



VCS VERIFICATION REPORT

LINSHU BIOGAS RECOVERY AND POWER
GENERATION PROJECT

(VCS PROJECT ID: 2402)



Document Prepared By

CTI Certification Co., Ltd.

Project Title	Linshu Biogas Recovery and Power Generation Project
Version	01.0
Report ID	CTISC-NC-CBN-202302021

Report Title	Linshu Biogas Recovery and Power Generation Project
Client	Swiss Carbon Value Ltd.
Pages	52
Date of Issue	17/05/2023
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Summary:

CTI Certification Co., Ltd (CTI) has performed the verification of the emission reductions reported for the project activity "Linshu Biogas Recovery and Power Generation Project" (VCS Project ID: 2402) for the monitoring period 11/10/2022 to 10/03/2023, to review and determine the monitored reductions in GHG emissions that have occurred as a result of the project activity. These emission reductions are claimed as Verified Carbon Units (VCU) under the Verified Carbon Standard (VCS) version 4.

The verification was performed on the basis of VCS Program Guide version 4.3 and VCS Standard version 4.4 for the VCS projects, as well as criteria given to provide for consistent project operations, monitoring and reporting. The verification was conducted by means of document review, follow-up interviews and site inspections, and the resolution of outstanding issues. The verification team identified 0 CL, 1 CAR and 0 FAR in this monitoring period.

In CTI's opinion, the GHG emission reductions reported for the project in the monitoring report (version 2.0 dated 04/05/2023) are fairly stated. The GHG emission reductions of the period were calculated correctly on the basis of approved methodology ACM0014 "Treatment of wastewater" (version 08.0) and the monitoring plan contained in the VCS PD (version 3.0 dated 19/07/2021).

CTI does not assume any responsibility towards the issuance and utilization of the VCUs hereby verified and certified. Request for issuance of VCUs shall be made by the project proponent to an approved VCS Program

Registry based on the requirements set out under the most recent version of the VCS Program Guidelines clause on VCS Registration.

The verification of reported emission reductions is based on the information made available to CTI and the engagement conditions detailed in this report. CTI cannot be held liable by any party for decisions made or not made based on this report.

Hence, CTI is able to certify that the emission reductions from the "Linshu Biogas Recovery and Power Generation Project" during the period amount to 158,898 tCO₂e.

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1 INTRODUCTION

Swiss Carbon Value Ltd. has commissioned CTI Certification Co., Ltd (CTI) to carry out the verification and certification of emission reductions reported for the "Linshu Biogas Recovery and Power Generation Project" (the project) for the period 11/10/2022 to 10/03/2023. This report contains the findings from the verification and includes a verification statement for the verified carbon units.

1.1 Objective

Verification is the periodic independent review and ex-post determination by an accredited verification body of the monitored reductions in GHG emissions that have occurred as a result of the registered VCS project activity during a defined verification period.

A verification statement is the written assurance by a verification body that, during a specific period in time, a project activity achieved the emission reductions as verified.

The objective of this verification was to verify and provide a verification statement of emission reductions reported for the "Linshu Biogas Recovery and Power Generation Project" for the period 11/10/2022 to 10/03/2023.

1.2 Scope and Criteria

The scope of the verification is:

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

The criteria of the verification are:

- VCS Program Guide (version 4.3) /43/
- VCS Standard (version 4.4) /42/ and other relevant requirements defined by Verra;
- The approved methodology ACM0014 (version 08.0) /45/ applied by the project;
- All information and references relevant to the project activity's resulting in emission reductions.

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

1.3 Level of Assurance

The verification report expresses a conclusion with a reasonable level of assurance about whether the reported GHG emissions reduction data is free from material misstatement. CTI applied a materiality threshold of 1% (for large projects with ER larger than 300,000 tCO₂e per year) with respect to emission or misstatements concerning reported quantities as per para 3.10.1 and 4.1.8 (4) of VCS Standard, v4.4.

1.4 Summary Description of the Project

Sectoral Scope and Project Type

According to the VCS Program Guide (version 4.3) /43/ and Annex A of the Kyoto Protocol, the project is applicable under the following activity categories:

- Sectoral Scope: 1. Energy (Renewable/non-renewable); 13. Waste handling and disposal
- Project type: Landfill gas power generation project.

Project Background

Project title:	Linshu Biogas Recovery and Power Generation Project
Project proponent:	VPOWER New Energy Technology (LinYi) LTD (China)
Project location:	Linshu County, Linyi City, Shandong Province, China
VCS Project ID:	2402
Applied methodology:	ACM0014 version 08.0
VCS project crediting period:	20/09/2019 to 19/09/2026 (the first 7-year VCS crediting period)
VCU verification period:	11/10/2022 to 10/03/2023

2 VERIFICATION PROCESS

2.1 Method and Criteria

The verification was performed through means of the following three phases in accordance with the requirement of the VCS PD (version 3.0 dated 19/07/2021), the applied methodology, and the VCS Standard (version 4.4) and other relevant VCS requirements:

- A desk review of the monitoring report and all support documents;

- Follow-up interviews with project stakeholders and site inspection;
- The resolution of outstanding issues and the issuance of the verification report and statement.

The following sections outline each step in more detail.

The verification of the emission reductions has assessed all factors and issues that constitute the basis for emission reductions from the project. These include:

- The emission reduction calculations and the relevant data records;
- The calibration and maintenance records for the monitoring instruments;
- The management systems to support the project operation and monitoring.

2.2 Document Review

Based on the requirements of competency, experience and qualified sectoral scopes, CTI appointed a verification team in accordance with CTI's internal procedures.

Function	Name	Technical competence	Task Performance*
Team Leader	Li Ziqi	1, 5, 11, 12, 13	☒ DR ☒ SV ☒ RP ☐ TR
Technical Reviewer	Lin Shunrong	1, 3, 13, 14, 15	☒ DR ☐ SV ☐ RP ☒ TR

*DR=Document review; SV=Site visit; RP=Reporting; TR=Technical review

In addition to the VER/VCU monitoring report /1/, VCS PD (version 3.0 dated 19/07/2021) /7/ and emission reduction calculation spreadsheet /2/, the following documents also were assessed as a part of the verification audit:

- VCS Validation Report of VCS PD, version 02.0 dated 20/07/2021 /8/;
- Baseline and monitoring methodology ACM0014 applied by the project /45/;
- Relevant decisions, clarifications and guidance from the Verra /42/-/45/; and
- Other information and references relevant to the project activity.

During the desk review, CTI has applied standard auditing techniques to assess the quality of information provided. The following activities were performed:

- A review of the data and information presented to verify their completeness;
- A review of the monitoring plan and monitoring methodology, paying particular attention to the frequency of measurements, the quality of metering equipment including calibration requirements, and the quality assurance and quality control procedures; and

An evaluation of data management and the quality assurance and quality control system in the context of their influence on the generation and reporting of emission reductions.

2.3 Interviews

On 14/04/2023 and 15/04/2023, CTI visited the project site (Linshu County, Linyi City, Shandong Province, China) performed on-site assessment. The key personnel of the project were interviewed or assisted the verification team. Main topics of the interview cover implementation of the project construction, applicability of selected methodology, implementation of project monitoring, emission reduction calculation, etc.

The key personnel interviewed are summarized in the table below:

Interviewed personnel	Role	Organization	Subject
Mr. Gao Yisheng	Staff	VPOWER New Energy Technology (LinYi) LTD	Operation of the project activity; Implementation of the monitor plan of the project activity; Data collection and data achievement; Calibration of meters and equipment maintenance; The on-going local stakeholder consultation; Project's sustainable development contributions
Ms. Zhang Shaoping	Accountant		
Ms. Wu Caixia	Staff	Jinyimeng Biological Technology Co., Ltd	Statistic of wastewater data
Mr. Zhang Futao	Staff		
Ms. Zheng Hong	Local resident	Xinyuan Community of Linshu County	The impact of the project activity; The complaint by local stakeholders; The stakeholder consultation during the operation of the project activity.
Mr. Liu Lei	Local resident	Xihekou Village, Linshu County	
Ms. Wang Lili	Local resident	Wuzhaizi Village, Linshu County	
Mr. Li Lei	Director	Linshu County Environmental Protection Bureau	
Ms. Hu Lixiang	Project Manager	Swiss Carbon Value Ltd.	Data collection and ER calculation.

2.4 Site Inspections

The verification team performed the on-site verification (Linshu County, Linyi City, Shandong Province, China) on 14/04/2023 and 15/04/2023. The interviewed personnel and objective are listed in above table. During the on-site assessment, CTI has applied standard auditing techniques to assess the quality of information provided. The following aspects of the project activity have been verified:

- An assessment of the implementation and operation of the registered project activity is as per the VCS PD;

- An assessment of the status and management of the landfill site is as per the VCS PD;
- A review of information flows for generating, aggregating and reporting the monitoring parameters; and
- Interviews with relevant personnel to determine whether the operational and data collection procedures are implemented in accordance with the monitoring plan in the VCS PD;
- A cross-check between information provided in the monitoring report and data from other sources such as plant logbooks and electricity sale receipts;
- A check of the monitoring equipment including calibration performance and observations of monitoring practices against the requirements of the VCS PD and the selected methodology;
- A review of calculations and assumptions made in determining the GHG data and emission reductions; and
- An identification that quality control and quality assurance procedures in place to prevent or identify and correct any errors or omissions in the reported monitoring parameters.

The data presented in the monitoring report were assessed by review of the detailed project documentation and production records, as well as by interviews with personnel from the project developer VPOWER New Energy Technology (LinYi) LTD and observation of collection of measurements, observation of established monitoring and reporting practices and assessment of the reliability of monitoring equipment. This has enabled the verification team to assess the accuracy and completeness of reported monitoring results, to verify the correct application of the approved monitoring methodology and the determination of the emission reductions.

In addition, all parameters required by the monitoring methodology ACM0014 (version 08.0), methodological tool, ie. "Tool to calculate the emission factor for an electricity system" (version 07), "Project and leakage emissions from anaerobic digesters" (version 02), "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03), "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03), "Project emissions from flaring (version 03.0)" and the management system were assessed during the site visit.

2.5 Resolution of Findings

A corrective action request (CAR) shall be raised, where:

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

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

The verification team identified 0 CL and 1 CAR in this monitoring period.

2.5.1 Forward Action Requests

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

CTI confirmed that there was no FAR identified in validation /7//8/, and no FAR was raised during this verification.

2.6 Eligibility for Validation Activities

The VCS PD of the project activity was validated by LGAI Technological Center, S.A. (Applus+ Certification) on 20/07/2021 /8/. The proposed monitoring period 11/10/2022 to 10/03/2023 is the 4th VCS verification, and CTI just undertook verification activities for the project according to the VCS Program Guide under scope 1 and 13. This section is thus not applicable.

