from the post-treatment ponds in the closed anaerobic system. Since the average water quality at the outlet of the project activity is better than that in the anaerobic lagoon ponds, the environmental impacts from overflow of wastewater has been significantly reduced. Overall, the project has positive impacts on the local environment by improving air quality through a reduction in odor and cleaner emissions. This can in turn improve the standard of living of the local population.

2 SAFEGUARDS

2.1 No Net Harm

The project activity does not have any potential to create any negative environmental and socio-economic impact. The project is a renewable energy biogas based thermal generation activity. In line with the operation license issued by the department of industrial work, the project follows the local regulation in order to maintain and prevent the environmental impact.

2.2 Local Stakeholder Consultation

A detailed Stakeholder consultation was conducted by the PP at the project site and is described as follows:

Invitation procedure

The project owner of P.S.C. Starch Products PCL has conducted the stakeholder consultation with assistance from South Pole Carbon Asset Management Limited (Switzerland based company responsible for VER project development).

Stakeholder groups have been identified and informed through orally about the meetings.

Place and date of the meetings

The stakeholder consultation was held in the factory compound on 9th December 2008. All participants were able to examine the location where the proposed project took place.

Meeting Participants on 9th December 2008

Local residents and representatives attended the meeting from following stakeholder categories:

1. Local residents
2. Local government representatives
3. Employees

20 participants have followed the invitation and attended the meeting.

Language

The meeting was conducted and documented in Thai (local language).

Meeting procedures

- Project description of the project and environmental impacts (10 min)
- Questions and Answers session (5 min)
- General feedback (5 min)

Meeting documents and protocols

On completion of the meeting the documentation in following subjects was collected and attested by the signatures of the stakeholders that were present:

1. Non-technical description of the project
2. Environmental impacts of the project
3. Contribution to sustainable development

Compilation of comments received:

The overall response to the project, from all invited stakeholders, was encouraging and positive towards local environment and social-economic conditions and towards cleaning the wastewater in a more efficient way, avoiding odour emissions from the lagoons and creating new jobs.

No adverse reactions or comments were received during the stakeholder consultation process. The project participants did not recognize any need to make changes to the project design or monitoring plan.

Short description:

The proposed project was implemented at P.S.C. Starch Products PLC.; a starch plant with a total production capacity of 200 t of native starch per day, 400 m³ per day of sweetener products and expected ethanol of 1600 m³ per day, generating an average of 350,000 m³, 240,000 m³ and 380,000 m³ per year respectively.

The proposed project activity entails the installation of an anaerobic wastewater treatment facility. Upflow Anaerobic Sludge Blanket (UASB) biogas reactor technology, at the existing starch manufacturing plant, replaces the open anaerobic lagoon-based system (composed of 12 cascading lagoons with a retention time of more than one year). The biogas reactor system generates and recovers biogas for energy generation purposes, avoiding methane emissions to the atmosphere. The captured methane is used as fuel in existing heat generating devices in the starch plant replacing heavy fuel oil, which lead to further CO₂ reductions by replacing a fossil fuel. Any surplus methane is flared in an open flare.

Environmental impacts:

The quality of the treated water, which is subject to effluent standards regulated by the environmental authorities, improved substantially due to the increased efficiency and improved process control of the biogas reactor as compared to open lagoons. In fact, the biogas reactor system allows the starch factory to reuse the treated effluent in the tapioca production process at more regular intervals and with less loss during storage, contributing to water conservation. Further, the project avoids significantly more odour emissions than would be released by an uncovered anaerobic lagoon, which contributes significantly to an improved quality of life around the project site.

Contribution to sustainable development:

The project activity does also contribute to technology transfer from Thailand and efficiency improvements in the agro-industry, which is beneficial for this rural and underdeveloped region of the country. New jobs are created during the construction and operation of the biogas reactor system and regional economic development is fostered through contracts to local firms related to construction, operation, and maintenance of the plant.

Current Practice

The project proponent maintains a register at the plant, to make sure any current feedback is provided by local people in fair and transparent manner.

2.3 AFOLU-Specific Safeguards

This is a not an-AFOLU projects, thus this section is not required.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project was registered on 07/05/2010. The current monitoring period is from 01/01/2019 to 30/11/2019. The emission reductions for this period are 59,738 tCO₂e (VCUs). This is the fifth verification of project activity.

The starting dates for each treatment units are summarized in below.

Project Components	Date of operation start / Commissioning
UASB	Year 2005
CL ₁	Year 2006
CL ₂	Year 2007

CL ₃	Oct - 2009
-----------------	------------

- The biogas treatment system, UASBs and covered lagoons have been completely operated since 2009 (first monitoring period) as per information in the registered PD.
- Following the implementation of covered lagoon no.3, the design of wastewater treatment process was reconfigured from its design in the registered PD. Since the wastewater discharged from ethanol plant is at a very high temperature and cannot be cooled down in the covered lagoon, the anaerobic digestion cannot occur at this high temperature ambient. Hence the CL3 is unable to work properly and the effluent from this lagoon still has very high Chemical Oxygen Demand (COD) content. The effluent from CL3 is retreated at CL1 instead of discharging to open lagoons. This reconfiguration has been started in October 2009, one week following the start of feeding wastewater into CL3. This change affects the calculation of $PE_{ww,discharge,PJ,y}$ in equation 8 of the registered PD, the description for this scenario is provided in deviation 1. The same approach has been provided and approved in the previous verification.

3.2 Deviations

2.3.1 Methodology Deviations

There is no methodology deviation proposed in this monitoring period.

2.3.2 Project Description Deviations

Deviation 1

Description of deviation

The $COD_{ww,discharge,PJ,y}$ is the COD of water coming out of from CL2 instead of the wastewater coming out from CL3.

Period of deviation

This deviated approach was applied for this whole crediting period.

Deviated approach

The $COD_{ww,discharge,PJ,y}$ is the COD of the treated wastewater discharged into the sea, river or lake in the project scenario. In the project activity case, the wastewater, was discharged into the pond.

Although the additional amount of biogas generated from the treating of effluent from CL3 at CL1 increases the amount of biogas combusted, the amount of biogas combusted is used for MD_y calculation and the result of MD_y is raised up in the same way. As per equation 13, in line with conservative principle, the final result of ER_{expost} is from the COD approach which is lower than MD_y approach. Hence, this change has no effect on the achieved emission reductions in this monitoring period.

Justification for deviated approach

The $PE_{ww,discharge,y}$; methane emissions from degradable organic carbon in treated wastewater, is the methane emission from the digestion of residue COD. COD remained even in the open system which methane can freely release into the environment.

In the monitoring diagram shown in the registered PD, the treated wastewater from CL3 is sent to pond system. The COD_{ww,discharge.PJ.y} is the COD at the outlet of CL3.

