



LINSHU BIOGAS RECOVERY AND POWER GENERATION PROJECT



Document Prepared By LGAI Technological Center, S.A. (Applus+ Certification)

Project Title	Linshu Biogas Recovery and Power Generation Project
Version	01.0
Report ID	A+SH_SYST_VCS_VER_8621

Report Title	Linshu Biogas Recovery and Power Generation Project
Client	Swiss Carbon Value Ltd.
Pages	60
Date of Issue	02/12/2021
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Summary:

LGAI Technological Center, S.A. (hereafter referred to as “Applus+ Certification”) has been commissioned by Swiss Carbon Value Ltd. to perform the verification of greenhouse gas emission reductions of the project activity “Linshu Biogas Recovery and Power Generation Project” (VCS Ref. No. 2402, hereafter referred to as “the project activity”) reported in the monitoring report /1/ for the monitoring period 20/09/2019 to 11/10/2021 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 4.1.

The project activity has been validated by Applus+ Certification which is available at <https://registry.verra.org/app/projectDetail/VCS/2402>.

The project activity 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 inlet COD concentration of anaerobic digester is 55,000 mg/L, and outlet 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 purpose and scope of this verification is to ensure that reported emission reductions are complete and accurate in accordance with applicable VCS standards and relevant UNFCCC requirements in order to be certified. A desk review and a site visit have been conducted to verify the data submitted in the monitoring report /1/. Applus+ Certification confirms the following has been reviewed:

- Monitoring plan included in the registered VCS PD (version 3.0 dated 19/07/2021) /3/;
- Validation report No. A+SH_SYST_VCS_VAL_8620 /4/, completed on 20/07/2021 by Applus+ Certification;
- Approved methodology, ACM0014: Treatment of wastewater /6/, version 08.0, dated 14/06/2019;
- VCS standards version 4.1 and VCS Program Guide version 4.0, as well as relevant UNFCCC requirements;
- All information and references relevant to the project activity's resulting in emission reductions.

During this verification, 1 CL, no CAR or FAR was identified related to the monitoring, implementation or operations of the project activity in relation to relevant VCS standards, guidance and UNFCCC requirements and relevant host party criteria and the applied baseline and monitoring methodology etc.

Applus+ Certification confirms that the project is implemented in accordance with the registered PD /3/. The monitoring plan complies with the applied methodology ACM0014: Treatment of wastewater /6/ version 08.0 and the monitoring has been carried out in accordance with the monitoring plan in the registered PD /3/. The monitoring system is in place and the emission reductions are calculated without material misstatements. The level of assurance of the verification is reasonable. Our opinion relates to the projects GHG emissions and the resulting

GHG emission reductions reported and related to the valid and registered project baseline and monitoring and its associated documents. Based on the information reviewed and evaluated Applus+ Certification confirms that the implementation of the project has resulted in 752,782 tCO₂e emission reductions during period 20/09/2019 to 11/10/2021.

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1 INTRODUCTION

1.1 Objective

LGAI Technological Center, S.A. (Applus+ Certification) has been commissioned by Swiss Carbon Value Ltd. to perform the verification of greenhouse gas emission reductions of the project activity “Linshu Biogas Recovery and Power Generation Project” (VCS Ref. No. 2402) reported in the Monitoring Report /1/ during monitoring period 20/09/2019 to 11/10/2021.

LGAI Technological Center, S.A. (Applus+ Certification) as the verification body of the project activity has been accredited as a DOE by UNFCCC and also meets the competence requirements as set out in ISO 14065:2007.

The objective of verification is to have an independent review and ex post determination by a Designated Operational Entity (DOE) of the monitored reductions in GHG emissions that have occurred as a result of the registration of VCS project. Certification is the written assurance by the DOE that, during a specific time period, a proposed VCS project activity achieved the reductions in anthropogenic emissions by sources of GHGs as verified.

The objective of this verification/certification is to verify and certify emission reductions, reported for the “Linshu Biogas Recovery and Power Generation Project” in China for the period 20/09/2019 to 11/10/2021.

1.2 Scope and Criteria

The verification scope is defined as an independent and objective review of the registered PD, the Project’s baseline study and Monitoring Report (MR) and other relevant documents. The information in these documents is reviewed against VCS Version 4 requirements, UNFCCC rules and associated interpretations.

The verification is not meant to provide any consulting towards the client. However, stated requests for forward actions and/or corrective actions may provide input for improvement of the Project monitoring towards reductions in the GHG emissions.

1.3 Level of Assurance

The verification report is based on the VCS-PD, the VCS Monitoring Report (MR), supporting evidences made available to the verifier and information collected through performing interviews and during the on-site assessment.

The verification conclusion is assured a reasonable level of assurance.

1.4 Summary Description of the Project

Project title	Linshu Biogas Recovery and Power Generation Project
VCS reference number	2402
Project Participants	VPOWER New Energy Technology (LinYi) LTD (Project Owner, host country, P. R. China)
Location of the project	Linshu County, Linyi City, Shandong Province, P.R China Geographic coordinates: Longitude: 118° 34'18.78" E Latitude: 34°54'52.95"N
Project start date	Construction date: 01/11/2018 Operation start date: 20/09/2019
Version of VCS PD	version 3.0 dated 19/07/2021
Monitoring period	20/09/2019 to 11/10/2021
First monitoring report	Version 1.0 dated 29/10/2021
Final monitoring report	Version 2.0 dated 30/11/2021
Applied Methodology/Version	ACM0014: Treatment of wastewater, version 08.0, dated 14/06/2019
Scope/Technical Area	Scope 01: energy industries (renewable-/non-renewable sources) scope 13: Waste handling and disposal

The project activity 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 inlet COD concentration of anaerobic digester is 55,000 mg/L, and outlet 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 project activity has been validated by Applus+ Certification which is available at <https://registry.verra.org/app/projectDetail/VCS/2402>.

2 VERIFICATION PROCESS

2.1 Method and Criteria

Verification was conducted using Applus+ Certification's procedures in line with the requirements specified in the VCS Standard version 4.1, the latest version of the CDM Validation and Verification Standard, and relevant UNFCCC requirements and applying standard auditing techniques.

Applus+ Certification completed a strategic review and risk assessment of the projects activities and processes in order to gain a full understanding of:

- Activities associated with all the sources contributing to the project emissions and emission reductions, including leakage if relevant;
- Protocols used to estimate or measure GHG emissions from these sources;
- Collection and handling of data;
- Controls on the collection and handling of data;
- Means of verifying reported data; and
- Compilation of the monitoring report.

Applus+ Certification verified the implementation of the monitoring plan and the data presented in the Monitoring Report /1/ for the period in question. This involved a site visit and a desk review of the Monitoring Report. This Verification Report describes the findings of this assessment.

The information of the assessment team is included in below:

Assessment team

According to the sectoral scopes / technical area and experiences in the sectoral or national business environment, Applus+ Certification has composed a project assessment team in accordance with the appointment rules in Applus+ Certification. The composition of assessment team has to be approved by the Applus+ Certification ensuring that the required skills are covered by the team. The four qualification levels for team members that are assigned by formal appointment rules as below:

- Leader Auditor (LA)
- Auditor (A)/ Auditor Trainee (AiT)
- Technical Reviewer (TR)
- Technical Experts (TE)

Name	Qualification	Coverage of scope	Coverage of Technical Area	Host country experience
Doris Dai	LA/TE	Y (1.1 and 13.1)	Y	Y
Simon Shen	TR	Y (1.1 and 13.1)	Y	Y

Doris Dai (Master's Degree in Environmental Sciences, Bachelor's Degree in Environmental Technology) is an Auditor appointed by Applus+ LGAI for the GHG project assessment and auditing. She has more than 6 years of work experience in CDM/VCS project assessment. Before she joined Applus+ LGAI, she has been working for CTI Certification as senior GHG Auditor for 3.5 years.