Furthermore, CTI confirmed that VVBs conducted registration and issuance of the project activity were as follows:

Item	VVB
Registration of VCS PD	LGA Technological Center, S.A. (Applus+ Certification)
Verification of 1 st VCS monitoring period 20/09/2019-11/10/2021	LGA Technological Center, S.A. (Applus+ Certification)
Verification of 2 nd VCS monitoring period 12/10/2021-10/04/2022	CTI
Verification of 3 rd VCS monitoring period 11/04/2022- 10/10/2022	CTI
Verification of 4 th (this) VCS monitoring period 11/10/2022-10/03/2023	CTI

As per 4.1.23 of VCS Standard version 4.4, Validation (including project crediting period renewal validation) and the first verification of a project (in a given project crediting period) may be undertaken by the same validation/verification body and a validation/verification body shall not verify more than six consecutive years of a project's GHG emission reductions or removals. CTI conducted validation and first verification (with monitoring period less than 6 years) of the project activity and therefore it is confirmed that 4.1.23 of VCS Standard version 4.4 have been met.

3 VALIDATION FINDINGS

3.1 Participation under Other GHG Programs

The project was validated by LGAI Technological Center, S.A. (Applus+ Certification) on 20/07/2021 for registration of VCS PD (<https://registry.verra.org/app/projectDetail/VCS/2402>). The project does not participate in the other emissions trading program by checking public information on Internet, interviewing with project owner and statement issued by project owner.

Therefore, CTI deemed the project is eligible to participate under the VCS Program as there is no double counting for the emission reduction during any period.

3.2 Methodology Deviations

The validation process /8/ has assessed all factors and issues that constitute the basis for emission reductions from the project according to the applicable CDM methodology ACM0014 (version 08.0) /42//45/. There was not any methodology deviation applied to this project. Details refer to section 4.1.

3.3 Project Description Deviations

By checking the registered VCS PD /7/ and site visit interview with project owner, it is confirmed that there were no project description deviations identified by CTI to this monitoring period.

The verification team assessed through visual inspection and document review that all physical features of the proposed project activity including data monitoring, reporting and collecting systems have been implemented in accordance with the monitoring plan included in the registered VCS PD (version 3.0 dated 19/07/2021) /7/. Details refer to section 4.1.

3.4 Grouped Project

The project was not a grouped project; hence this clause is not applicable.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

Project Implementation in accordance with the registered project design document

The project is a biogas recovery and power generation project located in Linshu County, Linyi City,

Shandong Province, P.R China, of which the main purpose is to use biogas recovered from the wastewater generated in alcohol production process to generate electricity and heat, which will be used for the production of Jinyimeng company to replace those from North China Power Grid (NCPG) and coal boilers. The total installed capacity of the project activity is 13.6 MW, consisting of 6 units of 1.2 MW generators and 4 units of 1.6 MW generators, and 1 unit of 1.2 MW for backup. During the 7 years crediting period, the annual power generated by the project is expected to be 93,840 MWh which will be exported to the grid. The annual heat generated by the project is about 54,000 t. The Project can reduce GHG emissions by replacing the electricity generated by fossil fuel fired power plants of North China Power Grid (NCPG). Meanwhile by utilization the biogas recovered by the project, the project activity avoids the emission of methane that would be generated during treating through a series of deep open anaerobic lagoons without biogas recovery. As per registered PD, the wastewater treatment amount is about 10,000 m³/day, the inflow COD concentration of anaerobic digester is 55,000 mg/L, and inflow COD is 1,000 mg/L. After a series of treatment, the discharge COD will meet the national waste water discharging standard. The project participant only claims emission reductions from methane recovery and electricity generation. It's estimated that the proposed project could avoiding methane of 290,883 tCO₂e and achieve GHG emission reductions of 359,691 tCO₂e annually in the first crediting period.

The actual implementation of the project during this verification period was verified in terms of name plate capacities of each gas engine, steam boiler and monitoring equipment. The details of gas engine and steam boiler with respect to installation and capacity have been verified to be consistent with description indicated in the VCS PD. The project started construction on 01/11/2018, which has been verified by checking the Validation Report of registered VCS PD /8/. The project activity put into operation on 20/09/2019, which has been verified by site visit interview,checking operation log /6/ and Commission Report issued by the design party /31/. The electricity generated by the project activity was supplied to the North China Power Grid (NCPG), which can be confirmed by the Power Purchase Agreement (PPA) signed between the project owner and Jinyimeng company /3/. The project start date was identified as 20/09/2019 when the project activity started to operate and began generating GHG emission reductions.

The technical parameters have been verified with the nameplates /22/ as below:

Equipment	Model	Number	Key technical parameters
Gas engine	12V 4000 L32FB (engine model)	7 (including 1 backup)	Capacity: 1200kW Lifetime: no less than 21 years Year of manufacture: 2017
Gas engine	16V 4000 L32FB (engine model)	4	Capacity: 1600kW Lifetime: no less than 21 years Year of manufacture: 2017
Steam boiler	Q33.4/445-5.0-1.0/220	1	Evaporation: 5t/h

			Rated steam pressure: 1.0MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018
Steam boiler	Q24.6/445-3.8-1.0/220	1	Evaporation: 3.8t/h Rated steam pressure: 1.0MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018

As per registered VCS PD, the project activity involves the installation of anaerobic biogas recovery system, consisting of biogas generation system, biogas handling and utilization and post-treatment system. The same was confirmed through onsite inspection. The details were as follows:

Anaerobic treatment (Biogas generation system): The effluent from the alcohol production process will be treated by the biogas system using three phase anaerobic fermentation tanks. In these methane reactors, organic compounds in wastewater are transformed mainly into biogas.

Biogas handling and utilization system: The biogas generated are stored in the biogas tank, and then treated in Washing tower and desulfurization tower, and purification equipment. After desulfurization, filter, dehydration, pressurization, the biogas will be routed to gas engines and boilers for the generation of power and thermal energy. Gas engines for power generation are installed with a total capacity of 13.6MW. When the generator set are in malfunction, or excess biogas, if any, the biogas will be sent to high temperature open flare to destroy.

Post-treatment system: The wastewater will continue to flow from the anaerobic digesters to a series of open lagoons. After the whole treatment process, the COD concentration of the wastewater will be in comply with national integrated wastewater discharge standard and will be discharged to local wastewater treatment area.

By checking operation log /6/, on site investigation and interviewing PP during site visit, the verification team confirmed that:

- The project is completely operational;
- there is no proposed or actual change to the VCS PD during this monitoring period;
- All required equipments and procedures are available and implemented in an appropriate manner;
- All necessary monitoring instruments are installed;
- All required instruments including standby and operating procedures for the same have been implemented in an appropriate manner;
- Neither mistakes nor malfunction on main meters have been observed during this monitoring period;

- The control system at the power plant is automated and assures continuous operation, including monitoring on malfunction of equipment;
- No serious malfunction happened and the plant was under a normal operation as expected in this monitoring period.

All the monitoring system in operation period is consistent with the description and monitoring plan in the VCS PD. The control system at the power plant is automated and assures continuous operation, including monitoring on malfunction of equipment. By checking the daily operation and maintenance records /6/, CTI can confirm that no serious malfunction happened and the plant was under a normal operation as expected in this monitoring period.

Furthermore, on-site training for the related procedures including monitoring, recording and reporting was verified to be in place /5/ and their implementation was confirmed by interview with the key operators and observing the operation.

In conclusion, as part of the site visit, CTI confirms that:

- the monitoring plan contained in the registered VCS PD (version 3.0 dated 19/07/2021) is in accordance with the approved methodology applied by the project activity, i.e. ACM0014 (Version 08.0);
- the project implementation is in accordance with the monitoring plan contained in the the registered VCS PD (version 3.0 dated 19/07/2021);
- all the monitoring system in operation period is consistent with the description and monitoring plan in the VCS PD;
- all physical features of the proposed project activity including data collection systems and storage systems have been implemented in accordance with monitoring plan contained in the VCS PD (version 3.0 dated 19/07/2021) through visual inspection and document review.

Participation or any rejection under any other GHG programs

CTI checked public information from the UNFCCC website, REC Mechanism database of China, Chinese Emission Trading System, Gold Standard Registry and interviewed with project owner during site visit, it is confirmed that except VCS scheme, the project has not been participated or been rejected under any other GHG programs since validation. The same has been confirmed through interviewing with project owner.

Other Forms of Credit and Supply Chain (Scope 3) Emissions

- ✓ Emission Trading Programs and Other Binding Limits: The verification team checked the REC Mechanism database of China, Chinese Emission Trading System (Chinese ETS) and Chinese Certified Emission Reduction Mechanism, and found that the project activity is not accredited / registered under REC mechanism, Chinese ETS, or CCER mechanism. Also, CCER mechanism is currently suspended by Chinese government, the project activity will not and is not allowed to

registered under CCER mechanism. Thus, the assessment team concluded that the project activity not involved on other emissions trading programs and other binding limits.

- ✓ Other Forms of Environmental Credit: The verification team checked the REC Mechanism database of China, I-REC database and confirmed that there are no other forms of environmental credits applied or issued for the project activity. The emission reduction resulted from the project during this monitoring period would only apply for VCUs.
- ✓ Supply Chain (Scope 3) Emissions: The Project can reduce GHG emissions by utilization biogas recovered from the wastewater generated in alcohol production process to generate electricity and heat, replacing those from North China Power Grid (NCPG) and coal boilers. No emission reductions from heat generation was claimed for the project activity, and for biogas utilization and power generation projects, the GHG emission reductions come from avoiding CO₂ emissions from those fossil fuel-based power plants connected to the grid and avoiding methane emissions from anaerobic treatment of the wastewater in open lagoons, and does not happen in a supply chain. Therefore, it is confirmed that the Supply Chain (Scope 3) Emissions are not applicable for the project activity.

In conclusion, the verification team confirmed that the project only applies VCUs under VCS, and no rejection from VCS occurs, there are no other forms of environmental credits applied or issued for the project activity, the emission reduction resulted from the project during this monitoring period would only apply for VCUs.

SD contributions resulted by implementation of the project activity

By checking registered VCS PD version 3.0 dated 19/07/2021, Employee list and salary record /21/, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development and 17 SDGs defined by UNDP, interviewing with stakeholders during site visit, the verification team confirmed that the project activity would contribute sustainable development in the region and China's Sustainable Development Goals (SDG). The specific sustainable development goals that the project activity could achieve have been listed as follows:

- **SDG13:** "Take urgent action to combat climate change and its impacts": The project will recover and utilize biogas from wastewater that would otherwise be released directly into the atmosphere, effectively reducing GHG emissions and air pollution in the surrounding area and decreasing odour nuisance and minimizing health risks of local residents. This contributes to achieve one of China's stated sustainable development priorities "Actively adapt to climate change and strengthen resistance capacity to climate risks in agriculture, forestry, water resources and other key fields, as well as cities, coastal regions and ecologically vulnerable areas". During this monitoring period, total GHG emission reductions were 158,898 tCO₂e. And the accumulative emission reductions since operation start were 1,302,579 tCO₂e.