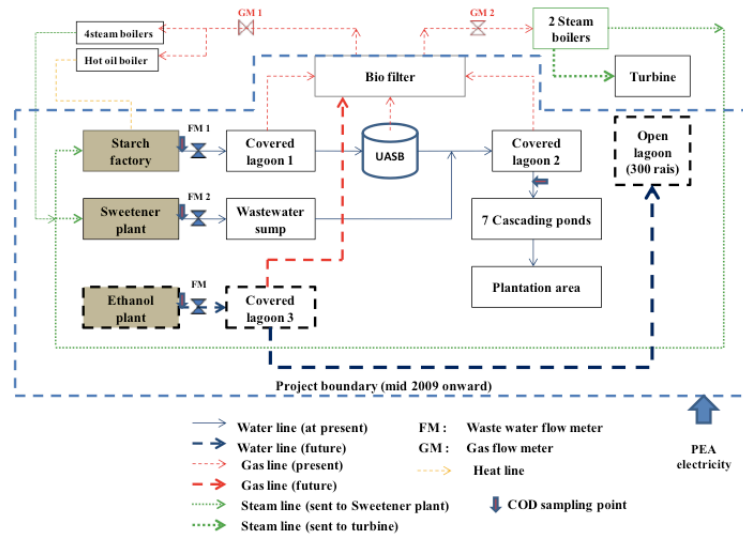


Figure 3 Monitoring diagram as per registered PD

As per the plant reconfiguration, the treated wastewater from CL3 is sent to CL1. Then the last unit for closed anaerobic system is CL2 before discharge to pond system. The COD_{ww,discharge.PJ.y} is changed to be the COD of treated wastewater from CL2 as per the new monitoring diagram below.

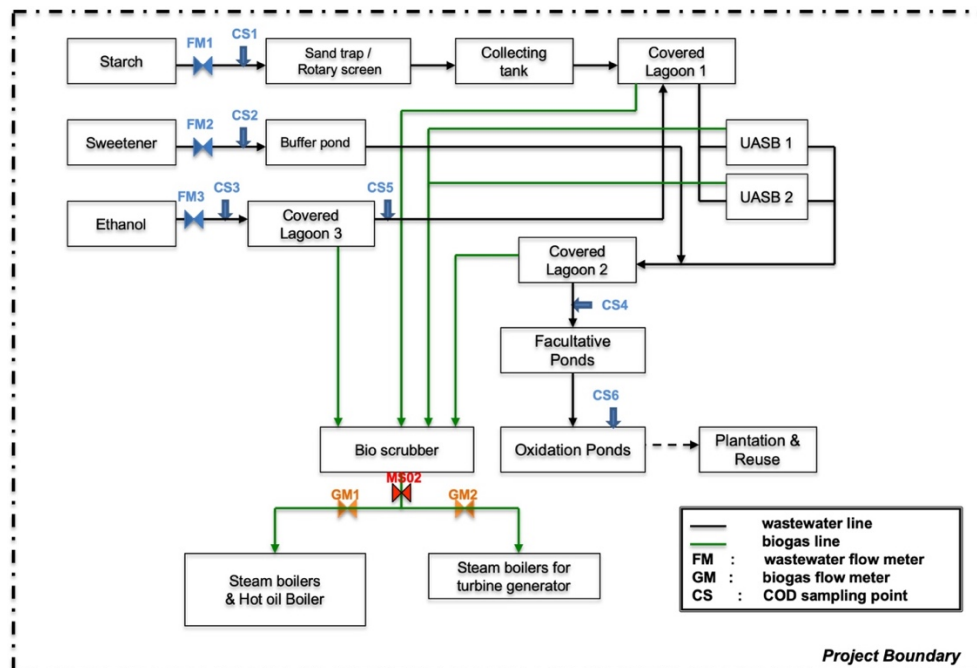


Figure 4 Monitoring diagram implementing at the project activity

Deviation 2

Description of deviation

The $COD_{y,ww,untreated,starch}$, $COD_{y,ww,untreated,sweetener}$, $COD_{y,ww,untreated,ethanol}$, $COD_{y,ww,reated,CL2}$, $COD_{y,ww,reated,CL3}$ and $COD_{y,ww,treated,lagoon}$ are not measured on daily basis which determined in the monitoring plan for COD parameters in the registered VCS PD.

Period of deviation

This deviation was applied for the entire monitoring period.

Deviated approach

The wastewater analysis of the samples was carried out by an internal laboratory, but not on every operational day. Refer to AMS III.H version 13, for COD parameters: Average value may be used through sampling with the confidence/precision level 90/10. The example of calculating this step from Annex 13 of EB 48 which is followed the standard statistical calculation is applied.

- 1) Calculate sample mean (μ).

$$\mu_{COD,y} = \sum_{m=1}^{n_m} COD_{y,ww} / n_m$$

Where:

$\mu_{COD,y}$ = Mean of the $COD_{y,ww,untreated,y}$ and $COD_{y,out,PJ,lagoon}$ in year y

$COD_{y,ww}$ = Monitored $COD_{y,ww}$ in measurement m in year y

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

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

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

Where:

$\sigma_{COD,y}$ = Standard deviation of COD_y in year y

- 3) Calculate the 95% confidence interval.

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

Where:

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

- 4) Use the lower bound of the 95% confidence interval obtained above for $COD_{y,ww,untreated}$ and the upper bound one for $COD_{y,ww,treated}$ to ensure conservativeness.

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

The above calculation is performed in the ER calculation spreadsheet.

Justification for deviated approach

This approach is in line with a principle of conservativeness, the upper bound value is used for project emission calculation while the lower bound value is used for baseline emissions calculation, in order to achieve the lower emission reductions.

3.3 Grouped Projects

This project is not a grouped project. This section is not applicable.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	GWP _{CH4}	
Data unit	tCO ₂ e/tCH ₄	
Description	Global Warming Potential for Methane	
Source of data	Default value as per IPCC	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	25
Justification of choice of data or description of measurement methods and procedures applied	Default value as per IPCC	
Purpose of Data	Calculation of baseline emission and project emissions	
Comments	Global Warming Potential value of methane valid for the commitment period (Fourth Assessment Report: AR4)	

Data / Parameter	B _{0,ww}	
Data unit	kg CH ₄ /kg COD	
Description	Methane producing capacity of the wastewater	
Source of data	1 st CP: AMS-III.H V13.0	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.21
Justification of choice of data or description of	IPCC default value	

measurement methods and procedures applied	
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	UF _{BL}				
Data unit	Factor				
Description	Model correction factor to account for model uncertainties				
Source of data	1 st CP: AMS-III.H V13.0 2 nd CP: AMS-III.H V19.0				
Value applied	<table border="1"> <tr> <th>MP under Crediting Periods</th><th>Value applied</th></tr> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>0.94</td></tr> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	0.94
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	0.94				
Justification of choice of data or description of measurement methods and procedures applied	Default value				
Purpose of Data	Calculation of baseline emissions				
Comments	-				

Data / Parameter	UF _{Pj}				
Data unit	Factor				
Description	Model correction factor to account for model uncertainties				
Source of data	1 st CP: AMS-III.H V13.0				
Value applied	<table border="1"> <tr> <th>MP under Crediting Periods</th><th>Value applied</th></tr> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>1.06</td></tr> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	1.06
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	1.06				
Justification of choice of data or description of measurement methods and procedures applied	Default value				
Purpose of Data	Calculation of project emissions				
Comments	-				

Data / Parameter	MCF _{ww,treatment,BL,i}
Data unit	Fraction

Description	Methane correction factor for baseline wastewater treatment systems i	
Source of data	AMS-III.H V13.0, Table III.H.1 AMS-III.H V19.0, Table 2	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.8
Justification of choice of data or description of measurement methods and procedures applied	Default value	
Purpose of Data	Calculation of baseline emissions	
Comments	-	