Simon Shen (Master Degree in Thermal Energy Engineering, Bachelor Degree in Environmental Engineering) is an Auditor appointed by Applus+ LGAI for the GHG project assessment, auditing and technical review. He has more than 6 years of work experience in CDM/GS4GG/VCS project assessment and review with Applus+, apart from the years of experience working as GHG Auditor and ISO 9001/14001 in TUV SUD before he joined Applus+ for 3.5 years. Mr. Simon Shen has extensive experience also as former Applus+ Shanghai CDM Technical Manager.

2.2 Document Review

The VCS monitoring report /1/ Version 1.0 dated 29/10/2021, Version 2.0 dated 30/11/2021 and the emission reduction calculations spreadsheet /2/, were assessed as part of the verification. In addition, the registered PD /3/ version 3.0 dated 19/07/2021 in particular the baseline estimations and the monitoring plan, the validation report /4/ version 02.0 dated 20/07/2021, as well as relevant documents, were reviewed. A detailed documents reviewed are listed in Appendix 1 of the report.

2.3 Interviews

The key personnel interviewed are summarized in the table below:

Interviewed personnel	Role	Organization	Subject
Mr. Cao Yuntong	Safety Manager	VPOWER New Energy Technology (LinYi) LTD	Operation of the project activity; Implementation of the monitoring plan of the project activity; Data collection and data achievement; Calibration of monitoring instruments and equipment maintenance.
Mr. Li Shoulai	Operation Manager		
Mr. Li Chaoshen	Head of Production Department		
Mr. Wei Zeqiang	Maintenance Staff	Jinyimeng Biological Technology Co., Ltd	Statistic of wastewater data
Ms. Wu Caiqing	Statistician	Jinyimeng Biological Technology Co., Ltd	
Mr. Li Lei	Director	Local Environmental Protection Bureau	The impact of the project activity during the monitoring period; The comments by local stakeholders during the monitoring period.
Ms. Wang Shanshan	Local resident	Xinyuan Community	
Mr. Zheng Hui	Local resident	Shadun Town	
Ms. Wang Lin	Local resident	Dalanglinzixi Village	
Ms. Hu Lixiang	Project Manager	Swiss Carbon Value Ltd.	Data collection and ER calculation.

2.4 Site Inspections

The assessment team performed the on-site verification (Linshu County, Linyi City, Shandong Province, P.R China) during 15/11/2021 - 16/11/2021. The interviewed personnel and objective are listed in above table.

2.5 Resolution of Findings

As an outcome of the verification process, the team can raise different types of findings.

Where a non-conformance arises the assessment team shall raise a Corrective Action Request (CAR). A CAR is issued, where:

- a) Non-compliance with the monitoring plan or methodology are found in monitoring and reporting and has not been sufficiently documented by the project participants, or if the evidence provided to prove conformity is insufficient;
- b) Modifications to the implementation, operation and monitoring of the project activity has not been sufficiently documented by the project participants;
- c) Mistakes have been made in applying assumptions, data or calculations of emission reductions that will impact the quantity of emission reductions;
- d) Issues identified in a FAR during validation to be verified during verification or previous verification(s) have not been resolved by the project participants.

The assessment team shall raise a Clarification Request (CL) if information is insufficient or not clear enough to determine whether the applicable CDM requirements have been met.

All CARs and CLs raised during verification shall be resolved prior to submitting a request for issuance.

1 CL, no CAR or FAR was raised for this monitoring period for the project.

2.5.1 Forward Action Requests

No FAR was raised during the verification process. Also there are no remaining from former verification and validation.

2.6 Eligibility for Validation Activities

Not applicable as LGAI Technological Center, S.A. holds the accreditation for the validation and verification for projects under scope 1 and 13.

3 VALIDATION FINDINGS

3.1 Participation under Other GHG Programs

Through reviewing the registered PD /3/ and validation report /4/, it was validated that the project has been registered as VCS project which is available at <https://registry.terra.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, Applus+ Certification consider 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

Not applicable as not deviation for methodology.

3.3 Project Description Deviations

Not applicable as not deviation for project description.

3.4 Grouped Project

Not applicable as not a grouped project.

4 VERIFICATION FINDINGS

4.1 Project Implementation Status

By means of on-site visit, the assessment team confirms that all physical features of the project activity proposed in the registered VCS PD /3/ are in place and the PP has operated the project as per registered VCS PD /3/. 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. The electricity generated is transmitted to the local Power Grid via a transformer station, which was then exported to the NCPG. 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. By checking Operation and Maintenance Record /16/ and commissioning evidence issued by Coal Industry Jinan Design and Research Institute Co., Ltd. /17/, it is confirmed the project started operation on 20/09/2019. There are no changes on the key equipment and technology since the validation of the project. No special event which would affect the monitoring of the project has been observed during the monitoring period.

By checking EIA Report /19/, Staff roster /11/, China's National Plan on Implementation of the 2030 Agenda for Sustainable Development and 17 SDGs defined by UNDP, interviewing stakeholders during site visit, the assessment team confirmed that the project activity would contribute sustainable development in the region and China's Sustainable Development Goals (SDG).

The employment opportunities created have been assessed through checking Staff roster and other relevant employment records /11/. The parameters in relation with electricity generation through recovery and utilization of renewable biogas from wastewater have been included in section 4.2 of the MR. These parameters have been monitored as per ACM0014 and relevant methodology tools. 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 reduction was 752,782 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 160075.581MWh.

- **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".

The technical parameters have been verified with the nameplates of the equipments /9/ as below:

Technical parameters of Gas engine and Steam boiler

Equipment	Model	Number	Key technical parameters
Gas engine	VGS1169BG	7 (including 1 backup)	Capacity: 1,200 kW Lifetime: no less than 21 years Year of manufacture: 2017
Gas engine	PPU1554BG	4	Capacity: 1,600 kW Lifetime: no less than 21 years Year of manufacture: 2017
Steam boiler	Q33.4/445-5.0-1.0/220	1	Evaporation: 5 t/h Rated steam pressure: 1.0 MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018
Steam boiler	Q24.6/445-3.8-1.0/220	1	Evaporation: 3.8 t/h Rated steam pressure: 1.0 MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018

The main purpose of the project activity 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 project activity involves the installation of anaerobic biogas recovery system, consisting of biogas generation system, biogas handling and utilization and post-treatment system.

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 registered PD /3/, validation report /4/ and interviewing with Project Developer during site visit, it is confirmed by the assessment team that VERs will only be claimed from the methane recovered and destroyed by power generation system and power displacement.

The assessment team confirmed that there is no proposed or actual change to the project design 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.

The project is completely operational and the same has been confirmed on-site. Neither mistakes nor malfunction on main meters have been observed during this monitoring period.

4.2 Safeguards

4.2.1 No Net Harm

By checking the EIA summary and conclusion provided in the registered PD, it is confirmed that the impact on the surrounding ecosystem and residents, water, and atmosphere etc., caused by electricity and heat generation from biogas recovered from wastewater generated in alcohol production process, is very little, there would be no net harm caused due to the project activity. Also, the EIA of the project are approved by the government.

Also, 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 and thus no net harm observed in air or water quality on-site. Furthermore, by checking Staff roster /11/, interviewing stakeholders during site visit, The assessment 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 /18/, the assessment 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 assessment 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 stakeholder consultation meeting, the project information and the continuous input / grievance mechanism have been introduced to the local stakeholders. Also, the proposed project information in which PO's telephone number was included had been posted on local village's bulletin and near the power plant for public comment. Therefore, through the physical stakeholder meeting and posters in local area, local residents know how to contact the PO directly and could give their opinions on this project.

During the meeting, 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. Communications with Local stakeholders was being carried out at periodic intervals.

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

By checking the filled questionnaires from local stakeholders /13/, it is confirmed by the assessment 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.

Through interviewing with stakeholders, it is confirmed that a grievance book is put in the communication room at the main door of the project owner company and in the village office of local area. The local stakeholders can provide feedbacks through these two ways. Also, the village head will reach PO if any comments are received. Via checking questionnaires from local stakeholders, interviewing with staff from local environmental protection bureau and local residents during the site visit, it is confirmed by the assessment 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 assessment 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

Not applicable as non-AFOLU project.