- **SDG7:** "Ensure access to affordable, reliable, sustainable and modern energy for all": the project activity provides clean and renewable energy source through making use of biogas, displacing the power generation of fossil fuel power plants by using renewable energy sources, reducing fossil fuel consumption in NCPG. This contributes to one of the China's actions for promoting sustainable

developing: "by 2030, increase the share of non-fossil fuels in primary energy consumption to about 20 percent". During this monitoring period, Net quantity of electricity generated during this monitoring period was 36,835.8MWh. And the accumulative electricity generation since operation start were 271,772 MWh.

- **SDG 8:** "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all": the project activity will increase employment opportunities for the management, operation and maintenance of the biogas power plant. This contributes to one of the China's actions for promoting sustainable developing: "by 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value". By checking Employee list and salary record /21/, it is confirmed that 22 long-term employment opportunity was provided by the project activity.

4.2 Safeguards

4.2.1 No Net Harm

By checking the EIA summary /14/ and conclusion provided in the VCS PD, it is confirmed that the impact caused by the construction and implementation of the project activity on the surrounding ecosystem and residents, water, and atmosphere etc. is very little, there would be no net harm caused due to the project activity. Also, the EIA of the project /14/ are approved by the government.

Furthermore, no potential environment or social economic matter was found during the site visit.

- ✓ The project uses biogas recovered from the wastewater generated in alcohol production process to generate electricity and heat, which avoids uncontrolled releasing of biogas. Therefore, it reduces greenhouse gas and effluvium emitting to air, and mitigates the possible danger of fire or explosion. The emission of SO₂ and NO_x for this project is less than the emission standards, the flue gas generated in the biogas generator will be cleaned with a set of purification equipment and then emitted by an 15m-high chimney.
- ✓ As per EIA Report /14/ and through onsite inspection, it is verified that the wastewater would come from demineralized water workshop, boiler, biogas treatment gas-liquid separation, desulfurization wastewater during the operation period. The wastewater will be treated in wastewater treatment center at the project site to comply with national standard for discharging. During the operation period, the project uses use biogas recovered from the wastewater generated in alcohol production process to generate electricity and heat, and it avoids uncontrolled releasing of biogas. Therefore, it reduces greenhouse gas and effluvium emitting to air, and mitigates the possible danger of fire or explosion. The emission of SO₂ and NO_x for this project is less than the emission standards, that is because the flue gas generated in the biogas generator will be cleaned with a set of purification equipment and then emitted by an 15m-high chimney.

- ✓ By checking Employee list and salary record /21/, interviewing stakeholders during site visit, the verification team confirmed that the implementation of the project activity could increase employment opportunities in the local area.

4.2.2 Local Stakeholder Consultation

By checking the attendance list of stakeholder consultation meeting /19/, the verification team confirmed that a local stakeholder consultation meeting was held on 16/08/2018 by the project owner. Through interviewing with stakeholders during site visit, the verification team confirmed that before the stakeholder consultation meeting, the project information with contact information and the stakeholder meeting notice were published on the bulletins at and nearby the project site 3 weeks before the stakeholder consultation meeting to invite Local stakeholders.

During the meeting, the project information and the continuous input / grievance mechanism have been introduced to the local stakeholders. The project information with contact information has also been posted on the bulletins at and nearby the project site. A survey was carried out on the local residents and comments received from the survey are summarized as follows. The survey was conducted through distributing and collecting responses to a questionnaire. In total 49 out of 49 questionnaires were returned with a 100% response rate. The opinions expressed by the stakeholders were recorded and are available on request. The stakeholder meeting and the survey showed that the project receives no negative comments on its the construction and operation.

All such conclusion has been verified through site visit and check registered VCS PD.

By checking the filled questionnaires from local stakeholders /18/, it is confirmed by the verification team that communications with local stakeholders was being carried out on 16/08/2018 by the project owner. There are no negative comments received for the project.

By checking the grievance book located in the communication room at the main door of the project owner company. It is confirmed that no negative comments received for the project. Via interviewing with staff from local environmental protection bureau and local residents during the site visit, it is confirmed by the verification team that during the implementation stage of this monitoring period, local authority has conducted spot checks on the implementation of the project periodically as per the request from the local governments' regulations. And it is confirmed by the verification team that there were no negative comments and issues from the local stakeholders during this monitoring period and the project passed all the periodic spot checks by local government.

4.3 AFOLU-Specific Safeguards

For non-AFOLU projects, this section is not required.

4.4 Accuracy of GHG Emission Reduction and Removal Calculations

The monitoring has been carried out in accordance with the monitoring plan contained in the VCS PD (version 3.0 dated 19/07/2021). CTI confirms that all parameters stated in the monitoring plan are

monitored and reported appropriately. All parameters required to be monitored by the monitoring plan as per the monitoring methodology ACM0014 (version 08.0) and the management system were assessed during the site visit. The monitoring report lists each parameter required by the monitoring plan and the information flow (i.e. from data generation, aggregation, recording, calculation and reporting) for these parameters is provided. The information flow for the each parameter is further verified in the following sections.

Parameters monitored

The monitoring has been carried out in accordance with the monitoring plan contained in the registered PD /3/.

Parameter monitored ex ante

The data in table below has been verified against the data sources and the registered PD.

Parameter title	Description	Data	Unit	Source
COD _{out,x}	COD of the effluent in the period x	3130	t COD/year	By checking registered VCS PD, it is confirmed that COD _{out,x} is determined ex ante as 3130 t COD/year, which is calculated by equation: the concentration of COD outflow of anaerobic digester (1,000 mg/L) * the amount of wastewater (10,000 m ³ /day) * the operation days per year (313d). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
COD _{in,x}	COD directed to the open lagoons (Scenario 1) in the period x	172,150	t COD/year	By checking registered VCS PD, it is confirmed that COD _{in,x} is determined ex ante as 172,150 t COD/year, which is calculated by equation: the concentration of COD inflow of anaerobic digester (55,000 mg/L), the amount of wastewater (10,000 m ³ /day), and the operation days per year (313d). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
ρ	Discount factor for historical information	1	/	By checking registered VCS PD, it is confirmed that ρ is determined ex ante as 1, which is sourced from ACM 0014. As per ACM0014, if one year of historical data is available ρ=1. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
B ₀	Maximum methane producing capacity, expressing the maximum amount of CH ₄ that can be produced from a given quantity of chemical	0.21	tCH ₄ /tCOD	By checking registered VCS PD, it is confirmed that B ₀ is determined ex ante as 0.21 tCH ₄ /tCOD, this is a default value from 2006 IPCC Guidelines. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.

	oxygen demand (COD)			consistent with that in the registered PD.
D	Average depth of the lagoons	3.0	m	By checking registered VCS PD, it is confirmed that D is determined ex ante as 3.0 m, which is sourced from FSR. As per FSR /32/, the depth of anaerobic open lagoon is 3m. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
GWP _{CH4}	Global warming potential for CH ₄	27.9	t CO ₂ e/t CH ₄	IPCC Fourth Assessment Report (AR6)
f _d	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation	0.7	/	By checking registered VCS PD, it is confirmed that f_d is determined ex ante as 0.7. As per ACM0014, for anaerobic open lagoon with depth greater than 2m. Therefore, a value of 0.7 has been applied for f_d. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
EF _{EL,j,y} or EF _{grid,CM,y}	Emission factor for electricity generation for source j (NCPG) in year y	0.7119	tCO ₂ /MWh	By checking registered VCS PD, it is confirmed that EF_{EL,j,y} or EF_{grid,CM,y} is determined ex ante as 0.7119 tCO₂/MWh. The value is sourced from 2019 Baseline Emission Factors for Regional Power Grids in China dated 29/12/2019 and calculated based on the “Tool to calculate the emission factor for an electricity system-v7.0”. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
TDL _{k,y}	Average technical transmission and distribution losses for providing electricity to NCPG in year y	3%	/	By checking registered VCS PD, it is confirmed that TDL_{k,y} is determined ex ante as 3%. This is a default value from ‘baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)’. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
TDL _{j,y}	Average technical transmission and distribution losses for providing electricity to source j in year y	20%	/	By checking registered VCS PD, it is confirmed that TDL_{j,y} is determined ex ante as 20%. This is a default value from ‘baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)’. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
F _{ww,CH4,default}	Default factor representing the remaining CH ₄	0.05 for UASB	Fraction	By checking registered VCS PD, it is confirmed that F _{ww,CH4,default} is determined ex ante as 0.05

	production capacity of liquid digestate			(for UASB). The project involves the installation of three-phase digesters. The data was selected based on the tool of project and leakage emissions from anaerobic digesters. The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
$EF_{CH_4, default}$	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester	0.05	$t\ CH_4\ leaked / t\ CH_4\ produced$	By checking registered VCS PD, it is confirmed that $EF_{CH_4, default}$ is determined ex ante as 0.05 $t\ CH_4\ leaked / t\ CH_4\ produced$. This is a default value from Tool of "project and leakage emissions from anaerobic digesters". The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
R_u	Universal ideal gases constant	8,314	$Pa.m^3/kmol.K$	By checking registered VCS PD, it is confirmed that R_u is determined ex ante as 8,314 $Pa.m^3/kmol.K$. This is a default value from "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
MM_i	Molecular mass of greenhouse gas i (CH_4)	16.04	$kg/kmol$	By checking registered VCS PD, it is confirmed that MM_i is determined ex ante as 16.04 $kg/kmol$. This is a default value from "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
P_n	Total pressure at normal conditions	101,325	Pa	By checking registered VCS PD, it is confirmed that P_n is determined ex ante as 101,325 Pa. This is a default value from "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.
T_n	Temperature at normal conditions	273.15	K	By checking registered VCS PD, it is confirmed that T_n is determined ex ante as 273.15 K. This is a default value from "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (version 03). The value in the monitoring report (version 2.0 dated 04/05/2023) has been verified to be consistent with that in the registered PD.

				dated 04/05/2023) has been verified to be consistent with that in the registered PD.
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Parameter monitored ex post

According to the monitoring plan contained in the registered VCS PD, monitoring parameters of the project are verified as follows:

- **Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m ($F_{PJ,dig,m}$)**

This parameter was monitored continuously by flow meter installed at the inlet of digester for measurement of the influent wastewater. By checking Water flow and COD monthly report /11/ and site inspection, the verification team confirmed that the readings of the flow meter was monitored and recorded continuously and aggregated monthly, which is consistent with the registered VCS PD.

$F_{PJ,dig,m}$ was sourced from Water flow and COD monthly report /11/ covering monitoring period. By checking the same, the verification team confirmed that the value of $F_{PJ,dig,m}$ of this monitoring period were:

Period	Value (m^3)
11/10/2022-31/12/2022	703,500
01/01/2023-10/03/2023	570,986

- **Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m ($COD_{dig,m}$)**

This parameter was analyzed daily by analyze instrument in laboratory of the treatment plant (Jinyimeng laboratory). By checking Water flow and COD monthly report /11/ and site inspection, the verification team confirmed that this parameter was analyzed and recorded daily and aggregated monthly. Monthly average value of $COD_{dig,m}$ was calculated, which is consistent with the registered PD.