Data / Parameter	$MCF_{ww,treatment,PJ,k}$	
Data unit	Fraction	
Description	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery	
Source of data	AMS-III.H V13.0, Table III.H.1	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	$MCF_{ww,treatment,PJ,UASB} = 0.8$ $MCF_{ww,treatment,PJ,CL1} = 0.8$ $MCF_{ww,treatment,PJ,CL2} = 0.8$ $MCF_{ww,treatment,PJ,CL3} = 0.8$
Justification of choice of data or description of measurement methods and procedures applied	Default value; All MCF values have been chosen in accordance with methodology AMS III.H. The project wastewater treatment system equipped with biogas recovery consists of a UASB system and covered lagoons, therefore MCF value is chosen as 0.8.	
Purpose of Data	Calculation of project emissions	
Comments	-	

Data / Parameter	$MCF_{ww,treatment,PJ,lagoon}$	
Data unit	Fraction	
Description	Methane correction factor not equipped with biogas recovery	
Source of data	AMS-III.H V13.0, Table III.H.1	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.8

Justification of choice of data or description of measurement methods and procedures applied	Default value; The project wastewater treatment system not equipped with biogas recovery consists of anaerobic lagoons, therefore MCF value is chosen as 0.8.
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	MCF _{ww, PJ, discharge}	
Data unit	Fraction	
Description	Methane correction factor based on discharge pathway in the project situation	
Source of data	AMS-III.H V13.0, Table III.H.1	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.8
Justification of choice of data or description of measurement methods and procedures applied	Default value; The wastewater coming out of the covered lagoon CL ₃ will be discharged into a series of new anaerobic lagoons. A value of 0.8 is chosen for conservativeness.	
Purpose of Data	Calculation of project emissions	
Comments	-	

Data / Parameter	CFE _{ww}	
Data unit	-	
Description	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems.	
Source of data	AMS-III.H V13.0	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.9
Justification of choice of data or description of measurement methods and procedures applied	Default value	
Purpose of Data	Calculation of project emissions	
Comments	-	

Data / Parameter	$\eta_{BL,starch}$				
Data unit	%				
Description	Chemical oxygen demand (COD) removal efficiency of baseline wastewater treatment system for the starch and sweetener plants				
Source of data	Calculated				
Value applied	<table> <tr> <td>MP under Crediting Periods</td><td>Value applied</td></tr> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>98.61%</td></tr> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	98.61%
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	98.61%				
Justification of choice of data or description of measurement methods and procedures applied	The COD removal efficiency is based on monitored historical COD values for baseline system before implementation of project activity.				
Purpose of Data	Calculation of baseline emissions				
Comments	-				

Data / Parameter	$\eta_{BL,ethanol}$				
Data unit	%				
Description	Chemical oxygen demand (COD) removal efficiency of baseline wastewater treatment system for the ethanol plants				
Source of data	Calculated				
Value applied	<table> <tr> <td>MP under Crediting Periods</td><td>Value applied</td></tr> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>87.76%</td></tr> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	87.76%
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	87.76%				
Justification of choice of data or description of measurement methods and procedures applied	The COD removal efficiency is based on COD values for open lagoons system multiply by 0.89.				
Purpose of Data	Calculation of baseline emissions				
Comments	-				

Data / Parameter	FE				
Data unit	%				
Description	Flare efficiency				
Source of data	Tool to determine project emissions from flaring gases containing methane				
Value applied	<table> <tr> <td>MP under Crediting Periods</td><td>Value applied</td></tr> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>50%</td></tr> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	50%
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	50%				

Justification of choice of data or description of measurement methods and procedures applied	Default value for open flare as per Tool to determine project emissions from flaring gases containing methane has been applied.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	P_{el}	
Data unit	kW	
Description	Total electrical capacity of the equipments installed in the project activity	
Source of data	Plant data	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	245.1
Justification of choice of data or description of measurement methods and procedures applied	Extract from nameplate of the electrical equipment	
Purpose of Data	Calculation of baseline emissions	
Comments	-	

Data / Parameter	EF_y	
Data unit	tCO ₂ /MWh	
Description	CO ₂ emission factor for grid power	
Source of data	Thai DNA ²	
Value applied	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	0.5057
Justification of choice of data or description of measurement methods and procedures applied	The value is based on the official public data. EF_y was calculated according to the “Tool to calculate the emission factor for an electricity system” as determined in the respective small-scale methodology for grid connected electricity generation (AMS I.D).	
Purpose of Data	Calculation of baseline and project emissions	
Comments	-	

² <http://ghgreduction.tgo.or.th/download-tver/68-2017-11-28-06-43-22/353-2559.html>

4.2 Data and Parameters Monitored

Data / Parameter	Q _{y,ww,starch}																	
Data unit	m ³																	
Description	Volume of wastewater treated in the year y from the starch plant																	
Source of data	Measured – Volumetric flow meter: FM1																	
Description of measurement methods and procedures to be applied	Monitoring: Volumetric flow meter Data type: Records in both hard files (log sheets) and soft files.																	
Frequency of monitoring/recording	Frequency: Continuous measurements Recording: Cumulative readings are recorded daily.																	
Value monitored	<table><tr><th>MP under Crediting Periods</th><th>Value applied</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>634,265</td></tr></table>		MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	634,265												
MP under Crediting Periods	Value applied																	
1 st CP; 01/01/2019 to 30/11/2019	634,265																	
Monitoring equipment	Monitoring equipment brand & details are as below; <table><tr><td>Meter name</td><td>FM1</td></tr><tr><td>Serial Number</td><td>3K672016320307</td></tr><tr><td>Brand</td><td>ABB</td></tr><tr><td>Model</td><td>FEV11</td></tr><tr><td>Accuracy</td><td>0.4%</td></tr><tr><td>Calibration Frequency</td><td>Once in 3 years</td></tr><tr><td>Calibration Date</td><td>05/03/2018</td></tr><tr><td>Validity</td><td>04/03/2021</td></tr></table>		Meter name	FM1	Serial Number	3K672016320307	Brand	ABB	Model	FEV11	Accuracy	0.4%	Calibration Frequency	Once in 3 years	Calibration Date	05/03/2018	Validity	04/03/2021
Meter name	FM1																	
Serial Number	3K672016320307																	
Brand	ABB																	
Model	FEV11																	
Accuracy	0.4%																	
Calibration Frequency	Once in 3 years																	
Calibration Date	05/03/2018																	
Validity	04/03/2021																	
QA/QC procedures to be applied	Periodic calibrations (once in three years) for wastewater flow meter were ensured via an external agency.																	
Purpose of the data	Calculation of baseline and project emissions																	
Calculation method	Not applicable																	
Comments	There was no calibration gap found in this monitoring period. Thus no error has been applied to the monitored value.																	

Data / Parameter	$Q_{y,ww,sweetener}$	
Data unit	m^3	
Description	Volume of wastewater treated in the year y from the sweetener plant	
Source of data	Measured – Volumetric flow meter: FM2	
Description of measurement methods and procedures to be applied	Monitoring: Volumetric flow meter Data type: Records in both hard files (log sheets) and soft files.	