4.4 Accuracy of GHG Emission Reduction and Removal Calculations

Data and Parameters Available at Validation

Below data 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	As per FSR /7/, the concentration of COD outflow of anaerobic digester is 1,000 mg/L, the 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 x 10,000 m ³ /day x 313 days/yr. The value 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	As per FSR /7/, the concentration of COD inflow of anaerobic digester is 55,000 mg/L, the 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 x 10,000 m ³ /day x 313

				days/yr. The value has been verified to be consistent with that in the registered PD.
ρ	Discount factor for historical information	1	/	As per ACM0014, if one year of historical data is available $\rho=1$.
B_o	Maximum methane producing capacity, expressing the maximum amount of CH ₄ that can be produced from a given quantity of chemical oxygen demand (COD)	0.21	tCH ₄ /tCOD	Default value in ACM0014
D	Average depth of the lagoons	3.0	m	As per FSR /7/, the depth of anaerobic open lagoon is 3m. The value has been verified to be consistent with that in the registered PD.
GWP _{CH₄}	Global warming potential for CH ₄	28	t CO ₂ e/t CH ₄	IPCC Fourth Assessment Report (AR5)
f_d	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation	0.7	/	As per ACM0014, for anaerobic open lagoon with depth greater than 2m, a value of 0.7 has been applied for f_d . The value 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	2019 Baseline Emission Factors for Regional Power Grids in China dated 29/12/2019 and the "Tool to calculate the emission factor for an electricity system-v7.0". The value 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%	/	Default value from 'baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)'. The value has been verified to be consistent with that in the registered PD.
TDL _{j,y}	Average technical transmission and	20%	/	Default value from 'baseline, project and or leakage emissions from electricity

	distribution losses for providing electricity to source j in year y			consumption and monitoring of electricity generation (v03.0)'. The value has been verified to be consistent with that in the registered PD.
$F_{ww,CH_4,default}$	Default factor representing the remaining CH_4 production capacity of liquid digestate	0.05 for UASB	Fraction	The project involves with the installation of three-phase digesters. The choice of data is based on the tool of project and leakage emissions from anaerobic digesters. The value 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	Default value from Tool of "project and leakage emissions from anaerobic digesters", 0.05 for UASB.
R_u	Universal ideal gases constant	8,314	Pa.m ³ /kmol .K	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03). The value 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	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03). The value has been verified to be consistent with that in the registered PD.
P_n	Total pressure at normal conditions	101,325	Pa	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03). The value has been verified to be consistent with that in the registered PD.
T_n	Temperature at normal conditions	273.15	K	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03). The value has been verified to be consistent with that in the registered PD.

Data and Parameters Monitored

The monitoring has been carried out in accordance with the monitoring plan contained in the registered PD /3/. All the parameters in the registered PD were monitored and determined as per the registered monitoring plan which is listed in below table.

Data / Parameter:	$F_{PJ,dig,m}$
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Data unit:	m³/month												
Description:	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m												
Purpose of the data:	Calculation of baseline and project emissions												
Parameter value:	20/09/2019-31/12/2019: 863,788m³ 01/01/2020-31/12/2020: 3,201,369m³ 01/01/2021-11/10/2021: 2,511,573 m³												
Source of data used:	Water flow and COD monthly report /12/												
Information flow:	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 /12/ and site inspection, the assessment team confirmed that the readings of the flow meter was continuously monitored and recorded. The reading records are aggregated monthly, which is consistent with the registered PD. The data has been sent to the project participants for reporting of GHG emission reduction.												
Monitoring method, frequency and equipments:	The parameter was monitored continuously by flow meter. The information of flow meter is: <table><tr><th>Equipment</th><th>Type</th><th>Serial Number</th><th>Accuracy</th></tr><tr><td>Electromagnetic flowmeter</td><td>YL-LDE-DN65</td><td>202011106</td><td>0.5%</td></tr></table> The type, serial number and accuracy have been confirmed by site visit /14/.			Equipment	Type	Serial Number	Accuracy	Electromagnetic flowmeter	YL-LDE-DN65	202011106	0.5%		
Equipment	Type	Serial Number	Accuracy										
Electromagnetic flowmeter	YL-LDE-DN65	202011106	0.5%										
Calibration:	The calibration information is shown as below /23/: <table><tr><th>Equipment</th><th>Calibration date</th><th>Valid until</th></tr><tr><td rowspan="3">Electromagnetic flowmeter</td><td>12/06/2019</td><td>11/06/2020</td></tr><tr><td>01/06/2020</td><td>31/05/2021</td></tr><tr><td>14/05/2021</td><td>13/05/2022</td></tr></table> The calibration was conducted by a qualified third party, Linyi Metrology Inspection Institute /29/.			Equipment	Calibration date	Valid until	Electromagnetic flowmeter	12/06/2019	11/06/2020	01/06/2020	31/05/2021	14/05/2021	13/05/2022
Equipment	Calibration date	Valid until											
Electromagnetic flowmeter	12/06/2019	11/06/2020											
	01/06/2020	31/05/2021											
	14/05/2021	13/05/2022											
QA/QC procedure:	The flow meter is calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.												

Means of verification:	Information flow was verified by checking Water flow and COD monthly report /12/, and all information are consistent; Data in the ER calculation sheet was verified by checking Water flow and COD monthly report /12/ and all information are consistent; Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD; Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.
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Data / Parameter:	COD _{dig,m}																
Data unit:	t COD/m ³																
Description:	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m																
Purpose of the data:	Calculation of baseline and project emissions																
Parameter value:	20/09/2019-31/12/2019: 0.054807 tCOD/m ³ 01/01/2020-31/12/2020: 0.055015 tCOD/m ³ 01/01/2021-11/10/2021: 0.054456 tCOD/m ³																
Source of data used:	Water flow and COD monthly report /12/																
Information flow:	During site visit, it is confirmed the COD content is analyzed by laboratory of the treatment plant. The analysis results will be recorded by operators in the plant. Monthly average value of this parameter will be calculated, which is consistent with the registered PD. The data has been sent to the project participants for reporting of GHG emission reduction.																
Monitoring method, frequency and equipments:	The parameter was analyzed daily and aggregated monthly by analyze instrument in laboratory of the treatment plant (Jinyimeng laboratory). The information of analyze instrument is: <table><tr><td></td><td>Type</td><td>Serial number</td><td>Accuracy</td></tr><tr><td>Electronic balance</td><td>AB204-S</td><td>1129150058</td><td>qualified</td></tr><tr><td>Acid burette</td><td>50ml</td><td>SD310602</td><td>qualified</td></tr><tr><td>Drying oven</td><td>DHG-9075A</td><td>3806004</td><td>qualified</td></tr></table> The type, serial number and accuracy have been confirmed by site visit /14/.		Type	Serial number	Accuracy	Electronic balance	AB204-S	1129150058	qualified	Acid burette	50ml	SD310602	qualified	Drying oven	DHG-9075A	3806004	qualified
	Type	Serial number	Accuracy														
Electronic balance	AB204-S	1129150058	qualified														
Acid burette	50ml	SD310602	qualified														
Drying oven	DHG-9075A	3806004	qualified														

Calibration:	The calibration information is shown as below /24/:		
	Equipment	Calibration date	Valid until
	Electronic balance	12/06/2019	11/06/2020
		01/06/2020	31/05/2021
		14/05/2021	13/05/2022
	Acid burette	12/06/2019	11/06/2020
		01/06/2020	31/05/2021
		14/05/2021	13/05/2022
	Drying oven	12/06/2019	11/06/2020
		01/06/2020	31/05/2021
		14/05/2021	13/05/2022
The calibration was conducted by Linshu County Metrology and Testing Institute /30/.			
QA/QC procedure:	The analyze instrument in laboratory of the treatment plant (Jinyimeng laboratory) is calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.		
Means of verification:	Information flow was verified by checking Water flow and COD monthly report /12/, and all information are consistent;		
	Data in the ER calculation sheet was verified by checking Water flow and COD monthly report /12/, and all information are consistent;		
	Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD;		
	Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.		