$COD_{dig,m}$ was sourced from Water flow and COD monthly report /11/ covering monitoring period. By checking the same, the verification team confirmed that the value of $COD_{dig,m}$ of this monitoring period were:

Period	Value ($tCOD/m^3$)
11/10/2022-31/12/2022	0.0542
01/01/2023-10/03/2023	0.0540

- **Average temperature at the project site in month m ($T_{2,m}$)**

This parameter was continuously monitored and monthly aggregated. The detailed monthly average temperature was from national or regional weather statistics¹, and was calculated based on equation: $T_{2,m} (K) = 273.15 K + T_{2,m} (Celsius)$

$T_{2,m}$ was sourced from national or regional weather statistics covering this monitoring period. By checking the same, the verification team confirmed that the value of $T_{2,m}$ of this monitoring period were:

¹ <https://www.tianqi24.com/linshu/history.html>

Jan.	Feb.	Mar.	Apr.	May	Jun.
274.65	275.65	283.65	289.65	294.65	300.15
Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
300.15	300.65	295.15	288.15	284.65	273.65

- **Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester ($EG_{PJ,y}$)**

2 bidirectional electricity meters (meter 1 and meter 2) installed between project site and Jinyimeng company are used to continuously monitor net quantity of electricity generated in year y with biogas from the new anaerobic biodigester (i.e. exported electricity to Jinyimeng company). The meter reading was recorded monthly. At 24:00 hr of 10th of each month, the staff from project owner and Jinyimeng company will record the electricity meter readings and generate Electricity and Biogas Production Monthly Report /12/ and Electricity Transaction Notes (ETNs) /15/.

$EG_{PJ,y}$ was sourced from Biogas Production Monthly Report and Electricity Transaction Notes (ETNs) /15/ covering monitoring period. The conservative data will be used for ER calculation. By checking the same, the verification team confirmed that the value of $EG_{PJ,y}$ of this monitoring period were:

Period	Value (MWh)
11/10/2022-31/12/2022	17,910,213
01/01/2023-10/03/2023	18,925,587

- **Net quantity of grid electricity consumed by the project in year y ($EC_{PJ,y}$)**

2 bidirectional electricity meters (meter 1 and meter 2) installed between project site and Jinyimeng company are used to continuously monitor net quantity of grid electricity consumed by the project in year y (i.e. electricity imported from Jinyimeng company). The meter reading was recorded monthly. At 24:00 hr of 10th of each month, the staff from project owner and Jinyimeng company will record the electricity meter readings and generate Electricity and Biogas Production Monthly Report /12/ and Electricity Transaction Notes (ETNs).

By checking Biogas Production Monthly Report /12/, it was verified no grid electricity was consumed by the project. The same has been confirmed through checking Statement from local power grid company /40/. Therefore, no Electricity Transaction Notes (ETNs) was issued for this monitoring period.

- **Total amount of biogas collected in the outlet of the new digester in year y ($F_{biogas,y}$ ($V_{t,db}$))**

This parameter was continuously monitored by volumetric flow meters (V cone flowmeter). By checking Electricity and Biogas production monthly report /12/ and through site inspection, the verification team confirmed that the readings of volumetric flow meters were continuously monitored and recorded, and was aggregated monthly. Furthermore, the monitored data is automatically converted into data in standard condition (0 °C and 101,325Pa) by DCS system based on the biogas temperature and pressure, which is consistent with methodology and registered PD.

$F_{\text{biogas},y} (V_{t,\text{db}})$ was sourced from Electricity and Biogas production monthly report /12/ covering this monitoring period. By checking the same, the verification team confirmed that the value of $F_{\text{biogas},y} (V_{t,\text{db}})$ of this monitoring period were:

Period	Value (Nm ³)
11/10/2022-31/12/2022	8,523,356
01/01/2023-10/03/2023	8,940,426

- **Concentration of methane in the total biogas supply in the outlet of the new digester at reference conditions ($w_{\text{CH}_4,\text{biogas},y} (V_{\text{CH}_4,t,\text{db}})$)**

Through onsite inspection, it is confirmed that the methane fraction in the total biogas supply in the outlet of the new digester was continuously measured by a methane detector and was recorded automatically by DCS system. By checking Monthly Report of Methane Concentration /13/, it is confirmed that the monitoring data was aggregated monthly. The parameter $w_{\text{CH}_4,\text{biogas},y} (V_{\text{CH}_4,t,\text{db}})$ is calculated through equation: methane fraction * methane density (0.716 kg/m³). All these are consistent with the registered PD.

$w_{\text{CH}_4,\text{biogas},y} (V_{\text{CH}_4,t,\text{db}})$ was sourced from Monthly Report of Methane Concentration /13/ covering this monitoring period. By checking the same, the verification team confirmed that the value of $w_{\text{CH}_4,\text{biogas},y} (V_{\text{CH}_4,t,\text{db}})$ of this monitoring period were:

Period	methane fraction (m ³ CH ₄ /m ³ dry gas)	Methane Concentration (kg CH ₄ /m ³)
11/10/2022-31/12/2022	59.92%	0.4290
01/01/2023-10/03/2023	59.84%	0.4284

CTI has on-site checked the location of the monitoring equipment against the diagram of monitoring system and found them to be consistent. The data reported in the monitoring report and ERs calculation spreadsheet has been verified by the verification team. Supporting references and data required to determine the parameters for calculating emission reductions are found to be complete and transparent.

Monitoring equipment and calibration

The monitoring equipments /30/ have been calibrated periodically as per the relevant industrial standard by the qualified third party to ensure the monitoring equipments' accuracy and in good conditions. The relevant information of monitoring equipments' calibration /23/-/27/ is listed as below.

Monitoring parameter	Monitoring equipment	Serial Number	Type	Accuracy Class	Calibration Date	Validity
F _{PJ,dig,m}	Electromagnetic flowmeter	202011106	JY-LDE-DN65	0.5%	14/05/2021	13/05/2022
					10/05/2022	09/05/2023
COD _{dig,m}	Electronic balance	1129150058	AB204-S	qualified	14/05/2021	13/05/2022
					10/05/2022	09/05/2023
	Acid burette	SD310602	50ml	qualified	14/05/2021	13/05/2022
					10/05/2022	09/05/2023
	Drying oven	3806004	DHG-9075A	qualified	14/05/2021	13/05/2022
					10/05/2022	09/05/2023
EG _{PJ,y} EC _{PJ,j,y}	Electricity meter 1	1708417085000001	DTSD341	0.2S	21/02/2022	20/02/2023
					15/02/2023	14/02/2024
	Electricity meter 2	1708417085000002	DTSD341	0.2S	22/02/2022	21/02/2023
					16/02/2023	15/02/2024
F _{biogas,y} (V _{t,db})	V cone flowmeter 1	F61-2005-0725	FFM61S300A10RFM2N	0.5	21/02/2022	20/02/2023
					15/02/2023	14/02/2024
	V cone flowmeter 2	F61-2005-0726	FFM61S300A10RFM2N	0.5	22/02/2022	21/02/2023
					16/02/2023	15/02/2024
	Temperature meter 1	3650022	644HAK5J6M5	±0.5°C	09/08/2022	08/02/2023
					06/02/2023	05/08/2023
	Temperature meter 2	3650023	644HAK5J6M5	±0.5°C	10/08/2022	09/02/2023
					07/02/2023	06/08/2023
	Pressure gauge 1	7917305	-10~50Kpa	0.065 class	09/08/2022	08/02/2023
					06/02/2023	05/08/2023
	Pressure gauge 2	7917306	-10~50Kpa	0.065 class	10/08/2022	09/02/2023
					07/02/2023	06/08/2023
WCH _{4,biogas,y} (VCH _{4,t,db})	Methane detector	201908130E01195	/	3%	02/08/2021	01/08/2022
					28/07/2022	27/07/2023

The electromagnetic flowmeter was calibrated by a qualified third party, Linyi Metrology Inspection Institute. Calibration records and accreditation certificates /23//28/ have been verified by the verification team. In the monitoring plan of the VCS PD, it stated that these monitoring instruments will be calibrated and checked for accuracy. By checking the calibration reports, CTI found the calibration frequency of the electromagnetic flowmeter is annual as per national or industry regulations and standards (i.e. Verification Regulation of Electromagnetic Flowmeter (JJG1033-2018) /35/), which is in line with the monitoring plan of the VCS PD and the calibrations of these monitoring instruments are verified to be valid for the whole reporting period.

The electronic balance, acid burette, drying oven were calibrated by a qualified third party, Linshu County Metrology and Testing Institute. Calibration records and accreditation certificates /24//29/ have been verified by the verification team. In the monitoring plan of the VCS PD, it stated that these monitoring instruments will be calibrated and checked for accuracy. By checking the calibration reports, CTI found the calibration frequency of the electronic balance, acid burette, drying oven is annual as per national or industry regulations and standards (i.e. Verification Regulation of Electronic Balance (JJG1036-2008) /35/, Verification Regulation of Working Glass Container (JJG196-2006) /36/, Verification Regulation of Digital Temperature Indicators and Controllers (JJG617-1996) /37/ respectively), which is in line with the monitoring plan of the VCS PD and the calibrations of these monitoring instruments are verified to be valid for the whole reporting period.

The electricity meters were calibrated by a qualified third party, Linyi Metrology Inspection Institute. Calibration records and accreditation certificates /25//28/ have been verified by the verification team. In the monitoring plan of the VCS PD, it stated that these monitoring instruments will be calibrated and checked for accuracy. By checking the calibration reports, CTI found the calibration frequency of the Linyi Metrology Inspection Institute. Calibration records and accreditation certificates /25//28/ is annual as per national or industry regulations and standards (i.e. Technical Administrative Code of Electric Energy Metering (DL/T 448-2016) /20/), which is in line with the monitoring plan of the VCS PD and the calibrations of these monitoring instruments are verified to be valid for the whole reporting period.

The V cone flowmeters, temperature meters, pressure gauges were calibrated by a qualified third party, Linyi Metrology Inspection Institute. Calibration records and accreditation certificates /26//28/ have been verified by the verification team. In the monitoring plan of the VCS PD, it stated that these monitoring instruments will be calibrated and checked for accuracy. By checking the calibration reports, CTI found the calibration frequency of the V cone flowmeters is annual as per national or industry regulations and standards (i.e. Verification Regulation of Differential Pressure Flowmeters (JJG640-2016) /41/), while that of the temperature meters, pressure gauges is every half year as per national or industry regulations and standards (i.e. Calibration Specification of the Temperature Transmitter (JJF1183-2007) /38/, Verification Regulations for Elastic Element General Pressure Gauges and Pressure Vacuum Gauges, and Vacuum Gauges (JJG52-2013) /39/), which is in line with the monitoring plan of the VCS PD and the calibrations of these monitoring instruments are verified to be valid for the whole reporting period.