Frequency of monitoring/recording	Frequency: Continuous measurements		
Value monitored	Recording: Cumulative readings are recorded daily.		
	MP under Crediting Periods	Value applied	
		Lower	Higher
	1 st CP; 01/01/2019 to 30/11/2019	384,607	392,861
Monitoring equipment	There were two meters being implemented during this monitoring period. Monitoring equipment brand & details are as below;		
	Meter name	FM2	
	Serial Number	6201472	
	Brand	Rosemount	
	Model	M4Q4	
	Accuracy	0.35%	
	Calibration Frequency	1 / 3 years	
	Calibration Date	26/12/2017	
	Validity	25/12/2020	
	Installation	COD to 01/05/2019	
	The new meter		
	Meter name	FM2	
	Serial Number	3K672017130820	
	Brand	ABB ³	
	Model	FEP31150A1D1D2B1A1-A0A1A1C1AYH1JNM5	
	Accuracy	0.4%	
	Calibration Frequency	1 / 3 years	
Calibration Date	14/05/2020		
Validity	13/05/2023		
Installation	01/05/2019 onwards		
QA/QC procedures to be applied	Periodic calibrations (Once in three years) for wastewater flow meter were ensured via an external agency.		
Purpose of the data	Calculation of baseline and project emissions		
Calculation method	Not applicable		
Comments	During the fourth verification (previous verification) it was found that the wastewater flow meter for sweetener was malfunction. Project owner has decided to replace the meter with the new one on 01/05/2019. The meter information can be found in the above section; monitoring equipment. The calibration gap was also identified during this monitoring period from 01/05/2019 to 30/11/2019. The maximum error as per the		

³ https://library.e.abb.com/public/5996486236d6463ab3375fb48033fd17/DS_FEP300_EN_K.pdf

	calibration certificate of 1.6% was chosen and applied to the monitoring data during the calibration gap.
--	---

Data / Parameter	Q _{y,ww,Ethanol}																	
Data unit	m ³																	
Description	Volume of wastewater treated in the year y from the ethanol plant																	
Source of data	Measured - Volumetric flow meter: FM3																	
Description of measurement methods and procedures to be applied	Monitoring: Volumetric flow meter Data type: Records in both hard files (log sheets) and soft files.																	
Frequency of monitoring/recording	Frequency: Continuous measurements Recording: Cumulative readings are recorded daily.																	
Value monitored	<table><tr><th>MP under Crediting Periods</th><th>Value applied</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>337,361</td></tr></table>		MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	337,361												
MP under Crediting Periods	Value applied																	
1 st CP; 01/01/2019 to 30/11/2019	337,361																	
Monitoring equipment	Monitoring equipment brand & details are as below; <table><tr><td>Meter name</td><td>FM3</td></tr><tr><td>Serial Number</td><td>3K672018091156</td></tr><tr><td>Brand</td><td>ABB</td></tr><tr><td>Model</td><td>FEP31150A1D1D2B1A-1A1C1AYH1M5</td></tr><tr><td>Accuracy</td><td>0.40%</td></tr><tr><td>Calibration Frequency</td><td>1 / 3 years</td></tr><tr><td>Calibration Date</td><td>08/03/2018</td></tr><tr><td>Validity</td><td>07/03/2021</td></tr></table>		Meter name	FM3	Serial Number	3K672018091156	Brand	ABB	Model	FEP31150A1D1D2B1A-1A1C1AYH1M5	Accuracy	0.40%	Calibration Frequency	1 / 3 years	Calibration Date	08/03/2018	Validity	07/03/2021
Meter name	FM3																	
Serial Number	3K672018091156																	
Brand	ABB																	
Model	FEP31150A1D1D2B1A-1A1C1AYH1M5																	
Accuracy	0.40%																	
Calibration Frequency	1 / 3 years																	
Calibration Date	08/03/2018																	
Validity	07/03/2021																	
QA/QC procedures to be applied	Periodic calibrations (Once in three years) for wastewater flow meter were ensured via an external agency.																	
Purpose of the data	Calculation of baseline and project emissions																	
Calculation method	Not applicable																	
Comments	There was no calibration gap found in this monitoring period. Thus no error has been applied to the monitored value.																	

Data / Parameter	$COD_{y,ww,untreated,starch}$
Data unit	mg/l
Description	COD of wastewater from starch plant: CS1
Source of data	Measured – Titrimetric analysis
Description of measurement methods and procedures to be applied	Monitoring: Closed reflux titrimetric method in the onsite laboratory of the treatment plant. Sample was taken from the outlet of wastewater from starch plant before entering CL1.

	Data type: Records in both hard and soft files.		
Frequency of monitoring/recording	Frequency: Daily basis Recording : Daily records		
Value monitored	Monitoring period	Value monitored	
		Lower	Higher
	1 st CP; 01/01/2019 to 30/11/2019	13,227	16,594
Monitoring equipment	N/A		
QA/QC procedures to be applied	In case the COD value is not available for a particular day, the same shall be estimated in a conservative manner (as per deviation 2 of section 2.2) or ignored out of emission reduction estimation. The closed reflux titrimetric method is well documented ⁴ and well accepted by international standards; method 5220 C approved by United States Environmental Protection Agency – USEPA		
Purpose of the data	Calculation of baseline emission		
Calculation method	-		
Comments	-		

Data / Parameter	COD _{y,ww,untreated,sweetener}		
Data unit	mg/l		
Description	COD of wastewater from sweetener plant: CS2		
Source of data	Measured – Titrimetric analysis		
Description of measurement methods and procedures to be applied	Monitoring: Closed reflux titrimetric method in the onsite laboratory of the treatment plant. Sample was taken from the outlet of wastewater from sweetener plant before entering CL2.		
Frequency of monitoring/recording	Frequency: Daily basis Recording: Daily records		
Value monitored	Monitoring period	Value monitored	
		Lower	Higher
	1 st CP; 01/01/2019 to 30/11/2019	5,972	9,112
Monitoring equipment	n/a		
QA/QC procedures to be applied	Please see COD _{y,ww,untreated,starch}		
Purpose of the data	Please see COD _{y,ww,untreated,starch}		
Calculation method	-		

⁴ The Examination of water and wastewater", 1st Ed 2005 and Wastewater analysis manual from Environmental Engineering Association , Thailand , 3rd Ed. 1997

Comments	-								
Data / Parameter	COD _{y,ww,untreated,Ethanol}								
Data unit	mg/l								
Description	COD of wastewater from ethanol plant: CS3								
Source of data	Measured – Titrimetric analysis								
Description of measurement methods and procedures to be applied	Monitoring: Closed reflux titrimetric method in the onsite laboratory of the treatment plant. Sample was be taken from the outlet of wastewater from ethanol plant before entering CL3.								
Frequency of monitoring/recording	Frequency: Daily basis Recording : Daily records								
Value monitored	<table><tr><th rowspan="2">Monitoring period</th><th colspan="2">Value monitored</th></tr><tr><th>Lower</th><th>Higher</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>48,327</td><td>56,170</td></tr></table>	Monitoring period	Value monitored		Lower	Higher	1 st CP; 01/01/2019 to 30/11/2019	48,327	56,170
Monitoring period	Value monitored								
	Lower	Higher							
1 st CP; 01/01/2019 to 30/11/2019	48,327	56,170							
Monitoring equipment	n/a								
QA/QC procedures to be applied	Please see COD _{y,ww,untreated,starch}								
Purpose of the data	Please see COD _{y,ww,untreated,starch}								
Calculation method	-								
Comments	-								