Data / Parameter:	T _{2,m}		
Data unit:	K		
Description:	Average temperature at the project site in month m		
Purpose of the data:	Calculation of baseline emissions		
Parameter value:	January	273.65	
	February	280.15	
	March	283.15	
	April	286.65	
	May	294.15	
	June	298.15	
	July	297.65	
	August	299.65	

		September	295.65	
		October	288.15	
		November	283.15	
		December	274.65	
Source of data used:	national or regional weather statistics /21/			
Information flow:	/			
Monitoring method, frequency and equipments:	The detailed monthly average temperature was from national or regional weather statistics /21/, and was calculated based on equation: $T_{2,m} (K) = 273.15 K + T_{2,m} (\text{Celsius})$			
Calibration:	/			
QA/QC procedure:	/			
Means of verification:	By checking national or regional weather statistics, detailed monthly average temperature has been checked and confirmed to be consistent with that in the MR. The data source and calculation method is consistent with the registered PD.			

Data / Parameter:	EG _{PJ,y}
Data unit:	MWh/year
Description:	Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester
Purpose of the data:	Calculation of baseline emissions
Parameter value:	20/09/2019-31/12/2019: 5464.200 MWh 01/01/2020-31/12/2020: 83808.600 MWh 01/01/2021-11/10/2021: 71244.600MWh
Source of data used:	Electricity and Biogas Production Monthly Report /10/ and Electricity Transaction Notes (ETNs) /20/ of net quantity of electricity generated with biogas from the new anaerobic biodigester covering monitoring period.
Information flow:	Bidirectional electricity meters (meter 1 and meter 2) are used to monitor both exported electricity to Jinyiment company and imported electricity from Jinyimeng company. Meter 1 and meter 2 were installed to monitor continuously and 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 and Electricity Transaction Notes (ETNs) /20/. The data for Electricity and Biogas Production Monthly Report and ETNs has been sent to the project participant for reporting of GHG emission reduction. The conservative one would be used for ER calculation.																	
Monitoring method, frequency and equipments:	The parameter was monitor continuously, recorded monthly by the electricity meter 1 and 2. See below for the information of the electricity meter verified by site visit and checking calibration certificates /25/: <table><tr><th>Meter</th><th>Type</th><th>Serial Number</th><th>Accuracy</th></tr><tr><td>Electricity meter 1</td><td>DTSD341</td><td>1708417085000001</td><td>0.2S</td></tr><tr><td>Electricity meter 2</td><td>DTSD341</td><td>1708417085000002</td><td>0.2S</td></tr></table> The type, serial number and accuracy have been confirmed by site visit /14/.	Meter	Type	Serial Number	Accuracy	Electricity meter 1	DTSD341	1708417085000001	0.2S	Electricity meter 2	DTSD341	1708417085000002	0.2S					
Meter	Type	Serial Number	Accuracy															
Electricity meter 1	DTSD341	1708417085000001	0.2S															
Electricity meter 2	DTSD341	1708417085000002	0.2S															
Calibration:	The calibration information is shown as below /25/: <table><tr><th>Meter</th><th>Calibration date</th><th>Valid until</th></tr><tr><td rowspan="3">Electricity meter 1</td><td>11/06/2019</td><td>10/06/2020</td></tr><tr><td>03/03/2020</td><td>02/03/2021</td></tr><tr><td>25/02/2021</td><td>24/02/2022</td></tr><tr><td rowspan="3">Electricity meter 2</td><td>12/06/2019</td><td>11/06/2020</td></tr><tr><td>04/03/2020</td><td>03/03/2021</td></tr><tr><td>26/02/2021</td><td>25/02/2022</td></tr></table> The calibration was conducted by a qualified third party, Linyi Metrology Inspection Institute /29/.	Meter	Calibration date	Valid until	Electricity meter 1	11/06/2019	10/06/2020	03/03/2020	02/03/2021	25/02/2021	24/02/2022	Electricity meter 2	12/06/2019	11/06/2020	04/03/2020	03/03/2021	26/02/2021	25/02/2022
Meter	Calibration date	Valid until																
Electricity meter 1	11/06/2019	10/06/2020																
	03/03/2020	02/03/2021																
	25/02/2021	24/02/2022																
Electricity meter 2	12/06/2019	11/06/2020																
	04/03/2020	03/03/2021																
	26/02/2021	25/02/2022																
QA/QC procedure:	The electricity meters are calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.																	
Means of verification:	Data of the parameter was verified by checking Electricity and Biogas Production Monthly Report and ETNs. All data is in line with Electricity and Biogas Production Monthly Report and ETNs; Information flow was verified by checking Electricity and Biogas Production Monthly Report and ETNs, and all information are consistent;																	

	Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD; Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.
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Data / Parameter:	$EC_{PJ, j, y}$
Data unit:	MWh/year
Description:	Net quantity of grid electricity consumed by the project in year y
Purpose of the data:	Calculation of project emissions
Parameter value:	20/09/2019-31/12/2019: 158.238 MWh 01/01/2020-31/12/2020: 235.371 MWh 01/01/2021-11/10/2021: 48.210 MWh
Source of data used:	Electricity and Biogas Production Monthly Report /10/, ETNs /20/ of net quantity of grid electricity consumed by the project covering monitoring period.
Information flow:	Bidirectional electricity meters (meter 1 and meter 2) are used to monitor both exported electricity to Jinyiment company and imported electricity from Jinyimeng company. Meter 3 and meter 4 are also used to monitor the electricity imported from Jinyimeng company. Meter 3 is used to monitor the electricity import from Jinyimeng to this project and another plant (plant A). Meter 4 is the meter that monitor the electricity imported from Jinyimeng to plant A. Therefore, $EC_{PJ, j, y}$ is calculated by electricity recorded by meters as: meter 1 + meter 2 + (meter 3 - meter 4) By checking Operation and Maintenance Record /16/ and Electricity and Biogas Production Monthly Report /10/ and through interviewing with project owner during site visit, it is confirmed meter 3 and meter 4 are not used since February 2021. Meter 1, meter 2, meter 3 and meter 4 were installed to monitor continuously and 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 /10/ and Electricity Transaction Notes (ETNs) /20/.

	The data for Electricity and Biogas Production Monthly Report /10/ and ETNs has been sent to the project participant for reporting of GHG emission reduction. The conservative one would be used for ER calculation.																															
Monitoring method, frequency and equipments:	The parameter was monitor continuously, recorded monthly by the electricity meters. See below for the information of the electricity meter verified by site visit and checking calibration certificates /25/: <table><tr><th>Meter</th><th>Type</th><th>Serial Number</th><th>Accuracy</th></tr><tr><td>Electricity meter 1</td><td>DTSD341</td><td>1708417085000001</td><td>0.2S</td></tr><tr><td>Electricity meter 2</td><td>DTSD341</td><td>1708417085000002</td><td>0.2S</td></tr><tr><td>Electricity meter 3</td><td>DTSD341</td><td>1706409537000003</td><td>0.2S</td></tr><tr><td>Electricity meter 4</td><td>DT862</td><td>102392417</td><td>2.0</td></tr></table> The type, serial number and accuracy have been confirmed by site visit /14/.	Meter	Type	Serial Number	Accuracy	Electricity meter 1	DTSD341	1708417085000001	0.2S	Electricity meter 2	DTSD341	1708417085000002	0.2S	Electricity meter 3	DTSD341	1706409537000003	0.2S	Electricity meter 4	DT862	102392417	2.0											
Meter	Type	Serial Number	Accuracy																													
Electricity meter 1	DTSD341	1708417085000001	0.2S																													
Electricity meter 2	DTSD341	1708417085000002	0.2S																													
Electricity meter 3	DTSD341	1706409537000003	0.2S																													
Electricity meter 4	DT862	102392417	2.0																													
Calibration:	The calibration information is shown as below /25/: <table><tr><th>Meter</th><th>Calibration date</th><th>Valid until</th></tr><tr><td rowspan="3">Electricity meter 1</td><td>11/06/2019</td><td>10/06/2020</td></tr><tr><td>03/03/2020</td><td>02/03/2021</td></tr><tr><td>25/02/2021</td><td>24/02/2022</td></tr><tr><td rowspan="3">Electricity meter 2</td><td>12/06/2019</td><td>11/06/2020</td></tr><tr><td>04/03/2020</td><td>03/03/2021</td></tr><tr><td>26/02/2021</td><td>25/02/2022</td></tr><tr><td rowspan="3">Electricity meter 3</td><td>12/06/2019</td><td>11/06/2020</td></tr><tr><td>04/03/2020</td><td>03/03/2021</td></tr><tr><td>26/02/2021</td><td>25/02/2022</td></tr><tr><td rowspan="3">Electricity meter 4</td><td>12/06/2019</td><td>11/06/2020</td></tr><tr><td>04/03/2020</td><td>03/03/2021</td></tr><tr><td>26/02/2021</td><td>25/02/2022</td></tr></table> The calibration was conducted by a qualified third party, Linyi Metrology Inspection Institute /29/.	Meter	Calibration date	Valid until	Electricity meter 1	11/06/2019	10/06/2020	03/03/2020	02/03/2021	25/02/2021	24/02/2022	Electricity meter 2	12/06/2019	11/06/2020	04/03/2020	03/03/2021	26/02/2021	25/02/2022	Electricity meter 3	12/06/2019	11/06/2020	04/03/2020	03/03/2021	26/02/2021	25/02/2022	Electricity meter 4	12/06/2019	11/06/2020	04/03/2020	03/03/2021	26/02/2021	25/02/2022
Meter	Calibration date	Valid until																														
Electricity meter 1	11/06/2019	10/06/2020																														
	03/03/2020	02/03/2021																														
	25/02/2021	24/02/2022																														
Electricity meter 2	12/06/2019	11/06/2020																														
	04/03/2020	03/03/2021																														
	26/02/2021	25/02/2022																														
Electricity meter 3	12/06/2019	11/06/2020																														
	04/03/2020	03/03/2021																														
	26/02/2021	25/02/2022																														
Electricity meter 4	12/06/2019	11/06/2020																														
	04/03/2020	03/03/2021																														
	26/02/2021	25/02/2022																														
QA/QC procedure:	The electricity meters are calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.																															