The methane detector was calibrated by a qualified third party, Linyi Metrology Inspection Institute. Calibration records and accreditation certificates /27//28/ have been verified by the verification team. In the monitoring plan of the VCS PD, it stated that the methane detector will be calibrated and checked for accuracy. By checking the calibration reports, CTI found the calibration frequency of the Methane detector is annual as per national or industry regulations and standards (i.e. Digital Indicating Weighing Instrument (JJG 539-2016) /29/), which is in line with the monitoring plan of the VCS PD and the calibrations of meters are verified to be valid for the whole reporting period.

Data management and control

The project owner is responsible for operation and routine maintenance of power plant under the project activity. The quality assurance and quality control procedures have been addressed in the VER project management and monitoring manual /4/, including the organization structure with the responsibilities, personnel competencies, monitoring procedures and monitoring management. By interview with the staff and check records /4/-/6/ during on-site visit, it can be confirmed that the monitoring management system is implemented following the project management and monitoring manual.

All monitoring devices have been calibrated and maintained periodically to ensure the accuracy of measurement. Calibration records of instruments used in measurements were made available during the verification visit and found to be valid for the entire period of the verification. Competence and training records of in-plant personnel engaged in measurement of plant parameters were presented during verification and found to be in order.

CTI confirms that appropriate methods and formulae for calculating baseline emissions, project emissions and leakage have been followed, and the assumptions, emission factors and default values that are applied in the calculation have been justified.

Emission reduction calculation

I. Baseline emissions

As per registered VCS PD, baseline reductions are determined as:

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y} \quad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year y (tCO ₂ e/yr)
$BE_{CH4,y}$	=	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 /yr)

$BE_{HG,y}$ = CO_2 emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (tCO_2/yr)

The project activity does not consider emission reductions of heat generation for simplification, which is conservative. Therefore, $BE_{HG,y} = 0$ and for the project activity, $BE_y = BE_{CH_4,y} + BE_{EL,y}$

Baseline emissions from anaerobic treatment of the wastewater ($BE_{CH_4,y}$)

As per ACM0014 and registered PD, the methodology proposes to use the minimum value between the methane produced after the implementation of the proposed project activity and methane conversion factor method for the estimation of methane emissions from open lagoons in case of the wastewater lagoons.

$$BE_{CH_4,y} = \min \{Q_{CH_4,y}; BE_{CH_4,MCF,y}\} \quad \text{Equation (2)}$$

Determination of $Q_{CH_4,y}$

As per ACM0014 and registered PD, project proponent shall use Step 1 “Determination of the quantity of methane produced in the digester ($Q_{CH_4,y}$)” of the latest version of the tool “Project and leakage emissions from anaerobic digesters” to determine the amount of methane produced after the implementation of the project activity ($Q_{CH_4,y}$).

As per step 1 of the “Project and leakage emissions from anaerobic digesters (v2.0)”, For large scale projects only Option 1 (procedure using monitored data) shall be used to determine the quantity of methane produced in the digester ($Q_{CH_4,y}$). For small scale projects, project participants may choose between Option 1 (procedure using monitored data) or Option 2 (procedure using a default value).

The project activity is a large scale project. Therefore, option 1 (Procedure using monitoring data) shall be used.

According to option 1, $Q_{CH_4,y}$ shall be measured using the “Tool to determine the mass flow of greenhouse gas in a gaseous stream”. When applying the tool, the following applies:

- (a) The gaseous stream to which the tool is applied is the biogas collected from the digester;
- (b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and
- (c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y . Please note that units need to be converted to tons, when applying the results in this tool.

As per para. 13 of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”, the mass flow of methane ($F_{CH_4,t}$) is determined through measurement of the flow and volumetric fraction of the gaseous stream. The proposed project proponent chooses the measurement option A as per table 2 (measurement options) of this tool.

The volume flow and the volumetric fraction of the gaseous stream is determined according to the option A under option 2 “simplified calculation without measurement of the moisture content”. In line with para 23 of this tool, the dry gaseous stream shall be demonstrated and there are two ways to do

this. Since the gaseous stream is less than 60°C at the flow measuring point, the project participant chosen method b. The temperature of gaseous stream has been confirmed through checking Yearly Biogas Recovery and Use Record. As per this tool, the mass flow of greenhouse gas i (in this case CH₄) (F_{CH₄}) is determined as follows:

$$F_{CH_4,t} = V_{t,db} * V_{CH_4,t,db} * \rho_{CH_4,t} \quad \text{Equation (3)}$$

Where:

F_{CH₄,t} = Mass flow of greenhouse gas CH₄ in the gaseous stream in time interval t (kg/h)

V_{t,db} = Volumetric flow of CH₄ in time interval t on a dry basis (Nm³/h)

V_{CH₄,t,db} = Volumetric fraction of the greenhouse gas CH₄ in the gaseous stream in time interval t on a dry basis (m³ CH₄/m³ dry gas)

ρ_{CH₄,t} = Density of greenhouse gas CH₄ in the gaseous stream in minute m (0.716 kg/m³) at reference conditions

As mentioned in the above equation, the mass flow of greenhouse gas CH₄ (F_{CH₄,t}) in the gaseous stream in the time interval t (kg) will be converted into the quantity of methane produced in the digester (Q_{CH₄,y}) in the unit tCH₄/year.

Density of methane (ρ_{CH₄,t}) is determined at the normal condition in line with below equation.

$$\rho_{i,t} = (P_t * MM_{CH_4}) / (R_u * T_t) \quad \text{Equation (4)}$$

Where:

ρ_{i,t} = Density of greenhouse gas (CH₄) in the gaseous stream in time interval t (kg/m³).

P_t = Absolute pressure of the gaseous stream in time interval t (Pa). 101,325

MM_{CH₄} = Molecular mass of CH₄ (kg/kmol). 16.04

R_u = Universal ideal gases constant (Pa.m³/kmol.K). 8,314

T_t = Temperature of the gaseous stream in time interval t(K). 273.15

The verification team confirmed that in normal conditions, P_t = 101,325 Pa, T_t = 273.15 K. MM_{CH₄} is 16.04 kg/kmol and R_u is 8,314 Pa.m³/kmol.K. Therefore, ρ_{CH₄,t} = (P_t * MM_{CH₄}) / (R_u * T_t) = 101,325*16.04/8,314/273.15 = 0.716. Parameters V_{t,db} and V_{CH₄,t,db} were monitored ex post and have been justified in section 4.1 of this report. Therefore, Q_{CH₄,y} of this monitoring period is calculated as:

Month	V _{t,db} (m ³ biogas)	V _{CH₄,t,db}	ρ _{CH₄,t} (kgCH ₄ /m ³ CH ₄)	F _{CH₄,t} (tCH ₄)	Q _{CH₄,y} (tCO ₂)
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11/10/2022-31/12/2022	8,523,356	59.92%	0.716	3657	102,030
01/01/2023-10/03/2023	8,940,426	59.84%	0.716	3831	106,885

Determination of $BE_{CH_4, MCF, y}$

As per ACM0014 and registered PD, the baseline methane emissions from anaerobic treatment of the wastewater in open lagoons are estimated based on the chemical oxygen demand (COD) of the wastewater that would enter the lagoon or sludge in the sludge pits in the absence of the project activity ($COD_{BL, y}$), the maximum methane producing capacity (B_o) and a methane conversion factor ($MCF_{BL, y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH_4, MCF, y} = GWP_{CH_4} * MCF_{BL, y} * B_o * COD_{BL, y} \quad \text{Equation (5)}$$

Where:

- GWP_{CH_4} = Global Warming Potential of methane valid for the commitment period (t CO₂e/tCH₄)
- B_o = Maximum methane producing capacity, expressing the maximum amount of CH₄ that can be produced from a given quantity of chemical oxygen demand (t CH₄/tCOD)
- $MCF_{BL, y}$ = Average baseline methane conversion factor (fraction) in year y, representing the fraction of ($COD_{PJ, y} \times B_o$) that would be degraded to CH₄ in the absence of the project activity
- $COD_{BL, y}$ = 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)

✓ Determination of $COD_{BL, y}$

v , 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 with the COD in the effluent.

$$COD_{BL, y} = \rho (1 - (COD_{out, x} / COD_{in, x})) * COD_{PJ, y} \quad \text{Equation (6)}$$

Where:

- $COD_{BL, y}$ = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in year y (t COD/yr)
- $COD_{out, x}$ = COD of the effluent in the period x (t COD)
- $COD_{in, x}$ = COD directed to the open lagoons (Scenario 1) in the period x (t COD)
- x = Representative historical reference period

ρ = Discount factor for historical information

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

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} * COD_{dig,m} \quad \text{Equation (7)}$$

Where:

$COD_{PJ,y}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester in the project activity in year y (tCOD/yr)

$F_{PJ,dig,m}$ = Quantity of wastewater that is treated in the anaerobic digester in the project activity in month m (m³/month)

$COD_{dig,m}$ = Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m (t COD/m³)

m = Months of year y of the crediting period

Parameters $F_{PJ,dig,m}$ and $COD_{dig,m}$ are monitored ex post and have been justified in section 4.1 of this report. The other input parameters for calculating $COD_{BL,y}$ have been verified by the verification team which are listed in below table:

Parameter	Data unit	Value applied	Verification
$COD_{out,x}$	tCOD/yr	3,130	As per registered VCS PD, outflow COD concentration of anaerobic digester is 1,000 mg/L, the designed amount of wastewater is 10,000 m ³ /day, and the operation days per year is 313d. Therefore, $COD_{out,x}$ is calculated as 1,000 mg/L * 10,000 m ³ /day * 313 days/yr.
$COD_{in,x}$	t COD/yr	172,150	As per registered VCS PD, inflow COD concentration of anaerobic digester is 55,000 mg/L, the designed amount of wastewater is 10,000 m ³ /day, and the operation days per year is 313d. Therefore, $COD_{in,x}$ is calculated as 55,000 mg/L * 10,000 m ³ /day * 313 days/yr.
ρ	/	1	This parameter is determined ex ante and has been justified in section 4.1 of this report.

Therefore, $COD_{BL,y}$ of this monitoring period is calculated as:

Monitoring period	$COD_{dig,m}$ (tCOD/m ³)	$F_{PJ,dig,m}$ (m ³)	$COD_{PJ,y}$ (tCOD)	$COD_{out,x}$ (tCOD)	$COD_{in,x}$ (tCOD)	$COD_{BL,y}$ (tCOD)
11/10/2022-31/12/2022	0.0542	703,500	38,141	3,130	172,150	37,447
01/01/2023-10/03/2023	0.0540	570,986	30,826	3,130	172,150	30,265

✓ Determination of $MCF_{BL,y}$

As per ACM0014 and registered PD, 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. Accordingly, the methane conversion factor is calculated based on a factor f_d , expressing the influence of the depth of the lagoon 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:

$$MCF_{BL,y} = f_d * f_{T,y} * 0.89 \quad \text{Equation (8)}$$

Where:

$MCF_{BL,y}$ = 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 on methane generation

$f_{T,y}$ = Factor expressing the influence of the temperature on the methane generation in year y

0.89 = Conservativeness factor

For parameter f_d in equation (8), this parameter represents the influence of the average depth of the lagoons on methane generation.

$$f_d = \begin{cases} 0; & \text{if } D < 1 \text{ m} \\ 0.5; & \text{if } 1\text{m} \leq D < 2\text{m} \\ 0.7; & \text{if } D \geq 2\text{m} \end{cases} \quad \text{Equation (9)}$$

Where:

f_d = Factor expressing the influence of the depth of the lagoons on methane generation

D = Average depth of the lagoons (m)

The value of f_d is determined from the average depth of the anaerobic open lagoon. Since the depth of anaerobic open lagoon is 3m in the baseline scenario, a value of 0.7 has been applied.