Data / Parameter	COD _{y,ww,treated,CL2}		
Data unit	mg/l		
Description	COD of wastewater exiting the covered lagoon 2 treatment process : CS4		
Source of data	Measured – Titrimetric analysis		
Description of measurement methods and procedures to be applied	Monitoring: Closed reflux titrimetric method in the onsite laboratory of the treatment plant. Sample was be taken from the outlet of CL2 before entering the open lagoons. Data type: Records in both hard and soft files.		
Frequency of monitoring/recording	Frequency: Daily basis Recording: Daily records		
Value monitored	Monitoring period	Value monitored	
		Lower	Higher
	1 st CP; 01/01/2019 to 30/11/2019	2,659	4,365
Monitoring equipment	n/a		

QA/QC procedures to be applied	Please see COD _{y,ww,untreated,starch}
Purpose of the data	Please see COD _{y,ww,untreated,starch}
Calculation method	-
Comments	-

Data / Parameter	COD _{y,ww,treated,CL3}		
Data unit	mg/l		
Description	COD of wastewater exiting the covered lagoon 3 treatment process : CS5		
Source of data	Measured – Titrimetric analysis		
Description of measurement methods and procedures to be applied	The monitoring of this parameter is in line with deviation 1 in section 2.3.2 above. Monitoring: Closed reflux titrimetric method in the onsite laboratory of the treatment plant. Sample was be taken from the outlet of CL3 before entering the open lagoons. Data type: Records in both hard and soft files.		
Frequency of monitoring/recording	Frequency: Daily basis Recording: Daily records		
Value monitored	Monitoring period	Value monitored	
		Lower	Higher
	1 st CP; 01/01/2019 to 30/11/2019	944	1,964
Monitoring equipment	n/a		
QA/QC procedures to be applied	Please see COD _{y,ww,untreated,starch}		
Purpose of the data	Please see COD _{y,ww,untreated,starch}		
Calculation method	-		
Comments	-		

Data / Parameter	W _{CH4}
Data unit	%
Description	Methane content in biogas
Source of data	Measured by online gas analyzer
Description of measurement methods and procedures to be applied	Monitoring: Online methane analyzer Data type: Records in both hard and soft files

Frequency of monitoring/recording	Frequency: Continuous measurement	
Value monitored	Recording: Daily records.	
Monitoring equipment	MP under Crediting Periods	Value applied
	1 st CP; 01/01/2019 to 30/11/2019	59.17%
	Meter name	MS02
	Serial Number	96159
	Brand	UNION
	Model	INCA 4002 T099-01
	Accuracy	1%
	Calibration Frequency	1 / 3 years
	Calibration Date	14/03/2017
	Validity	13/03/2020
QA/QC procedures to be applied	Periodic calibrations (generally once in three years) for methane analyser are ensured via an external agency according to national or international standard.	
Purpose of the data	Calculation of baseline emissions	
Calculation method	-	
Comments	-	

Data / Parameter	BG _{combusted,y}								
Data unit	Nm ³								
Description	Amount of biogas combusted for gainful use in the year y								
Source of data	Measured - Biogas flow meters: GM1, GM2								
Description of measurement methods and procedures to be applied	Measurements of volume of biogas sent to boilers are done continuously using gas flow meters. The gas flow meters were installed, and values recorded regularly by skilled employees. In recording this parameter, plant's operators first manually archived the monitored data onto log sheets then transferred to the computer for electronic storage.								
Frequency of monitoring/recording	The measurement monitoring was conducted continuously. The data achievement was done on a daily basis.								
Value monitored	BG_{combusted,y}<table><tr><th>MP under Crediting Periods</th><th>Value applied</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>10,400,242</td></tr></table> BG to boiler<table><tr><th>MP under Crediting Periods</th><th>Value applied</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>4,996,433</td></tr></table> BG to generation sets	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	10,400,242	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	4,996,433
MP under Crediting Periods	Value applied								
1 st CP; 01/01/2019 to 30/11/2019	10,400,242								
MP under Crediting Periods	Value applied								
1 st CP; 01/01/2019 to 30/11/2019	4,996,433								

	<table><tr><th>MP under Crediting Periods</th><th>Value applied</th></tr><tr><td>1st CP; 01/01/2019 to 30/11/2019</td><td>5,403,809</td></tr></table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	5,403,809																														
MP under Crediting Periods	Value applied																																		
1 st CP; 01/01/2019 to 30/11/2019	5,403,809																																		
Monitoring equipment	In this monitoring period, there are two monitoring points measure the biogas exported to boilers (GM1) and to generator set(GM2) as following details. GM1: The gas meter monitors the biogas volume sending to boilers. The details of equipment as below. <table><tr><td>Meter name</td><td>GM1_(starch-boilers)</td></tr><tr><td>Serial Number</td><td>503208</td></tr><tr><td>Brand</td><td>FCI</td></tr><tr><td>Model</td><td>ST51</td></tr><tr><td>Accuracy</td><td>2%</td></tr><tr><td>Calibration Frequency</td><td>1 / 3 years</td></tr><tr><td>Calibration Date</td><td>20/12/2017</td></tr><tr><td>Validity</td><td>19/12/2020</td></tr></table> GM2: The gas meter monitors the biogas sent to generators. The meter brand and detail as below. <table><tr><td>Meter name</td><td>GM2_(turbine generator)</td></tr><tr><td>Serial Number</td><td>630165</td></tr><tr><td>Brand</td><td>FCI</td></tr><tr><td>Model</td><td>ST51</td></tr><tr><td>Accuracy</td><td>2%</td></tr><tr><td>Calibration Frequency</td><td>1 / 3 years</td></tr><tr><td>Calibration Date</td><td>12/11/2018</td></tr><tr><td>Validity</td><td>11/11/2021</td></tr><tr><td>Installation period</td><td>The meter was installed on 08/10/2018 to present.</td></tr></table>	Meter name	GM1 _(starch-boilers)	Serial Number	503208	Brand	FCI	Model	ST51	Accuracy	2%	Calibration Frequency	1 / 3 years	Calibration Date	20/12/2017	Validity	19/12/2020	Meter name	GM2 _(turbine generator)	Serial Number	630165	Brand	FCI	Model	ST51	Accuracy	2%	Calibration Frequency	1 / 3 years	Calibration Date	12/11/2018	Validity	11/11/2021	Installation period	The meter was installed on 08/10/2018 to present.
Meter name	GM1 _(starch-boilers)																																		
Serial Number	503208																																		
Brand	FCI																																		
Model	ST51																																		
Accuracy	2%																																		
Calibration Frequency	1 / 3 years																																		
Calibration Date	20/12/2017																																		
Validity	19/12/2020																																		
Meter name	GM2 _(turbine generator)																																		
Serial Number	630165																																		
Brand	FCI																																		
Model	ST51																																		
Accuracy	2%																																		
Calibration Frequency	1 / 3 years																																		
Calibration Date	12/11/2018																																		
Validity	11/11/2021																																		
Installation period	The meter was installed on 08/10/2018 to present.																																		
QA/QC procedures to be applied	The flow meter should be subject to periodic calibration according to the equipment’s specifications and applicable industrial standards.																																		
Purpose of the data	Calculation of baseline and project emissions																																		
Calculation method	There are two measurements: GM1: At the monitoring point before the boilers GM2: At the monitoring point before the generators The sum of these two measurements were used in the calculation.																																		
Comments	There was no calibration gap found during this monitoring period thus, no error has been applied to the monitored value.																																		