Means of verification:	Data of the parameter was verified by checking Electricity and Biogas Production Monthly Report /10/ and ETNs. All data is in line with Electricity and Biogas Production Monthly Report /10/ and ETNs; Information flow was verified by checking Electricity and Biogas Production Monthly Report /10/ and ETNs, and all information are consistent; Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD; Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.
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Data / Parameter:	$F_{\text{biogas},y} (V_{t,db})$
Data unit:	m ³ /yr
Description:	Total amount of biogas collected in the outlet of the new digester in year y
Purpose of the data:	Calculation of baseline and project emissions
Parameter value:	20/09/2019-31/12/2019: 2,676,618Nm ³ 01/01/2020-31/12/2020: 39,688,784 Nm ³ 01/01/2021-11/10/2021: 33,455,765 Nm ³
Source of data used:	Electricity and Biogas production monthly report /10/ issued by the project owner
Information flow:	This parameter was monitored continuously by volumetric flow meters (V cone flowmeter). By checking Electricity and Biogas production monthly report /10/ and through interviewing with staff of project owner during site visit and site inspection, the assessment team confirmed that the readings of volumetric flow meters were continuously monitored and the value of this parameter was aggregated monthly. Furthermore, the monitored volume is automatically converted into volume 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. The data has been sent to the project participants for reporting of GHG emission reduction.

Monitoring method, frequency and equipments:	The parameter was monitored continuously by volumetric flow meters. The monitored volume is automatically converted into volume in standard condition (0℃ and 101,325Pa) by DCS system based on the biogas temperature and pressure.			
	Equipment	Type	Serial Number	Accuracy
	V cone flowmeter 1	FFM61S300A10RFM2N	F61-2005-0725	0.5
	V cone flowmeter 2	FFM61S300A10RFM2N	F61-2005-0726	0.5
	Temperature meter 1	644HAK5J6M5	3650022	±0.5℃
	Temperature meter 2	644HAK5J6M5	3650023	±0.5℃
	Pressure gauge 1	-10～50Kpa	7917305	0.065 class
	Pressure gauge 2	-10～50Kpa	7917306	0.065 class
The type, serial number and accuracy have been confirmed by site visit /14/.				
Calibration:	The calibration information is shown as below /26/ /27/:			
	Equipment	Calibration date	Valid until	
	V cone flowmeter 1	11/06/2019	10/06/2020	
		03/03/2020	02/03/2021	
		25/02/2021	24/02/2022	
	V cone flowmeter 2	12/06/2019	11/06/2020	
		04/03/2020	03/03/2021	
		26/02/2021	25/02/2022	
	Temperature meter 1	10/09/2019	09/03/2020	
		03/03/2020	02/09/2020	
		28/08/2020	27/02/2021	
		24/02/2021	23/08/2021	
		17/08/2021	16/02/2022	
	Temperature meter 2	11/09/2019	10/03/2020	
		04/03/2020	03/09/2020	
		29/08/2020	28/02/2021	
		25/02/2021	24/08/2021	
		18/08/2021	17/02/2022	

	Pressure gauge 1	10/09/2019	09/03/2020
		03/03/2020	02/09/2020
		28/08/2020	27/02/2021
		24/02/2021	23/08/2021
		17/08/2021	16/02/2022
	Pressure gauge 2	11/09/2019	10/03/2020
		04/03/2020	03/09/2020
		29/08/2020	28/02/2021
		25/02/2021	24/08/2021
		18/08/2021	17/02/2022
The V-cone flow meters are calibrated by Linyi metrology inspection institute /29/.			
The temperature meter, pressure gauge are calibrated by Linshu County Metrology and Testing Institute /30/.			
QA/QC procedure:	The volumetric flow meters, Temperature meters and Pressure gauges are calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.		
Means of verification:	Information flow was verified by checking Electricity and Biogas production monthly report /10/, and all information are consistent; Data in ER calculation sheet was verified by checking Electricity and Biogas production monthly report /10/, and all information are consistent; Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD; Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.		

Data / Parameter:	WCH ₄ ,biogas,y (V _{CH₄,t,db})			
Data unit:	kg CH ₄ /m ³			
Description:	Concentration of methane in the total biogas supply in the outlet of the new digester at reference conditions			
Purpose of the data:	Calculation of baseline and project emissions			
Parameter value:	Vintage	Methane fraction	Concentration of methane	
	20/09/2019-31/12/2019	57.23%	0.4098 kgCH ₄ /m ³	

	01/01/2020-31/12/2020	56.64%	0.4055 kgCH ₄ /m ³										
	01/01/2021-11/10/2021	55.92%	0.4004 kgCH ₄ /m ³										
	Concentration of methane is calculated as methane fraction * methane density (0.716 kg/m ³)												
Source of data used:	Monthly Report of Methane Concentration /22/ issued by the project owner												
Information flow:	Through site interview with staff of the project owner and site 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 gas analyzer (methane detector) and was recorded automatically by DCS system, which is consistent with the registered PD. The data was aggregated monthly by operator from DCS system. The data has been sent to the project participants for reporting of GHG emission reduction.												
Monitoring method, frequency and equipments:	The parameter was monitored continuously, monitoring data was aggregated monthly. <table><tr><th>Equipment</th><th>Serial Number</th><th>Accuracy</th></tr><tr><td>Methane detector</td><td>201908130E01195</td><td>3%</td></tr></table> The serial number and accuracy have been confirmed by site visit /14/.			Equipment	Serial Number	Accuracy	Methane detector	201908130E01195	3%				
Equipment	Serial Number	Accuracy											
Methane detector	201908130E01195	3%											
Calibration:	The calibration information is shown as below /29/: <table><tr><th>Equipment</th><th>Calibration date</th><th>Valid until</th></tr><tr><td rowspan="3">Methane detector</td><td>31/08/2019</td><td>30/08/2020</td></tr><tr><td>13/08/2020</td><td>12/08/2021</td></tr><tr><td>02/08/2021</td><td>01/08/2022</td></tr></table> The calibration was conducted by a qualified third party, Linyi Metrology Inspection Institute /29/.			Equipment	Calibration date	Valid until	Methane detector	31/08/2019	30/08/2020	13/08/2020	12/08/2021	02/08/2021	01/08/2022
Equipment	Calibration date	Valid until											
Methane detector	31/08/2019	30/08/2020											
	13/08/2020	12/08/2021											
	02/08/2021	01/08/2022											
QA/QC procedure:	The Methane detector is calibrated in accordance with the national standard, which has been confirmed through checking calibration certificates.												
Means of verification:	Information flow was verified by checking Monthly Report of Methane Concentration /22/, and all information are consistent; Data in ER calculation sheet was verified by checking Monthly Report of Methane Concentration /22/, and all information are consistent;												