For parameter $f_{T,y}$ in equation (8), 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, 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, less any effluent, plus the COD that may have remained in the lagoon from previous months, as follows:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m-1}) * COD_{available,m-1} \quad \text{Equation (10)}$$

Where:

$COD_{available,m}$ = Quantity of chemical oxygen demand available for degradation in the open lagoon in month m (tCOD/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 (tCOD/month)

$f_{T,m-1}$ = Factor expressing the influence of the temperature on the methane generation in previous month ($m-1$)

m = Months of year y of the crediting period

T = Temperature of the lagoon in the month (deg K)

$COD_{available, m-1}$ = Quantity of chemical oxygen demand that may have remained in the lagoon from previous month $m-1$ (tCOD/month)

$$COD_{BL,y} = (1 - (COD_{out,x}/COD_{in,x})) * COD_{PJ,m} \quad \text{Equation (11)}$$

Where:

$COD_{out,x}$ = COD of the effluent in the period x (tCOD)

$COD_{in,x}$ = COD directed to the open lagoons (Scenario 1) in the period x (tCOD)

$COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month m (tCOD/month)

x = Representative historical reference period

and

$$COD_{PJ,m} = F_{PJ,dig,m} * COD_{dig,m} \quad \text{Equation (12)}$$

Where:

$COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month m (tCOD/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)

$\text{COD}_{\text{dig},m}$ = Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m ($\text{t COD}/\text{m}^3$)

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:

$$f_{T,m} = \begin{cases} 0 & \text{if } T_{2,m} < 278K \\ e^{\left(\frac{E \times (T_{2,m} - T_1)}{R \times T_1 \times T_{2,m}}\right)} & \text{if } 278K \leq T_{2,m} \leq 302.5K \\ 0.95 & \text{if } T_{2,m} > 302.5K \end{cases} \quad \text{Equation (13)}$$

Where:

$f_{T,m}$ = 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:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times \text{COD}_{\text{available},m}}{\sum_{m=1}^{12} \text{COD}_{\text{BL},m}} \quad \text{Equation (14)}$$

Where:

$f_{T,y}$ = 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

$\text{COD}_{\text{available},m}$ = Quantity of chemical oxygen demand available for degradation in the open lagoon in month m ($\text{t COD}/\text{month}$)

$COD_{BL,m}$ = 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)

m = Months of year y of the crediting period

The input parameters for calculating $f_{T,y}$ have been verified by the verification team which are listed in below table:

Parameter	Data unit	Value applied		Verification
$COD_{BL,m}$	tCOD/month	14,292		By checking ER calculation sheet, it is verified that $COD_{BL,m}$ is calculated based on equation: the designed amount of wastewater (10,000 m³/day) * inflow COD concentration of anaerobic digester (0.055 t/m³) * monthly operation days (26 days) * Effluent adjustment factor (0.9995). Effluent adjustment factor is calculated based on equation: 1 - Design COD outflow from the baseline anaerobic lagoon per year / Design COD inflow to the baseline anaerobic lagoon per year Design COD inflow from the baseline anaerobic lagoon per year = design wastewater treatment amount (10,000 m³/day) * inflow COD concentration of baseline anaerobic lagoon (0.055 t/m³) * monthly operation days (26 days) * 12 = 171,600 t COD/year Design COD outflow from the baseline anaerobic lagoon per year = design wastewater treatment amount (10,000 m³/day) * outflow COD concentration of baseline anaerobic lagoon (0.00003 t/m³) * monthly operation days (26 days) * 12 = 94 t COD/year
$f_{T,m}$	/	January	0.00	The parameter is calculated based on equation (13) based on parameter $T_{2,m}$ that is monitored ex post. The detailed calculation process has been included in ER calculation sheet and has verified to be correct.
		February	0.00	
		March	0.18	
		April	0.31	
		May	0.48	
		June	0.78	
		July	0.78	
		August	0.81	
		September	0.50	

		October	0.27	
		November	0.19	
		December	0.00	
COD _{available,m}	tCOD/month	January	14,292	The parameter is calculated through equation (10) and based on parameter COD_{BL,m}, f_{T,m-1}, and COD_{available,m-1}. In the first month, the value of COD_{available,m-1} is assumed to be 0. The detailed calculation process has been included in ER calculation sheet and has verified to be correct.
		February	14,292	
		March	28,584	
		April	26,058	
		May	34,049	
		June	27,762	
		July	21,894	
		August	20,490	
		September	18,445	
		October	24,440	
		November	27,771	
		December	42,064	
COD _{PJ,m}	t COD/m	14,300		By checking ER calculation sheet, it is verified that COD _{PJ,m} is calculated based on equation: the designed amount of wastewater (10,000 m ³ /day) * inflow COD concentration of anaerobic digester (0.055 t/m ³) * monthly operation days (26 days)
f _{T,y}	/	0.6181		The parameter is calculated through equation (14) and based on parameters f _{T,M} , COD _{available,m} and COD _{BL,m} . The detailed calculation process has been included in ER calculation sheet and has verified to be correct.

Based on parameters justified above, BE_{CH₄,MCF,y} of this monitoring period is calculated as:

Monitoring period	MCF _{BL,y}	B ₀ (tCH ₄ /tCOD)	COD _{BL,y} (tCOD)	GWP _{CH₄} (tCO ₂ /tCH ₄)	BE _{CH₄,MCF,y} (tCO ₂)
	A	B	C	D	E=A*B*C*D
11/10/2022-31/12/2022	0.3851	0.21	37,447	27.9	84,492
01/01/2023-10/03/2023	0.3851	0.21	30,265	27.9	68,288

As per ACM0014 and registered VCS PD, BE_{CH₄,y} is calculated as:

Monitoring period	BE _{CH₄,MCF,y} (tCO ₂ /yr)	Q _{CH₄,y} (tCO ₂ /yr)	BE _{CH₄,y} =min(BE _{CH₄,MCF,y} , Q _{CH₄,y})
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11/10/2022-31/12/2022	84,492	102,030	84,492
01/01/2023-10/03/2023	68,288	106,885	68,288
Total in this monitoring period	/	/	152,780

Baseline emissions from generation and/or consumption of electricity ($BE_{EL,y}$)

As per ACM0014 and registered VCS PD, the baseline emissions associated with electricity generation in year y shall be calculated using the "Methodological tool: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". In this step, baseline emissions from the following sources are estimated. In this step, baseline emissions from the following sources are estimated:

(a) Baseline emissions from consumption of electricity associated with the treatment of wastewater (Scenario 1)

(b) Baseline emissions from the generation of electricity in the grid (E2) in the absence of the electricity generation with biogas.

Therefore, baseline emissions from the generation and/or consumption of electricity can be simplified as follows:

$$BE_{EL,y} = (EC_{BL} * EF_{BL,EL,y}) + (EG_{PJ,y} * EF_{PJ,EL,y}) \quad \text{Equation (15)}$$

Where:

$BE_{EL,y}$ = CO₂ 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 (tCO₂/yr)

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) and which is displaced by electricity produced from the project activity (MWh/yr).

$EF_{BL,EL,y}$ = Baseline emission factor for electricity consumed in the baseline in the absence of the project activity in year y (tCO₂/MWh)

$EG_{PJ,y}$ = Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester (MWh/yr)

$EF_{PJ,EL,y}$ = Baseline emission factor for electricity generated by the project activity in year y (tCO₂/MWh).

For simplification, project participants neglect the baseline reductions from source (a). Therefore, $EC_{BL}=0$

$$\text{Therefore, } BE_{EL,y} = (EC_{BL} \times EF_{BL,EL,y}) + (EG_{PJ,y} \times EF_{PJ,EL,y}) = EG_{PJ,y} \times EF_{PJ,EL,y}$$

Before implementation of the project activity, the electricity was from NCPG. Therefore, $EF_{PJ,EL,y} = EF_{grid,CM,y}$.

✓ Determination of $EF_{PJ,EL,y}$ ($EF_{grid,CM,y}$)

The grid emission factor ($EF_{grid,CM,y}$) is calculated as the weighted average of the operating margin (0.5) and build margin (0.5) values. The value of combined margin is sourced from 2019 Baseline Emission Factors for Regional Power Grids in China dated 29/12/2020 published by China DNA. China DNA calculates the data based on Tool to Calculate the Emission Factor for an Electricity System", Version 07.0. No further assessment is required for grid emission calculation as the ex-ante value is sourced directly from the Chinese DNA.

Emission factor ($EF_{grid,CM,y}$): $EF_y = EF_{grid,CM,y} = 0.9419 \times 0.5 + 0.4819 \times 0.5 = 0.7119 \text{ tCO}_2/\text{MWh}$.

Therefore, $BE_{EL,y}$ and BE_y is calculated as:

Monitoring period	$EG_{PJ,y}$ (MWh)	$EF_{grid,CM,y}$ (tCO ₂ /MWh)	TDL _{k,y}	$BE_{EL,y}$ (tCO ₂)
	A	B	C	$D = A \times B \times (1 + C)$
11/10/2022-31/12/2022	17,910.213	0.7119	3%	13,133
01/01/2023-10/03/2023	18,925.587	0.7119	3%	13,877
Total in this monitoring period	36,835.8	0.7119	3%	27,010

Monitoring period	$BE_{EL,y}$ (tCO ₂)	$BE_{CH_4,y}$ (tCO ₂)	BE_y (tCO ₂)
11/10/2022-31/12/2022	13,133	84,492	97,624
01/01/2023-10/03/2023	13,877	68,288	82,165
Total in this monitoring period	27,010	152,780	179,789

II. Project emissions

Project emissions associated with anaerobic digester ($PE_{AD,y}$)

As per ACM0014, emissions attributed to the project activity depend on which scenario in Table 2 of the methodology applies and the configuration of the project activity:

- In the case of project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge. Use the latest approved version of the tool "Project and leakage emissions from anaerobic digesters" to calculate project emissions;
- In the case of project activities that introduce a treatment of sludge or land application of wastewater. Estimate methane and nitrous oxide emissions from land application of sludge following section 5.5.1 of the methodology;

(c) In the case of project activities where wastewater is dewatered and directed to land application. Estimate methane and nitrous oxide emissions from land application of wastewater following section 5.5.2 of the methodology.

The project activity applies for condition (a) above, therefore, the latest approved version of the tool “Project and leakage emissions from anaerobic digesters” was used by the project participant to calculate project emissions.