Data / Parameter	EC _y				
Data unit	MWh/year				
Description	Electricity consumption by wastewater treatment system and biogas plant in year y				
Source of data	Maximum rated consumption is calculated by multiplying total electrical capacity with 8,760 hours and 10% additional factor to be conservative.				
Description of measurement methods and procedures to be applied	Calculation based on maximum rated consumption is conducted in a conservative manner				
Frequency of monitoring/recording	-				
Value monitored	<table border="1"> <thead> <tr> <th>MP under Crediting Periods</th><th>Value applied</th></tr> </thead> <tbody> <tr> <td>1st CP; 01/01/2019 to 30/11/2019</td><td>2,167</td></tr> </tbody> </table>	MP under Crediting Periods	Value applied	1 st CP; 01/01/2019 to 30/11/2019	2,167
MP under Crediting Periods	Value applied				
1 st CP; 01/01/2019 to 30/11/2019	2,167				
Monitoring equipment	-				
QA/QC procedures to be applied	Since there was no electric meter for the electricity consumption of project activity, maximum rated consumption was used to calculate the emissions from PE _{power, y} . This approach has taken into account the distribution losses of 10% and the calculation is based on an assumption that the electrical appliances are running at full capacity for 8,760 hours per year, the QA/QC aspect has already been assured.				
Purpose of the data	Calculation of project emissions				
Calculation method	-				
Comments	-				

4.3 Monitoring Plan

1. Monitoring management

The project hires people to operate the biogas generation and utilization plants. The required monitoring equipment are installed by the technology provider who are in consultation with the equipment suppliers and under the supervision of the managing director as well as the Environmental Officer and Consulting. Flow meters are to be calibrated generally on once in three years basis using recognized procedures. Sampling is carried out by onsite staffs according to appropriate industrial standards.

Data acquisition from the gas and wastewater flow meters are executed through log- book system and record by on-site operators, while the COD of wastewater at sampling point is monitored on a daily basis and reported by an on-site environmental laboratory.

The collected data must be approved and supervised by the Environmental Officer who is in charge of data processing.

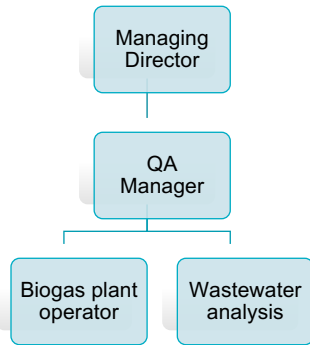


Figure 5 : Organization Chart

2. Quality Assurance and Quality Control

The Environmental Officer monitors the overall performance of the plant ensures that proper and timely calibration, data acquisition and storage have been observed.

3. On-site procedures

Plant performance is recorded daily using log sheets and later stored in electronic format for periodic download onsite or remote transfer for further processing. In terms of procedures for calibration of equipment, the Environmental Officer can contact a third party to carry out calibration according to international standards. Note that the Environmental Officer is responsible for executing timely calibration as per the specification from the equipment supplier or at least once in three years.

4. Data storage and filing – Electric Workbook

All relevant data is stored electronically on a computer. A daily record is kept. All parameters monitored under the monitoring plan are kept for a period of two years following the end of the crediting period or the last issuance of VERs for the project activity, whichever occurs later.

5. Emergency preparedness

The project activity does not result in any unidentified activity that can result in substantial emissions from the project activity.

However, the leakages, if any, in the piping or digester shall come under notice of plant operator either during the regular monitoring of data parameters, else at the time of data logging, due to mismatch between the expected biogas generation from wastewater quantities processed or the other way around.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

(A) Methane destruction component (AMS.III.H)

According to the AMS III.H, baseline emissions for the systems affected by the project activity may consist of:

- Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);
- Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);
- Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);
- Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea ($BE_{ww,discharge,y}$);
- Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

Baseline emissions (BE_y)

The baseline emissions are calculated as follows.

$$BE_y = \{BE_{power,y} + BE_{ww,treatment,y} + BE_{s,treatment,y} + BE_{ww,discharge,y} + BE_{s,final,y}\} \quad (1)$$

Where,

Parameter	Details	Quantification
BE_y	Baseline emissions in year y (tCO_2e)	1 st CP; 01/01/2019 to 30/11/2019 = 98,090
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO_2e)	1 st CP; 01/01/2019 to 30/11/2019 = 0
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e)	1 st CP; 01/01/2019 to 30/11/2019 = 98,090
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e)	1 st CP; 01/01/2019 to 30/11/2019 = 0
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO_2e).	1 st CP; 01/01/2019 to 30/11/2019 = 0
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e). If the sludge is controlled combusted, disposed of in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected.	1 st CP; 01/01/2019 to 30/11/2019 = 0

Baseline emissions of the wastewater treatment systems affected by the project activity
(BE_{ww,treatment,y}):

Methane emissions from the baseline wastewater treatment systems affected by the project (BE_{ww,treatment,y}) are determined using the methane generation potential of the wastewater treatment systems as per the paragraph 29 of AMS III.H version 18. The following equation is used.

$$BE_{ww,treatment,y} = \sum Q_{ww,i,y} * COD_{inflow,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i} * B_{o,ww} * UF_{BL} * GWP_{CH_4} \quad (2)$$

Where,

Parameter	Details	Quantification
BE _{ww,treatment,y}	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 98,090
Q _{ww,i,y}	Volume of wastewater treated in baseline wastewater treatment system i in year y (m ³) Lower value was chosen for the calculation of baseline emission as the calibration gap of FM2 has been identified during the monitoring period.	1 st CP; 01/01/2019 to 30/11/2019 = 1,353,673
COD _{inflow,i,y}	Chemical oxygen demand of the wastewater inflow to the baseline treatment system i in year y. Average value may be used through sampling with the confidence/precision level 90/10 (t/m ³).	1 st CP; 01/01/2019 to 30/11/2019 = 0.027
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline treatment system i	$\eta_{BL,starch}$ 1 st CP; 01/01/2019 to 30/11/2019 = 98.61% $\eta_{BL,ethanol}$ 1 st CP; 01/01/2019 to 30/11/2019 = 87.76%
MCF _{ww,treatment,BL,i}	Methane correction factor for the baseline anaerobic wastewater treatment i (MCF values as per table III.H.2)	1 st CP; 01/01/2019 to 30/11/2019 = 0.8
i	Index for baseline wastewater treatment system	-
B _{o,ww}	Methane producing capacity of the wastewater	1 st CP; 01/01/2019 to 30/11/2019 = 0.21
UF _{BL}	Model correction factor to account for model uncertainties	1 st CP; 01/01/2019 to 30/11/2019 = 0.94
GWP _{CH₄}	Global Warming Potential for methane	1 st CP; 01/01/2019 to 30/11/2019 = 25