	Monitoring method was verified by site visit, checking calibration certificates, all monitoring method meets the description in the PD; Calibration was verified by checking calibration certificate, all calibration of monitoring equipment meets the requirement indicated in the PD.
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Quantification of GHG Emission Reductions and Removals

Assessment team checked the baseline, project and leakage calculation and confirm that the evaluation of baseline, project and leakage is as per the approved methodology and formula used to calculate the same is correct. The detail analysis is as below:

Baseline emissions

Baseline emissions are estimated as follows:

$$BE_y = BE_{CH_4,y} + BE_{EL,y} + BE_{HG,y}$$

Where:

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

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

Determination of $Q_{CH_4,y}$

As per ACM0014, 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 /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 CH_4) (F_{CH_4}) is determined as follows:

$$F_{CH_4,t} = V_{t,db} * V_{CH_4,t,db} * \rho_{CH_4,t}$$

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 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.

$$\rho_{i,t} = (P_t \times MM_{CH_4}) / (R_u \times T_t)$$

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 assessment 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. Therefore, Q_{CH₄,y} of this monitoring period is calculated as:

Vintage	V _{t,db} (m ³ biogas)	V _{CH₄,t,db}	ρ _{CH₄,t} (kgCH ₄ /m ³ CH ₄)	F _{CH₄,t}	Q _{CH₄,y}
	A	B	C	D=A*B*C	E=D*GWP _{CH₄}
20/09/2019-31/12/2019	2,676,618	57.23%	0.716	1,097	30,716
01/01/2020-31/12/2020	39,688,784	56.64%	0.716	16,097	450,716
01/01/2021-11/10/2021	33,455,765	55.92%	0.716	13,395	375,060
Total in this monitoring period	75,821,167	/	/	/	856,492

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

As per ACM0014, 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:

$$BE_{CH_4, MCF, y} = GWP_{CH_4} * MCF_{BL, y} * B_o * COD_{BL, y}$$

Where:

GWP_{CH_4}	=	Global Warming Potential of methane valid for the commitment period (t CO ₂ e/tCH ₄)
B_o	=	Maximum methane producing capacity, expressing the maximum amount of CH ₄ that can be produced from a given quantity of chemical oxygen demand (t CH ₄ /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 CH ₄ 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 $COD_{BL, y}$

As per ACM0014, 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.

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

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:

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

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

Determination of $MCF_{BL,y}$

As per ACM0014, 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:

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

Where:

$MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year y , representing the fraction of ($COD_{PJ,y} \times B_0$) that would be degraded to CH₄ 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

Determination of f_d

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

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

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.

Determination of $f_{T,y}$

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

For each month m , the quantity of wastewater directed to the lagoon, 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:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m-1}) * COD_{available,m-1}$$

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)

$$COD_{BL,y} = (1 - (COD_{out,x}/COD_{in,x})) \times COD_{PJ,m}$$

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

$$COD_{PJ,m} = F_{PJ,dig,m} * COD_{dig,m}$$

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 (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)

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:

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

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:

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

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

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

$COD_{BL,m}$ = Quantity of chemical oxygen demand that would be treated in open lagoons (Scenario 1) in the absence of the project activity in month m (t COD/month)

m = Months of year y of the crediting period

The input figures for calculating $BE_{CH_4,MCF,y}$ have been verified by the assessment team which are listed in below table:

Parameter	Data unit	Value applied	Data source																								
GWP _{CH4}	tCO ₂ e/tCH ₄	28	IPCC Fourth Assessment Report (AR5)																								
B _o	tCH ₄ /tCOD	0.21	Default value in ACM0014																								
COD _{out,x}	tCOD/yr	3,130	As per FSR /7/, the concentration of COD outflow of anaerobic digester is 1,000 mg/L, the 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 x 10,000 m ³ /day x 313 days/yr.																								
COD _{in,x}	t COD/yr	172,150	As per FSR /7/, the concentration of COD inflow of anaerobic digester is 55,000 mg/L, the 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 x 10,000 m ³ /day x 313 days/yr.																								
ρ	/	1	As per ACM0014, if one year of historical data is available ρ=1.																								
f _d	/	0.7	As per ACM0014, for anerobic open lagoon with depth greater than 2m, a value of 0.7 has been applied for f _d .																								
D	m	3	As per FSR /7/, the depth of anerobic open lagoon is 3m.																								
Conservativeness factor	/	0.89	Default value in ACM0014																								
T _{2,m}	K	<table><tr><td>January</td><td>273.65</td></tr><tr><td>February</td><td>280.15</td></tr><tr><td>March</td><td>283.15</td></tr><tr><td>April</td><td>286.65</td></tr><tr><td>May</td><td>294.15</td></tr><tr><td>June</td><td>298.15</td></tr><tr><td>July</td><td>297.65</td></tr><tr><td>August</td><td>299.65</td></tr><tr><td>September</td><td>295.65</td></tr><tr><td>October</td><td>288.15</td></tr><tr><td>November</td><td>283.15</td></tr><tr><td>December</td><td>274.65</td></tr></table>	January	273.65	February	280.15	March	283.15	April	286.65	May	294.15	June	298.15	July	297.65	August	299.65	September	295.65	October	288.15	November	283.15	December	274.65	Refer to detailed assessment in previous section of this report
January	273.65																										
February	280.15																										
March	283.15																										
April	286.65																										
May	294.15																										
June	298.15																										
July	297.65																										
August	299.65																										
September	295.65																										
October	288.15																										
November	283.15																										
December	274.65																										
f _{T,y}	/	0.6135																									
MCF _{BL,y}	fraction	0.3822																									

Therefore, $F_{PJ,dig,m}$ and $COD_{PJ,y}$ 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)
	A	B	C	D	E	$F=(1-D/E)*C$
20/09/2019-31/12/2019	0.0548	863,788	47,342	3,130	172,150	46,481
01/01/2020-31/12/2020	0.0550	3,201,369	176,123	3,130	172,150	172,921
01/01/2021-11/10/2021	0.0545	2,511,573	136,770	3,130	172,150	134,283
Total in this monitoring period	/	6,576,730	360,235	/	/	353,685

Based on parameters justified above, $BE_{CH_4,MCF,y}$ of this monitoring period is calculated as:

Vintage	$MCF_{BL,y}$	B_o (tCH ₄ /tCOD)	$COD_{BL,y}$ (tCOD)	GWP_{CH_4}	$BE_{CH_4,MCF,y}$ (tCO ₂)
	A	B	C	D	$E=A*B*C*D$
20/09/2019-31/12/2019	0.3822	0.21	46,481	28	104,458
01/01/2020-31/12/2020	0.3822	0.21	172,921	28	388,612
01/01/2021-11/10/2021	0.3822	0.21	134,283	28	301,780
Total in this monitoring period	/	/	353,685	/	794,850

As per ACM0014, $BE_{CH_4,y}$ is calculated as:

Monitoring period	$BE_{CH_4,MCF,y}$ (tCO ₂ /yr)	$Q_{CH_4,y}$ (tCO ₂ /yr)	$BE_{CH_4,y} = \min(BE_{CH_4,MCF,y}, Q_{CH_4,y})$
20/09/2019-31/12/2019	104,458	30,716	30,716
01/01/2020-31/12/2020	388,612	450,716	388,612
01/01/2021-11/10/2021	301,780	375,060	301,780
Total in this monitoring period	794,850	856,492	721,108

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

As per ACM0014, 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:

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

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, $EC_{BL}=0$

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

For the project activity, the electricity generation annually is expected to be 93,840 MWh.

