



**Verified Carbon
Standard**

LINSHU BIOGAS RECOVERY AND POWER GENERATION PROJECT



Document Prepared by Swiss Carbon Value Ltd.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The Linshu Biogas Recovery and Power Generation Project (hereafter referred to as the Project) is implemented by VPOWER New Energy Technology (LinYi) LTD., (hereafter as VPOWER). The project recovers biogas from the wastewater generated in alcohol production process. The electricity and steam generated by this project will be supplied to Jinyimeng company (hereafter as Jinyimeng).

Prior to the project, the wastewater from alcohol production was treated through a series of deep open anaerobic lagoons without biogas recovery. The methane would have been released into the atmosphere. The equivalent electricity generated by the project would have otherwise been from North China Power Grid (NCPG) which is fossil fuel dominated. The equivalent heat of the project has otherwise been from coal boiler.

The project activity will install wastewater treatment equipment, biogas storage and purification equipment, biogas generator and waste heat boiler to utilize the biogas to generate electricity and heat. The electricity and heat generated will be used for the production of Jinyimeng to replace those from NCPG and coal boilers. Therefore, the project would significantly reduce GHG emissions.

The total installed capacity of the project is 13.6MW, including 6 units of 1.2MW generators and 4 units of 1.6MW generators, and 1 unit of 1.2MW for backup. 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. The project owner only claims emission reductions from methane recovery and electricity generation. The annual emission reductions by methane avoidance are 290,883tCO₂e/yr. The annual average estimation of GHG emission reduction from the methane recovery and electricity generation in the 1st crediting period are about 359,691 tCO₂e/yr.

The project started construction on 01/11/2018 and come into continuous operation on 20/09/2019. This monitoring period is from 20/09/2019 to 11/10/2021, and the total emission reductions in this monitoring period are 752,782CO₂.

1.2 Sectoral Scope and Project Type

The project activity involves recovery of fugitive methane emissions using anaerobic covered lagoon system and utilization of biogas as fuel to generate heat and electricity. Therefore, the following sectoral scopes are applicable to the project activity.

- Sectoral scope 13: Waste handling and disposal
- Sectoral scope 1: Energy industries (renewable - / non-renewable sources)

The project is not AFOLU project and a grouped project.

1.3 Project Proponent

Organization name	VPOWER New Energy Technology (LinYi) LTD
Contact person	Li Xia
Title	Manager
Address	High-Tech Entrepreneurship Service Center, LinShu County, LinYi City, Shan Dong Province
Telephone	+86 539 60888170
Email	psm.ly@vpower.cn

1.4 Other Entities Involved in the Project

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

1.5 Project Start Date

The project activity started operation on 20/09/2019, which is the date that generates emission reductions.

1.6 Project Crediting Period

The 1st crediting period is from 20/09/2019 to 19/09/2026, which is 7 years and can be renewed twice. Therefore, the total crediting period is 21 years, from 20/09/2019 to 19/09/2040.

1.7 Project Location

The proposed project activity is located at Linshu County, Linyi City, Shandong Province, China. The proposed project activity location is depicted in figure 1 and figure 2.

Project coordinates are 34°54'52.95"N, 118° 34'18.78" E



Figure 1. Location of Shandong province in China



Figure 2. Location of the project

1.8 Title and Reference of Methodology

The following methodology is applicable to the proposed project activity:

ACM0014 “Treatment of wastewater” (version 08.0)

The following methodological tools will also be used in this project activity:

- “Tool for the demonstration and assessment of additionality” (version 07)
- “Tool to calculate the emission factor for an electricity system” (version 07)
- “Project and leakage emissions from anaerobic digesters” (version 02)
- “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03)
- “Tool to determine the mass flow of a greenhouse gas in a gaseous stream” (version 03)
- Project emissions from flaring (version 03.0)

1.9 Participation under other GHG Programs

The project is not registered under any other GHG programs.

1.10 Other Forms of Credit

The Project is not included in any other emissions trading program or any other mechanism that includes GHG allowance trading.

The project has not sought or received another form of GHG-related environmental credit.

1.11 Sustainable Development

The project provides many benefits that will help achieve China’s Sustainable Development Goals (SDG)¹, a set of 17 universal goals covering the thematic areas of environmental, economic and social development.

¹ https://www.fmprc.gov.cn/mfa_eng/zxxx_662805/W020161014332600482185.pdf



The project will directly contribute to sustainable development in several ways as shown below:

- Provide clean energy. The project makes use of biogas generated from wastewater treatment to generate electricity and heat. The clean electricity generation of this project is supplied to Jinyimeng to replace the same amount of electricity that would have otherwise been supplied by NCPG, which is dominated by fossil fuel fired electricity. This helps diversify power structure of the NCPG and reduce the dependence on fossil fuels. The heat of this project is supplied to Jinyimeng company to replace coal consumption. This contributes to one of the China's actions for promoting the sustainable developing, "By 2030, increase the share of non-fossil fuels in primary energy consumption to about 20 percent"; (SDG 7). In this monitoring period, the net electricity generation is 160,075.581MWh.
- Provide decent work. The project provides employment opportunities related to the operation and maintenance of the power plant, which meets one of the China's action plans "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." (SDG 8)
- Reduce CH₄ emissions. The project recovers and utilizes biogas generated during wastewater treatment that would otherwise be released into the atmosphere, effectively reducing GHG emissions and air pollution. That means not only the project will reduce GHG emissions to local environment, but also provide an environmentally sound solution to minimize explosion risks and odour at the project site, which improves the environment around landfills. This contributes to achieving 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"; (SDG 13). The total emission reductions in this monitoring period are 752,782tCO₂.