According to para. 13 of the tool “Project and leakage emissions from anaerobic digesters (v2.0)”, the project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y} \quad \text{Equation (16)}$$

Where:

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year y (t CO₂e)

$PE_{EC,y}$ = Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO₂e)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption associated with the anaerobic digester in year y (t CO₂e)

$PE_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year y (t CO₂e)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (t CO₂e)

✓ Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

As per this tool, for large scale project, Option 1 shall be used for determination of the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). $Q_{CH4,y}$ shall be measured using “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. When the applying the tool, the following applies:

The gaseous stream to which the tool is applied is the biogas collected from the digester;

CH₄ is the greenhouse gas i for which the mass flow should be determined; and

The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

The quantity of methane produced in the digester ($Q_{CH4,y}$) is determined as following equation of the tool;

$$Q_{CH4,y} = F_{CH4,t} = V_{t,db} * V_{CH4,t,db} * \rho_{CH4,t} \quad \text{Equation (17)}$$

Where:

$F_{CH_4,t}$	=	Mass flow of greenhouse gas CH_4 in the gaseous stream in time interval t (kg/h)
$V_{t,db}$	=	Volumetric flow of CH_4 in time interval t on a dry basis (Nm^3/h)
$V_{CH_4,t,db}$	=	Volumetric fraction of the greenhouse gas CH_4 in the gaseous stream in time interval t on a dry basis ($m^3 CH_4/m^3$ dry gas)
$\rho_{CH_4,t}$	=	Density of greenhouse gas CH_4 in the gaseous stream in minute m ($0.716 kg/m^3$) at reference conditions

As mentioned in the above equation, the mass flow of greenhouse gas CH_4 ($F_{CH_4,t}$) in the gaseous stream in the time interval t (kg) will be converted into the quantity of methane produced in the digester ($Q_{CH_4,y}$) in the unit $tCH_4/year$.

Project emission 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:

$$PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4} \quad \text{Equation (18)}$$

Where:

$PE_{CH_4,y}$	=	Project emissions of methane from anaerobic digester in year y (tCO_2e)
$Q_{CH_4,y}$	=	Quantity of methane produced in the anaerobic digester in year y (tCH_4)
$EF_{CH_4,default}$	=	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester (fraction)
GWP_{CH_4}	=	Global warming potential of CH_4 ($tCO_2/t CH_4$)

Based on parameters justified above, $PE_{CH_4,y}$ is calculated as:

Monitoring period	$Q_{CH_4,y}$ (tCH_4)	$EF_{CH_4,default}$	GWP_{CH_4} (tCO_2/tCH_4)	$PE_{CH_4,y}$ (tCO_2)
	A	B	C	D=A*B*C
11/10/2022-31/12/2022	3,657	0.05	27.9	5,101
01/01/2023-10/03/2023	3,831	0.05	27.9	5,344
Total in this monitoring period	7,488	/	/	10,445

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

As per the tool “Project and leakage emissions from anaerobic digesters”, the project emissions from electricity consumption ($PE_{EC,y}$) shall be determined using the “Tool to calculated baseline, project and/or leakage emission from electricity consumption”.

The Option 1 of the tool “Project and leakage emissions from anaerobic digesters” is applied. The project emissions from consumption of electricity are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses, as follows:

$$PE_{EC,y} = \sum_j EC_{PJ,j,y} * EF_{EL,j,y} * (1 + TDL_{j,y}) \quad \text{Equation (19)}$$

Where:

- $PE_{power,y}$ = Project emissions from electricity consumption in year y (tCO₂/yr)
- $EC_{PJ,j,y}$ = Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr).
- $EF_{EL,j,y}$ = Emission factor for electricity generation source j in year y (tCO₂/MWh).
- $TDL_{j,y}$ = Average technical transmission and distribution losses for providing electricity to source j in year y.
- j = Source of electricity consumption in the project. For the project activity, the electricity from the national grid is consumed.

The project emissions from electricity consumption ($PE_{EC,y}$) in this monitoring period is calculated as:

Monitoring period	$EC_{PJ,j,y}$ (MWh)	$EF_{EF,grid,y}$ (tCO _{2e} /MWh)	$TDL_{j,y}$	$PE_{EC,y}$ (tCO ₂)
	A	B	C	D=A*B*(1+C)
11/10/2022-31/12/2022	0	0.7119	20%	0
01/01/2023-10/03/2023	0	0.7119	20%	0
Total in this monitoring period	0	/	/	0

✓ 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 digestate or any other on-site transportation).

By checking Operation and Maintenance Record /16/, through site inspection and interview with project owner during site visit, it is confirmed electricity are used for restart the auxiliary equipment, steam boiler and generator. No fossil fuel are used for the project activity during this monitoring period. Therefore, $PE_{FC,y} = 0$.

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

If case unexpected emergencies occur, such as engine failure or malfunction or if the biogas is excessive, an open combustion system will be used. In this case, project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the “Tool to determine project emissions from flaring gases containing methane”. The following applies:

- (a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH4,default}$) in applying the tool; and
- (b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

By checking the monitoring report /9/ and verification report /10/ of previous monitoring period, as well as statement from the project owner and through on site investigation, it is confirmed that flaring system will be used when wastewater treatment equipment was stopped for maintenance and/or for normal repairs. The V cone flowmeters were installed in the inlet of generator, not in the main pulp. When the equipment was shutdown, the valve on the pipeline to the generator will be closed, and the biogas will enter the flaring system. During this monitoring period, only a short time of shutdown happened due to normal maintenance.

When calculate the baseline emissions of the project activity, only the biogas entering the generator is included, the biogas flared is not included. That is to say, emission reductions from flared methane are not claimed. Therefore, project emissions due to flaring are not considered, which is deemed by CTI to be conservative and reasonable. Therefore, $PE_{flare,y} = 0$

Therefore, $PE_{AD,y}$ is calculated as:

Monitoring period	$PE_{EC,y}$ (tCO ₂)	$PE_{CH4,y}$ (tCO ₂)	$PE_{flare,y}$ (tCO ₂)	$PE_{FC,y}$ (tCO ₂)	$PE_{AD,y}$ (tCO ₂)
11/10/2022-31/12/2022	0	5,101	0	0	5,101
01/01/2023-10/03/2023	0	5,344	0	0	5,344
Total in this monitoring period	0	10,445	0	0	10,445

Project emissions from leakage associated with storage of digestate ($LE_{storage,y}$)

According to the tool “Project and leakage emissions from anaerobic digesters”, if the storage of digestate or the composting of digestate is occurring within the project boundary, these emissions will be considered as project emissions.

$$LE_y = LE_{AD,y} = LE_{storage,y} + LE_{comp,y} \quad \text{Equation (20)}$$

Where:

$LE_{AD,y}$ = Leakage emissions associated with the anaerobic digester in year y (tCO₂e/yr)

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (tCO₂e/yr)

$LE_{comp,y}$ = Leakage emissions associated with composting digestate in year y (tCO₂e/yr)

Since the project activity does not contain composting, and the effluent treated is the liquid digestate. Therefore, the leakage emission is associated with storage of digestate ($LE_{storage,y}$). In order to determine $LE_{storage,y}$ for liquid digestate, Option 2 of the tool is chosen.

Therefore,

$$LE_y = LE_{AD} = LE_{storage} = F_{ww,CH_4,default} * Q_{CH_4,y} * GWP_{CH_4} \quad \text{Equation (21)}$$

Where:

LE_{AD} = Leakage emissions associated with the anaerobic digester in year y (tCO₂e/yr)

$LE_{storage}$ = Leakage emissions associated with storage of digestate in year y (tCO₂e/yr)

$F_{ww,CH_4,default}$ = Default factor representing the remaining methane production capacity of liquid digestate (fraction)

$Q_{CH_4,y}$ = Quantity of methane produced in the digester in year y (tCH₄)

GWP_{CH_4} = Global warming potential of CH₄ (tCO₂e/t CH₄)

Based on the parameters justified above, $LE_{AD,y}$ is calculated as:

Monitoring period	$F_{ww,CH_4,default}$	$Q_{CH_4,y}$ (tCH ₄)	$GWP_{CH_4,y}$ (tCO ₂ e/t CH ₄)	$LE_{AD,y}$ (tCO ₂)
11/10/2022-31/12/2022	0.05	3,657	27.9	5,101
01/01/2023-10/03/2023	0.05	3,831	27.9	5,344
Total in this monitoring period	0.05	7,701	/	10,445

Therefore, PE_y of the project activity in this monitoring period is calculated as:

Monitoring period	$PE_{AD,y}$ (tCO ₂)	$LE_{AD,y}$ (tCO ₂)	PE_y (tCO ₂)
11/10/2022-31/12/2022	5,101	5,101	10,203
01/01/2023-10/03/2023	5,344	5,344	10,688
Total in this monitoring period	10,445	10,445	20,891

III. Leakages

According to the tool “Project and leakage emissions from anaerobic digesters”, if the storage of digestate or the composting of digestate is occurring within the project boundary, these emissions will be considered as project emissions. Therefore, no leakage is accounted for the project activity and $LE_y = 0$, which is verified to be consistent with registered VCS PD and ACM0014, version 08.0.

IV. Emission reductions

The emission reductions for this monitoring period was calculated as:

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)
11/10/2022-31/12/2022	97,624	10,203	0	87,421
01/01/2023-10/03/2023	82,165	10,688	0	71,477
Total	179,789	20,891	0	158,898

V. Comparison of actual emission reductions or net anthropogenic GHG removals by sinks with estimates in validated VCS PD

Year	Ex-ante emissions reductions/removals	Achieved emissions reductions/removals	Percent difference	Justification for the difference
11/04/2022 - 10/03/2023	148,804	158,898	+6.78%	The main reasons of decreased emission reductions is because the value of GWP_{CH_4} applied for this monitoring period is 27.9 tCO ₂ e/t CH ₄ , while the value in the registered PD is 25 tCO ₂ e/t CH ₄ .

The emission reductions claimed are 158,898 tCO₂e in this monitoring period (i.e. 151 days). Compared with expected emission reductions 148,804 tCO₂e (calculated as $359,691/365 \times 151$) in the VCS PD, the reported emission reductions in this monitoring period are 6.78% higher than that estimated in the registered VCS PD. This is because the value of GWP_{CH_4} applied for this monitoring period is 27.9 tCO₂e/t CH₄, while the value in the registered PD is 25 tCO₂e/t CH₄. The increase of GWP_{CH_4} value and emission reductions has no impact on additionality of the project activity.

Therefore, CTI is able to confirm that the emission reductions reported in this monitoring period are reasonable and appropriate. CTI verified the input data for calculating emission reductions and the calculating process, and confirmed the result were complete and transparent.

4.5 Quality of Evidence to Determine GHG Emission Reductions and Removals

All necessary documentations are collected, referenced and aggregated, which is easily accessible in hard-copy or electronic format. Measurements are performed by calibrated equipment, and the key data can also be cross-checked via other sources, such as records, receipts and inventory data. No assumptions are used that have any material influence on reported emission reductions.