According to the paragraph 31 AMS-III.H version 13.0 emission reduction achieved by the project activity is limited to the ex-post calculated baseline emissions minus project emission using the actual monitored data for the project activity. The emission reductions achieved in any year are

the lowest value of the following:

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

As per paragraph 32 in AMS III.H. version 13.0, in case of flaring/combustion, MD_y was measured using the conditions of the flaring process:

$$MD_y = BG_{bunt,y} * W_{CH_4,y} * D_{CH_4} * FE * GWP_{CH_4} \quad (3)$$

Where:

Parameter	Details	Quantification
MD_y	Methane captured and destroyed/ gainfully used by the project activity in the year y	1 st CP; 01/01/2019 to 30/11/2019 = 110,159
$BG_{burnt,y}$	Biogas flared/combusted in year y (m^3)	$BG_{combusted,y}$ 1 st CP; 01/01/2019 to 30/11/2019 = 10,400,242 $BG_{flared,y}$ 1 st CP; 01/01/2019 to 30/11/2019 = 0
W_{CH_4}	Methane content in the biogas in the year y (mass fraction)	1 st CP; 01/01/2019 to 30/11/2019 = 59.17%
D_{CH_4}	Density of methane at the temperature and pressure of the biogas in the year y (tonnes/ m^3)	1 st CP; 01/01/2019 to 30/11/2019 = 0.0007
FE	Flare efficiency in year y (fraction)	1 st CP; 01/01/2019 to 30/11/2019 = 0

Baseline emission from electricity and fuel consumptions ($BE_{power,y}$)

There is no consumption of fossil fuels in wastewater treatment system in baseline scenario, thereby $BE_{heat,y} = 0$.

For $BE_{elec,y}$ the power consumed in baseline case was negligible and was ignored for conservativeness.

Baseline emissions from electricity and fuel consumptions ($BE_{power,y}$) are assumed to be zero.

$$BE_{power,y} = 0$$

Baseline emission from wastewater discharge ($BE_{ww,discharge,y}$)

In the baseline scenario, treated wastewater is not discharged into sea/lake/river, therefore methane emissions from degradable organic carbon in treated wastewater discharged ($BE_{ww,discharge,y}$) The baseline situation was taken as zero.

$$BE_{ww,discharge,y} = 0$$

Baseline emissions of the sludge treatment systems affected by the project ($BE_{s,treatment,y}$)

The generated sludge in the baseline scenario was close to null and was anyway used aerobically for soil application. There is no sludge treatment system. Therefore baseline methane emissions from sludge treatment and anaerobic decay of the final sludge ($BE_{s, \text{treatment}, y}$ and $BE_{s, \text{final}, y}$) produced were omitted from the baseline emissions.

Baseline emissions from final sludge disposal ($BE_{s, \text{final}, y}$)

Refer to explanation above.

$$BE_{s, \text{final}, y} = 0$$

5.2 Project Emissions

Methane destruction component: (AMS III.H)

As per AMS III.H, Project activity emissions from the systems affected by the project activity are:

- CO₂ emissions from electricity and fuel used by the project facilities ($PE_{\text{power}, y}$);
- Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{\text{ww, treatment}, y}$);
- Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s, \text{treatment}, y}$);
- Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{\text{ww discharge}, y}$);
- Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s, \text{final}, y}$);
- Methane fugitive emissions on account of inefficiencies in capture systems ($PE_{\text{fugitive}, y}$);
- Methane emissions due to incomplete flaring ($PE_{\text{flaring}, y}$);
- Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{\text{biomass}, y}$).

$$PE_y = \{PE_{\text{power}, y} + PE_{\text{ww, treatment}, y} + PE_{s, \text{treatment}, y} + PE_{\text{ww discharge}, y} + PE_{s, \text{final}, y} + PE_{\text{fugitive}, y} + PE_{\text{biomass}, y} + PE_{\text{flaring}, y}\} \quad (4)$$

Where,

Parameter	Details	Quantification
PE_y	Project emissions in year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 38,352
$PE_{\text{power}, y}$	Emissions from electricity or fuel consumption in the year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 1,097
$PE_{\text{ww, treatment}, y}$	Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 24,141

PE _{s, treatment, y}	Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 0
PE _{ww, discharge, y}	Methane emissions from degradable organic carbon in treated wastewater in year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 0
PE _{s, final, y}	Methane emissions from anaerobic decay of the final sludge produced in year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 0
PE _{fugitive, y}	Methane emissions from biogas release in capture systems in year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 13,114
PE _{biomass, y}	Methane emissions from biomass stored under anaerobic conditions (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 0
PE _{flaring, y}	Methane emissions due to incomplete flaring in year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 0

(a) Emissions from electricity consumption (PE_{y, power} = PE_{EC,y})

These emissions were calculated using “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”. The energy consumption data of all equipment/devices is required in the project activity wastewater, sludge treatment systems and systems for biogas recovery and flaring/gainful use.

$$PE_{Power, y} = EC_{PJ, j, y} * EF_{EF, j, y} \quad (5)$$

Where,

Parameters	Details	Quantification
PE _{y, power}	Emissions from electricity consumption in the year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 1,097
EC _{PJ,j,y}	Electricity from the grid consumed by the project activity (wastewater treatment, biogas recovery and biogas utilisation/flaring systems) (MWh)	1 st CP; 01/01/2019 to 30/11/2019 = 2,167
EF _y	Grid emission factor (tCO _{2e} /MWh)	1 st CP; 01/01/2019 to 30/11/2019 = 0.5057

Remark: Emission factor is considered as zero because the project consumes biogas as fuel source.

(b) Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{ww, treatment, y}$)

Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation were calculated as per AMS.III.H using an uncertainty factor of 1.06 for the first crediting period and 1.12 for the second crediting period. The following equation was used.

$$PE_{ww, treatment, y} = \sum (Q_{ww, y} * COD_{removed, PJ, lagoon, y} * MCF_{ww, treatment, PJ, k} * B_{o, ww} * UF_{PJ} * GWP_{CH_4}) \quad (6)$$

Where,

Parameter	Details	Quantification
$PE_{ww, treatment, y}$	Emissions from degradable organic carbon in treated wastewater in year y (tCO _{2e})	1 st CP; 01/01/2019 to 30/11/2019 = 24,141
$Q_{ww, k, y}$	Volume of wastewater treated in project activity (m ³) Higher value was chosen for the calculation of project emission. This is the conservative approach as the calibration gap of FM2 has been identified during the monitoring period.	1 st CP; 01/01/2019 to 30/11/2019 = 1,361,927
$COD_{removed, PJ, lagoon, n, y}$	Chemical oxygen demand removed by project secondary wastewater treatment system in year y (metric tons/m ³), calculated as $COD_{inflow, lagoon}(CS4)$ minus $COD_{outflow, lagoon}(CS5)$	1 st CP; 01/01/2019 to 30/11/2019 = 0.0041
$MCF_{ww, treatment, PJ, k}$	Methane correction factor for the project wastewater treatment system k (MCF values as per AMS III.H.)	1 st CP; 01/01/2019 to 30/11/2019 = 0.8
$B_{o, ww}$	Methane producing capacity of the wastewater	1 st CP; 01/01/2019 to 30/11/2019 = 0.21
UF_{PJ}	Model correction factor to account for model uncertainties	1 st CP; 01/01/2019 to 30/11/2019 = 1.06
GWP_{CH_4}	Global warming potential for methane (value of 25)	1 st CP; 01/01/2019 to 30/11/2019 = 25

(c) Methane emissions from sludge treatment systems affected by the project activity, and not Eligibility for Validation Activities

(d) TUV SUD is accredited for validating and verifying GHG emission reduction project activities falling under sectoral scope 13, waste handling and disposal .