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

As per "Tool to calculated baseline, project and/or leakage emission from electricity consumption". $TDL_{BL,y} = 3\%$.

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

Vintage	$EG_{PJ,y}$ (MWh)	$EF_{grid,CM,y}$ (tCO ₂ /MWh)	$TDL_{k,y}$	$BE_{EL,y}$ (tCO ₂)
	A	B	C	$D=A*B*(1+C)$
20/09/2019-31/12/2019	5464.200	0.7119	3%	4,007
01/01/2020-31/12/2020	83808.600	0.7119	3%	61,453
01/01/2021-11/10/2021	71244.600	0.7119	3%	52,241
Total in this monitoring period	160,517.400	0.7119	3%	117,701

Vintage	$BE_{EL,y}$ (tCO ₂)	$BE_{CH_4,y}$ (tCO ₂)	BE_y (tCO ₂)
20/09/2019-31/12/2019	4,007	30,716	34,722
01/01/2020-31/12/2020	61,453	388,612	450,065
01/01/2021-11/10/2021	52,241	301,780	354,020
Total in this monitoring period	117,701	721,108	838,807

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:

(a) 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;

(b) 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:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y}$$

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)

$PE_{CH_4,y}$ = 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 ($PE_{CH_4,y}$)

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 ($Q_{CH_4,y}$). $Q_{CH_4,y}$ 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:

- (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.

The quantity of methane produced in the digester ($Q_{CH_4,y}$) is determined as following equation of the tool;

$$Q_{CH_4,y} = F_{CH_4,t} = V_{t,db} * V_{CH_4,t,db} * \rho_{CH_4,t}$$

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 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.

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_{CH₄,default}), as follows:

$$PE_{CH_4,y} = Q_{CH_4,y} \times EF_{CH_4,default} \times GWP_{CH_4}$$

Where:

PE_{CH₄,y} = Project emissions of methane from anaerobic digester in year y (tCO₂e)

Q_{CH₄,y} = Quantity of methane produced in the anaerobic digester in year y (tCH₄)

EF_{CH₄,default} = Default emission factor for the fraction of CH₄ produced that leaks from the anaerobic digester (fraction)

GWP_{CH₄} = Global warming potential of CH₄ (tCO₂/t CH₄)

Based on parameters justified above, PE_{CH₄,y} is calculated as:

Vintage	Q _{CH₄,y} (tCH ₄)	EF _{CH₄,default}	GWP _{CH₄} (tCO ₂ /tCH ₄)	PE _{CH₄,y} (tCO ₂)
	A	B	C	D=A*B*C
20/09/2019-31/12/2019	1,097	0.05	28	1,536
01/01/2020-31/12/2020	16,097	0.05	28	22,535
01/01/2021-11/10/2021	13,395	0.05	28	18,753
Total in this monitoring period	30,589	0.05	28	42,824

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:

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

Where:

- $PE_{power,y}$ = Project emissions from electricity consumption in year y (tCO_2/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 (tCO_2/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 electricity that anaerobic digester consumes is from the electricity generated by the project activity and when an emergency situation happens, electricity from NCPG will be used. $PE_{EC,y}$ is 0 for ex-ante estimation which will be monitored ex-post and calculated according to “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”.

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

Vintage	$EC_{PJ,j,y}$ (MWh)	$EF_{EF,grid,y}$ (tCO_2e / MWh)	$TDL_{j,y}$	$PE_{EC,y}$ (tCO_2)
	A	B	C	D=A*B*(1+C)
20/09/2019-31/12/2019	158	0.7119	20%	135
01/01/2020-31/12/2020	235	0.7119	20%	201
01/01/2021-11/10/2021	48	0.7119	20%	41
Total in this monitoring period	441	/	/	377

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 instead of fossil fuel are used for restart the auxiliary equipment, steam boiler and generator. 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 statement from the project owner and by site inspection, it is confirmed that flaring system will be used when wastewater treatment equipment was stopped for maintenance or small repairs.

The V cone flowmeters were installed in the inlet of generator, not in the main pulp. When shutdown of equipment happened, the valve on the pipeline to the generator will be closed, and the biogas will enter the torch for the flaring system. During this monitoring period, only a short time of shutdown happened.

When calculate the baseline emissions of the project activity, only the biogas entering the generator is included, the biogas flared is not included. Therefore, the baseline emission and project emission due to flaring was not calculated. The PO will not claim the emission reductions of flared methane, therefore, project emissions due to flaring should not be considered, which is conservative and reasonable. Therefore, $PE_{flare,y} = 0$

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

Vintage	$PE_{EC,y}$ (tCO ₂)	$PE_{CH4,y}$ (tCO ₂)	$PE_{AD,y}$ (tCO ₂)
20/09/2019-31/12/2019	135	1,536	1,671

01/01/2020-31/12/2020	201	22,535	22,736
01/01/2021-11/10/2021	41	18,753	18,794
Total in this monitoring period	377	42,824	43,201

- 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.

$$LE_y = LE_{AD,y} = LE_{storage,y} + LE_{comp,y}$$

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 ($LE_{storage,y}$). $LE_y = LE_{AD,y} = LE_{storage,y}$

In order to determine $LE_{storage,y}$ for liquid digestate, Option 2 of the tool is chosen.

$$LE_y = LE_{AD} = LE_{storage} = F_{ww,CH4,default} * Q_{CH4,y} * GWP_{CH4}$$

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)

$F_{ww,CH4,default}$ Default factor representing the remaining methane production capacity of liquid digestate (fraction)

$Q_{CH4,y}$ Quantity of methane produced in the digester in year y (tCH₄)

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

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

Vintage	$F_{w,CH_4,default}$	$Q_{CH_4,y}$ (tCH ₄)	$GWP_{CH_4,y}$	$LE_{AD,y}$ (tCO ₂)
20/09/2019-31/12/2019	0.05	1,097	28	1,536
01/01/2020-31/12/2020	0.05	16,097	28	22,535
01/01/2021-11/10/2021	0.05	13,395	28	18,753
Total in this monitoring period	/	30,589	/	42,824

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

Vintage	$PE_{AD,y}$ (tCO ₂)	$LE_{AD,y}$ (tCO ₂)	PE_y (tCO ₂)
20/09/2019-31/12/2019	1,671	1,536	3,207
01/01/2020-31/12/2020	22,736	22,535	45,271
01/01/2021-11/10/2021	18,794	18,753	37,547
Total in this monitoring period	43,201	42,824	86,025

Leakage

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 $LE_y = 0$. The assessment team deems this consideration is correct and in line with methodology ACM0014, version 08.0.

Emission Reductions

According to ACM0014, version 08.0, emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$

Where:

ER_y = Emission reductions in year y (tCO₂e/yr)

BE_y = Baseline emissions in year y (tCO₂e/yr)

PE_y = Project emissions in year y (tCO₂e/yr)

LE_y = Leakage emissions in year y (tCO₂e/yr)

Based on the calculations and results presented in the sections above, emission reductions resulted in the implementation of the project activity of this monitoring period is:

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)
20/09/2019 - 31/12/2019	34,722	3,207	0	31,515
01/01/2020 - 31/12/2020	450,065	45,271	0	404,794
01/01/2021 - 11/10/2021	354,020	37,547	0	316,473
Total	838,807	86,025	0	752,782

By comparing the actual ER claimed in this monitoring period with that estimated in the registered PD, the actual emission reductions (752,782 tCO₂e) are 5.95% higher than what is stated in the registered PD (i.e. 710,513 tCO₂e, based on the estimated value of ER indicated in the registered PD). This is because the value of GWP_{CH4} in this monitoring period is 28, while the value in the registered PD is 25. The increase of GWP_{CH4} value and emission reductions has no impact on additionality of the project activity.

4.5 Quality of Evidence to Determine GHG Emission Reductions and Removals

The monitoring has been carried out in accordance with the monitoring plan contained in the registered PD (version 3.0 dated 19/07/2021) /3/.