CTI concludes that during this monitoring period, the evidences for determination of emission reductions are sufficient and reasonable, and the calculation of emission reductions is reliable.

4.6 Non-Permanence Risk Analysis

The project is not AFOLU project, and thus non-permanence risk analysis is not applicable for the project.

5 VERIFICATION CONCLUSION

CTI Certification Co., Ltd (CTI) has performed the verification of the emission reductions that have been reported for the project activity "Linshu Biogas Recovery and Power Generation Project" in China (VCS Project ID: 2402) for the period 11/10/2022 to 10/03/2023.

The verification is based on the baseline and monitoring methodology ACM0014 (version 08.0), VCS PD (version 3.0 dated 19/07/2021) and the monitoring report (version 2.0 dated 04/05/2023). The verification consisted of the following three phases:

- i) desk review of the project design and the baseline and monitoring plan;
- ii) follow-up interviews with project stakeholders;
- iii) resolution of outstanding issues and the issuance of the final verification and certification report.

The project proponents are responsible for the collection, calculation and determination of the GHG data in accordance with the monitoring plan and the reporting of GHG emission reductions on the basis set out within the project monitoring report.

Our verification approach was based on the requirements as defined under the applicable VCS Version 4 and relevant UNFCCC requirements. Our approach is risk-based, drawing on an understanding of the risks associated with reporting GHG emissions data and the controls in place to mitigate these. The verification can confirm that:

- the project is implemented and operated as per the VCS PD;
- the monitoring plan in VCS PD is as per the applied methodology;

- the monitoring complies with the monitoring plan in the VCS PD;
- the monitoring report and other supporting documents provided are complete and verifiable and in accordance with the applicable VCS Version 4 and CDM requirements;
- the installed equipment being essential for generating emission reduction runs reliably and is calibrated appropriately;
- the monitoring system is in place and generates GHG emission reductions data;
- the GHG emission reductions are calculated without material misstatements.

It is CTI's responsibility to provide an independent verification statement on the reported GHG emission reductions for the project. Based on an understanding of the risks associated with reporting of GHG emission data and the controls in place to mitigate these, CTI planned and performed our work to obtain the information and explanations that we considered necessary to provide reasonable assurance that reported GHG emission reductions are fairly stated.

CTI does not assume any responsibility towards the issuance and utilization of the VCUs hereby verified and certified. Request for issuance of VCUs shall be made by the project proponent to an approved VCS Program Registry based on the requirements set out under the most recent version of the VCS Program Guidelines clause on VCS Registration.

The verification of reported emission reductions is based on the information made available to CTI and the engagement conditions detailed in this report. CTI cannot be held liable by any party for decisions made or not made based on this report.

In CTI's opinion the GHG emissions reductions of the "Linshu Biogas Recovery and Power Generation Project" for the period 11/10/2022 to 10/03/2023 are fairly stated in the monitoring report (version 2.0 dated 04/05/2023). The GHG emission reductions were calculated correctly on the basis of the approved methodology ACM0014 (version 08.0) and the monitoring plan contained in the VCS PD (version 3.0 dated 19/07/2021).

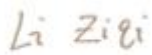
CTI can confirm that the GHG emission reductions are calculated without material misstatements. Based on the evidence and information that are considered necessary to guarantee that GHG emission reductions are appropriately calculated, CTI confirms the following statement:

Verification period: From 11/10/2022 to 10/03/2023

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

Year	Baseline emissions or removals (tCO ₂ e)	Project emissions or removals (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Net GHG emission reductions or removals (tCO ₂ e)
11/10/2022-31/12/2022	97,624	10,203	0	87,421

01/01/2023-10/03/2023	82,165	10,688	0	71,477
Total	179,789	20,891	0	158,898



Mr. Li Ziqi

Team Leader

17/05/2023



Ms. Lin Shunrong

Technical Reviewer

17/05/2023

APPENDIX A: ABBREVIATIONS

CAR	Corrective Action Request
CER	Certified Emission Reduction(s)
CL	Clarification request
CO ₂	Carbon Dioxide
CO ₂ e	Carbon Dioxide Equivalent
CTI	CTI Certification Co., Ltd
DOE	Designated Operational Entity
EF	Emission Factor
ER	Emission Reduction
FAR	Forward Action Request
GHG	Greenhouse Gas(es)
MP	MONITORING REPORT
MR	Monitoring Report
MRRs	Meter Reading Records
NCPG	North China Power Grid
PD	Project Description
PP	Project Proponent
VCS	Verified Carbon Standard
VCU	Verified Carbon Unit

APPENDIX B: REFERENCES

Documentation used to verify the information provided by the project proponents

- /1/ Swiss Carbon Value Ltd.: VER/VCU Monitoring Report for Linshu Biogas Recovery and Power Generation Project, version 1.0 dated 23/03/2023 and version 2.0 dated 04/05/2023.
- /2/ Swiss Carbon Value Ltd.: Emission reduction calculation spreadsheet for Linshu Biogas Recovery and Power Generation Project
- /3/ VPOWER New Energy Technology (LinYi) LTD and Jinyimeng company: Power Purchase Agreement for Linshu Biogas Recovery and Power Generation Project.
- /4/ VPOWER New Energy Technology (LinYi) LTD: VER monitoring manual and management procedure.
- /5/ VPOWER New Energy Technology (LinYi) LTD: Records of training for on-site staff.
- /6/ VPOWER New Energy Technology (LinYi) LTD: Operation log, from 11/10/2022 to 10/03/2023.
- /7/ Registered VCS PD version 3.0 dated 19/07/2021.
- /8/ LGAI Technological Center, S.A. (Applus+ Certification): VCS Validation Report of VCS PD version 02.0 dated 20/07/2021
- /9/ VERRA Website: VCS Monitoring Report of monitoring period (1st) from 20/09/2019 to 11/10/2021, version 2.0 dated 30/11/2021
- /10/ LGAI Technological Center, S.A. (Applus+ Certification): VCS Verification Report of monitoring period (1st) from 20/09/2019 to 11/10/2021, version 01.0 dated 02/12/2021
- /11/ VPOWER New Energy Technology (LinYi) LTD: Water flow and COD monthly report covering the monitoring period
- /12/ VPOWER New Energy Technology (LinYi) LTD: Electricity and Biogas Production Monthly Report covering the monitoring period
- /13/ VPOWER New Energy Technology (LinYi) LTD: Monthly Report of Methane Concentration covering the monitoring period
- /14/ EIA Report compiled on 20/07/2017 and approved by Linshu Country Environmental Protection Bureau on 07/08/2017
- /15/ Electricity Transaction Notes (ETNs) of net quantity of electricity generated with biogas from the new anaerobic biodigester
- /16/ National or regional weather statistics: <https://www.tianqi24.com/linyi2/history202005.html>

- /17/ 2019 Baseline Emission Factors for Regional Power Grids in China dated 29/12/2020 published by China DNA
- /18/ VPOWER New Energy Technology (LinYi) LTD: The filled questionnaires from local stakeholders
- /19/ VPOWER New Energy Technology (LinYi) LTD: The attendance list of stakeholder consultation meeting
- /20/ State Economic and Trade Commission: Technical administrative code of electric energy metering (DL/T 448-2016).
- /21/ VPOWER New Energy Technology (LinYi) LTD: Employee list and salary record
- /22/ VPOWER New Energy Technology (LinYi) LTD: nameplate of the equipment
- /23/ Calibration certificates of Electromagnetic flowmeter covering the whole monitoring period issued by Linyi Metrology Inspection Institute
- /24/ Calibration certificates of Electronic balance, Acid burette, Drying oven covering the whole monitoring period issued by Linyi County Metrology Test Institute
- /25/ Calibration certificates of Electricity meter covering the whole monitoring period issued by Linyi Metrology Inspection Institute
- /26/ Calibration certificates of V cone flowmeters, Temperature meter, Pressure gauge covering the whole monitoring period issued by Linyi Metrology Inspection Institute
- /27/ Calibration certificates of Methane detector covering the whole monitoring period issued by Linyi Metrology Inspection Institute
- /28/ Metrological Authorization Certification of Linyi Metrology Inspection Institute, issued by Shandong Quality and Technical Supervision Bureau on 29/06/2018, valid till 28/06/2023 (<http://jyjczx.linyi.cn/info/1051/1473.htm>).
- /29/ Metrological Authorization Certification of Linshu County Metrology and Testing Institute, issued by Shandong Quality and Technical Supervision Bureau on 11/10/2020, valid till 10/10/2025.
- /30/ Photos of DCS system, Electromagnetic flowmeter, Electronic balance, Acid burette, Drying oven, Electricity meters, V cone flowmeter, Temperature meter, Pressure gauge, Methane detector
- /31/ Commission Report issued by China National Technology Import Corporation and Coal Industry Jinan Design and Research Institute Co., Ltd.
- /32/ Coal Industry Jinan Design and Research Institute Co., Ltd.: FSR completed in May 2017

- /33/ VPOWER New Energy Technology (LinYi) LTD: Operation Management Manual of the project activity
- /34/ VPOWER New Energy Technology (LinYi) LTD: Daily Implementation Report of the project activity
- /35/ Verification Regulation of Electromagnetic Flowmeter (JJG1033-2018)
- /36/ Verification Regulation of Electronic Balance (JJG1036-2008)
- /37/ Verification Regulation of Digital Temperature Indicators and Controllers (JJG617-1996)
- /38/ Calibration Specification of the Temperature Transmitter (JJF1183-2007)
- /39/ Verification Regulations for Elastic Element General Pressure Gauges and Pressure Vacuum Gauges, and Vacuum Gauges (JJG52-2013)
- /40/ Statement from local power grid company about quantity of grid electricity consumed by the project
- /41/ Verification Regulation of Differential Pressure Flowmeters (JJG640-2016)

Methodologies, tools and other guidance

- /42/ Verified Carbon Standard: VCS Standard, version 4.4.
- /43/ Verified Carbon Standard: VCS Program Guide, version 4.3.
- /44/ Verified Carbon Standard: Registration and Issuance Process, version 4.3.
- /45/ UNFCCC EB: Approved methodology, ACM0014, version 08.0

APPENDIX C: CORRECTIVE ACTION REQUESTS, CLARIFICATION REQUESTS AND FORWARD ACTION REQUESTS

Table 1: Clarification Requests

CL ID	Clarification Request	Response by Project Proponent	Verification Team Assessment
NA	NA	NA	NA

Table 2: Corrective Action Requests

CAR ID	Corrective Action Request	Response by Project Proponent	Verification Team Assessment
01	Please apply latest IPCC default value for GWP_{CH_4} , i.e. 27.9 from AR6, when calculating emission reductions.	The value of GWP_{CH_4} is updated in the revised MR.	The latest IPCC default value for GWP_{CH_4} has been applied and emission reductions have been updated. Therefore, CAR01 was closed.

Table 3: Forward Action Requests

FAR ID	Forward Action Request	Response by Project Proponent	Verification Team Assessment
NA	NA	NA	NA