(e) equipped with biogas recovery (PE_{s, treatment, y})

The project activity does not include sludge treatment system, therefore the emission from sludge treatment system were not taken into consideration.

(f) Methane emissions from degradable organic carbon in treated wastewater (PE_{ww discharge, y})

In the project activity the treated wastewater was discharged in existing open lagoons and there was no discharge to a river, the sea or a lake. Hence, emissions from this component have not been included in the assessment.

(g) Methane emissions from the decay of the final sludge produced (PE_{s, final, y})

A relatively small amount of final sludge would be removed from the digester. The project proponent would apply final sludge for field application as fertilizer and the final disposal of the sludge would be monitored during the crediting period. Therefore, as suggested by the AMS III.H, the emissions from the anaerobic decay of the final sludge produced can be omitted.

(h) Methane emissions from biogas release in capture systems (PE_{fugitive, y})

Project activity emissions from the release of methane release in capture systems are determined as per paragraph 42 of AMS III.H as given below.

$$PE_{fugitive, y} = PE_{fugitive, ww, y} + PE_{fugitive, s, y} \quad (7)$$

Where,

Parameter	Details	Quantification
PE _{fugitive, y}	Methane emissions from methane release in capture and utilization/combustion/flare \systems in year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 13,114
PE _{fugitive, ww, y}	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 13,114
PE _{y, fugitive, s}	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y (tCO ₂ e)	1 st CP; 01/01/2019 to 30/11/2019 = 0

- Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment**
(PE_{fugitive,ww,y})

These emissions are calculated as follows:

$$PE_{fugitive\,ww,y} = (1 - CEF_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \quad (8)$$

Where,

Parameter	Details	Quantification
CEF _{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)	1 st CP; 01/01/2019 to 30/11/2019 = 0.9
MEP _{ww,treatment,y}	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (tonne)	1 st CP; 01/01/2019 to 30/11/2019 = 5,245

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} \quad (9)$$

Where,

Parameter	Details	Quantification
Q _{ww,y}	Volume of wastewater treated in project wastewater treatment system k in year y (m ³ /year)	1 st CP; 01/01/2019 to 30/11/2019 = 1,361,927
B _{o,ww}	Methane producing capacity of the wastewater	1 st CP; 01/01/2019 to 30/11/2019 = 0.21
UF _{PJ}	Model correction factor to account for model uncertainties	1 st CP; 01/01/2019 to 30/11/2019 = 1.06
COD _{removed,PJ,k,y}	The chemical oxygen demand removed by the treatment system k of the project activity equipped with biogas recovery in the year y (tonnes/m ³) calculated as; K= CL2: $COD_{removed,PJ,CL2,y} = COD_{ww,untreated,y,starch/sweetener/ethanol} - COD_{loadout,PJ,CL2,y}$	1 st CP; 01/01/2019 to 30/11/2019 = 0.025
MCF _{ww,treatment,PJ,k}	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment (MCF values as per table III.H.2)	1 st CP; 01/01/2019 to 30/11/2019 = 0.8

- **Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year y ($PE_{y, \text{fugitive}, s}$) :**

No sludge has been generated during this monitoring period. According to registered PD, the sludge would be used only for land application, and no sludge treatment envisaged in the project activity. Therefore, emission from sludge treatment were not taken into consideration.

- (i) **Methane emissions due to incomplete flaring ($PE_{\text{flaring}, y}$)**

No biogas will be flared, since the capacity of the six steam boilers and of the hot oil boiler is higher than the maximum generation capacity of the wastewater treatment plant.

- (j) **Methane emissions from biomass stored under anaerobic conditions which does not take place in the baseline situation ($PE_{\text{biomass}, y}$).**

Biomass storage was not envisaged in the project activity. Therefore, methane emissions from biomass stored under anaerobic conditions were not taken into consideration.

5.3 Leakage

The used technology does not involve any equipment transferred from another activity, therefore according to AMS-III.H, there is no leakage to be considered.

5.4 Net GHG Emission Reductions and Removals

As per the AMS III.H, emission reductions were calculated using formulas mentioned in baseline, project and leakage emissions sections above. Emission reductions were estimated as follows;

$$ER_{y, \text{ex-post}} = BE_{y, \text{ex-post}} - (PE_{y, \text{ex-post}} + LE_{y, \text{ex-post}}) \quad (10)$$

According to the AMS III.H, emission reduction achieved by the project activity is limited to the ex-post calculated baseline emissions minus project emissions using the actual monitored data for the project activity. Emission reductions achieved on any year are the lowest value of the following;

$$ER_{y, \text{ex-post}} = \min (BE_{y, \text{ex-post}} - PE_{y, \text{ex-post}} - LE_{y, \text{ex-post}}), (MD_y - PE_{\text{power}, y} - LE_{y, \text{ex-post}}) \quad (11)$$

According to the equation 16, the emission reduction achieved for the monitoring period is as following;

Parameter	Details	Quantification
$ER_{y, \text{ex-post}}$	Emission reductions achieved by the project activity based on monitored values for year y (tCO_2e)	1 st CP; 01/01/2019 to 30/11/2019 = 59,738
$BE_{y, \text{ex-post}}$	Baseline emissions calculated as per paragraph ex post monitored values	1 st CP; 01/01/2019 to 30/11/2019 = 98,090

PE _{y, ex-post}	Project emissions calculated as per paragraph ex post monitored values	For AMS-III.H BE_{y, ex-post} approach 1 st CP; 01/01/2019 to 30/11/2019 = 38,352 For AMS-III.H MD_y approach 1 st CP; 01/01/2019 to 30/11/2019 = 1,097
MD _y	Methane captured and destroyed/gainfully used by the project activity in the year y	1 st CP; 01/01/2019 to 30/11/2019 = 101,159

The ex-post emission reductions during this monitoring period, from 01/01/2019 to 30/11/2019 were based on the lower value between the COD approach and MD approach. The emission reductions for this monitoring period as calculated, are equal to 59,738 tCO₂e.

During this monitoring period, the ex-post emission reduction was higher than the ex-ante estimation. The reason for the higher emission reduction came from higher quantity of wastewater entering the system. The project owner has claimed that cassava roots themselves have higher water content in them. Another reason is from the 75% conservative value that was applied to the ex-ante calculation during validation.

It may also be the case that, in the future verifications, the quantity of biogas increase. Therefore; it can be concluded that the decrease in emission reductions is not permanent but dependent on various factors, which can neither be controlled nor predicted in advance.

Where,

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
2019	98,090	38,352	0	59,738
Total			0	59,738