As a result of verification of the ER calculation process, the assessment team confirmed that all the parameters required for the determination of the emission reductions have been included in the Monitoring Report /1/ and ER Calculation Spreadsheet /2/ and are consistent with the applied methodology ACM0014: Treatment of wastewater version 08.0 and the monitoring plan contained in the registered PD. The parameters are complete in this monitoring period.

After verifying the reported figures with the raw data sources, it's confirmed that the values of the parameters from the raw data sources are consistent with those quoted in the ER Calculation Spreadsheet and the MR Report. The verification process for the same has been clearly described above in section 4.4 of the report.

4.6 Non-Permanence Risk Analysis

Not applicable as a renewable project.

5 VERIFICATION CONCLUSION

Applus+ Certification has been commissioned by Swiss Carbon Value Ltd. to perform the verification of greenhouse gas emission reductions of the project activity “Linshu Biogas Recovery and Power Generation Project” (VCS Ref. No. 2402).

The management of VPOWER New Energy Technology (LinYi) LTD is responsible for the preparation of the GHG emissions data and the reported GHG emissions reductions on the basis set out within the project’s Monitoring Plan in the registered PD (version 3.0 dated 19/07/2021) /3/.

Our verification approach was based on the requirements as defined under the applicable VCS standards 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 registered PD;
- the monitoring plan in registered PD is as per the applied methodology;
- the monitoring complies with the monitoring plan in the registered PD;
- the monitoring report and other supporting documents provided are complete and verifiable and in accordance with the applicable VCS 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.

In our opinion, the GHG emission reductions for “Linshu Biogas Recovery and Power Generation Project” during the monitoring period 20/09/2019 to 11/10/2021 as reported in Monitoring Report, prepared on the basis of the project’s Monitoring Plan are fairly stated. Based on the information we have seen and evaluated, we confirm the following statement:

Verification period: From 20/09/2019 to 11/10/2021 (divided into 3 vintage periods).

Verified GHG emission reductions or removals in the above reporting 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)
20/09/2019 - 31/12/2019	34,722	3,207	0	31,515
01/01/2020 - 31/12/2020	450,065	45,271	0	404,794
01/01/2021 - 11/10/2021	354,020	37,547	0	316,473
Total	838,807	86,025	0	752,782

APPENDIX 1: REFERENCE LIST

1. Monitoring report, Version 1.0 dated 29/10/2021; Version 2.0 dated 30/11/2021
2. ER calculation spreadsheet
3. Registered VCS PD, version 3.0 dated 19/07/2021
4. Validation report, Version 02.0, completed on 20/07/2021 by Applus+ Certification
5. VCS Standard version 4.1, dated on 22/04/2021
6. Approved methodology ACM0014: Treatment of wastewater, version 08.0, dated 14/06/2019
7. FSR completed by Coal Industry Jinan Design and Research Institute Co., Ltd. On May 2017
8. VCS Monitoring procedure
9. Nameplate of Gas engine and Steam boiler
10. Electricity and Biogas Production Monthly Report covering the monitoring period
11. Staff roster and HR records provided by the project owner
12. Water flow and COD monthly report covering the monitoring period
13. Questionnaires from local stakeholders
14. Photos of DCS system, Electromagnetic flowmeter, Electronic balance, Acid burette, Drying oven, Electricity meters, V cone flowmeter, Temperature meter, Pressure gauge, Methane detector
15. 2019 Baseline Emission Factors for Regional Power Grids in China dated 29/12/2020 published by China DNA
16. Operation and Maintenance Record provided by the project owner
17. Commissioning evidence issued by Coal Industry Jinan Design and Research Institute Co., Ltd
18. Attendance list of stakeholder consultation meeting

- 19 Environmental Impact Assessment Report compiled on 20/07/2017 and approved by Linshu Country Environmental Protection Bureau on 07/08/2017
- 20 Electricity Transaction Notes (ETNs) of net quantity of electricity generated with biogas from the new anaerobic biodigester and net quantity of grid electricity consumed by the project
- 21 National or regional weather statistics: <https://www.tianqi24.com/linyi2/history202005.html>
- 22 Monthly Report of Methane Concentration covering the monitoring period
- 23 Calibration certificates of Electromagnetic flowmeter covering the whole monitoring period issued by Linyi County Metrology Test 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 County Metrology Test Institute
- 26 Calibration certificates of Temperature meter, Pressure gauge covering the whole monitoring period issued by Linyi County Metrology Test Institute
- 27 Calibration certificates of V cone flowmeter covering the whole monitoring period issued by Linyi County Metrology Test Institute.
- 28 Calibration certificates of gas analyzer (Methane detector) covering the whole monitoring period issued by Shenzhen Teis Electronics Co., Ltd.
- 29 Metrological Authorization Certification of Linyi Metrology Inspection Institute, issued by Linyi Quality and Technical Supervision Bureau of Shandong Province, valid till 23/04/2024.
- 30 Metrological Authorization Certification of Linshu County Metrology and Testing Institute, issued by Linyi Quality and Technical Supervision Bureau of Shandong Province, valid till 11/10/2021.

APPENDIX 2: <CLARIFICATION REQUESTS, CORRECTIVE ACTION REQUESTS, FORWARD ACTION REQUESTS (CAR/CL/FAR)>

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

FAR ID	NA	Section no.	NA	Date: NA
Description of FAR				
NA				
Project participant response				Date: NA
NA				
Documentation provided by project participant				
NA				
DOE assessment				Date: NA
NA				

Table 2. CL from this verification

CL ID	01	Section no.	4.4	Date: 28/11/2021
Description of CL				
In MR (Version 1.0 dated 29/10/2021). it is stated that no project emissions from flaring of biogas ($PE_{flare,y}$) and no project emissions from fossil fuel consumption ($PE_{FC,y}$) was generated of the project activity during this monitoring period. PP is request to provide evidence to further clarify that no biogas is flared and no fossil fuel is consumed during this monitoring period.				
Project participant response				Date: 30/11/2021

There is flaring when there is stop running for maintenance or small repair. The biogas volume meter is installed in the inlet of generator, not in the main pulp. When shutdown, the valve on the pipeline to the generator will be closed, and the biogas will enter the torch for flaring. During this monitoring period, only a short time of shutdown happened.

The PO will not claim the emission reductions of flared methane. This is also conservative. When calculate the baseline emissions, only the biogas entering the generator is included, the biogas flared is not included.

No fossil fuel is consumed in this monitoring period. When restart the auxiliary equipment, steam boiler and generator, only electricity will be consumed. There is no need to consume diesel or other fossil fuel.

Therefore, $PE_{FC,y} = 0$ and $PE_{flare,y} = 0$,

Documentation provided by project participant

statement from the project owner, Operation and Maintenance Record, updated MR

DOE assessment

Date: 01/12/2021

By checking statement from the project owner and by site inspection, it is confirmed that flaring system will be used when wastewater treatment equipment was stopped for maintenance or small repairs.

The V cone flowmeters were installed in the inlet of generator, not in the main pulp. When shutdown of equipment happened, the valve on the pipeline to the generator will be closed, and the biogas will enter the torch for the flaring system. During this monitoring period, only a short time of shutdown happened.

When calculate the baseline emissions of the project activity, only the biogas entering the generator is included, the biogas flared is not included. Therefore, the baseline emission and project emission due to flaring was not calculated. The PO will not claim the emission reductions of flared methane, therefore, project emissions due to flaring should not be considered, which is conservative and reasonable. Therefore, $PE_{flare,y} = 0$

By checking Operation and Maintenance Record, through site inspection and interview with project owner during site visit, it is confirmed electricity instead of fossil fuel are used for restart the auxiliary equipment, steam boiler and generator. Therefore, $PE_{FC,y} = 0$.

Therefore, CL 01 was closed.

Table 3. CAR from this verification

CAR ID	NA	Section no.	NA	Date: NA
Description of CAR				
NA				
Project participant response				Date:

NA	
Documentation provided by project participant	
NA	
DOE assessment	Date:
NA	

Table 4. FAR from this verification

FAR ID	NA	Section No.	NA	Date: NA
Description of FAR				
NA				
Project participant response				Date: NA
NA				
Documentation provided by project participant				
NA				
DOE assessment				Date: NA
NA				