2 SAFEGUARDS

2.1 No Net Harm

There is no negative environmental and socio-economic impact. The project is a renewable energy biogas based electrical and thermal generation activity, which could reduce GHG emissions thus is good for the environment. The project follows the local and national regulation in order to maintain and prevent the environmental impact. Besides, the project could provide job opportunities for local people, which is beneficial for local people's livelihood.

The EIA of the project has been approved by Linshu County Environmental Protection Bureau on 07/08/2017.

2.2 Local Stakeholder Consultation

The stakeholder consultation was held in office of VPOWER on 16/08/2018. The stakeholder consultation was conducted by VPOWER. Participants, including local residents and employees attended the meeting.

Before the stakeholder consultation meeting, stakeholders were identified and informed through oral and written means. Invitation notice were put on the bulletin of local villages and in person to participants nearby the project site. The invitation process was conducted 3 weeks prior to the meeting date.

Meeting Agenda

- Registration
- Welcome speech and purpose of the meeting by representative of VPOWER.
- Description of the background of the project implementation by VPOWER.
- Description of the project and environmental impacts by VPOWER.
- Questions and Answers session
- Completing questionnaires

Compilation of comments received

The survey was conducted through distributing and collecting responses to the questionnaire. 49 questionnaire were sent and 49 responses were collected.

The questionnaires mainly focus on following issues:

- What do you think is the possible environment problem that the proposed project may generate?
- What do you think is the effect of the proposed project on local environment?
- Are you satisfied about the environment protection measures that the proposed project has made?
- What do you think is the impact of the proposed project on local economy?
- What do you think is the impact of the proposed project on local employment?

- Are you agree or disagree with the construction of the proposed project?
- Do you have any suggestions on this project?

The proposed project activity and its environmental impacts were described to the stakeholders during the meeting. Stakeholders acknowledged that the development of the proposed project reduce odour emissions to the surrounding area. The biogas utilization will also help improve environmental impacts by replacing fossil fuel consumption for electricity and thermal generation.

Table 1. Interviewee statistics

Basic information	Classified items	Number of Persons	Percentage
Age	Younger than 30	4	8%
	30-40	26	53%
	>41	19	39%
Occupation	Working staff	16	33%
	Farmers	10	20%
	Teachers	8	16%
	Students	3	6%
	Others	12	25%
Education	Primary school	10	20%
	Middle school	18	37%
	College and above	21	43%
Gender	Male	37	76%
	Female	12	24%

The responses are concluded as follows:

- 100% people think the project would not generate environment problem.
- 100% people think the proposed project would improve local environment.
- 100% people are satisfied about the environment protection measures that the proposed project has made.
- 100% people think the proposed project has good impact on local economy.
- 100% people think the proposed project is good for local employment.
- 100% people agree with the construction of the proposed project.

According to the feedback provided both orally during the meeting and in writing through the filled questionnaires by participants, the stakeholders support and have a positive opinion about the proposed project activity and provided environmental and safety measures. Therefore, this project activity is perceived as an environmentally friendly project, which can improve the quality of life of the surrounding community. The proposed project activity is expected to deliver multiple benefits in respect of sustainable development including environmental, social and economic benefits.

Before the stakeholder consultation meeting, the proposed project information in which PO's telephone was included was put on local village's bulletin and near the power plant for public comment.

During the stakeholder consultation meeting, the contact information of the project owner had been made public to the attenders.

Through the physical stakeholder meeting and telephone public in local area, all local residents know how to contact the PO and could give their comments or grievance to this project.

Besides, a grievance book is put in the communication room at the main door of the project owner company. The local stakeholders can provide feedbacks there as well. The village head will reach PO if any comments are received. No comments were received in this monitoring period.

2.3 AFOLU-Specific Safeguards

N/A

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The project installs series of wastewater treatment equipment, and recover the biogas generated during the wastewater treatment process for electricity and heat generation. The electricity and heat will be supplied to Jinyimeng for industrial production via NCPG and steam pipes.

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

The 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.

The biogas generated are stored in the biogas tank, and then be 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 being about 13.6MWel. When the generator set are in malfunction, or excess biogas, if any, will be sent to high temperature open flare to destroy.

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 low and comply with national integrated wastewater discharge standard. And it is discharged to local wastewater treatment area.

The main equipment and key technical parameters are listed below

Table 1. Key parameters of main equipment

Equipment	Model	Number	Key technical parameters
Gas engine	12V 4000 L32FB (engine model)	7 (including 1 backup)	Capacity: 1200kW Lifetime: no less than 21 years Year of manufacture: 2017
Gas engine	16V 4000 L32FB (engine model)	4	Capacity: 1600kW Lifetime: no less than 21 years Year of manufacture: 2017
Steam boiler	Q33.4/445-5.0-1.0/220	1	Evaporation: 5t/h Rated steam pressure: 1.0MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018
Steam boiler	Q24.6/445-3.8-1.0/220	1	Evaporation: 3.8t/h Rated steam pressure: 1.0MPa Rated steam temperature: 220°C Lifetime: 25 years Year of manufacture: 2018

The project started construction on 01/11/2018 and come into continuous operation on 20/09/2019.

This monitoring period covers from 20/09/2019 to 11/10/2021. During this monitoring period, the Project was implemented in line with the monitoring plan. And in this monitoring period, the plant runs well, no equipment is overhauled or replaced. No events or emergency which may impact the emission reductions and monitoring occurred during this monitoring period.

3.2 Deviations

2.1.1 Methodology Deviations

There is no methodology deviation in this monitoring period.

2.1.2 Project Description Deviations

There are no project description deviations in this monitoring period.

3.3 Grouped Projects

N/A

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data / Parameter	COD _{out,x}
Data unit	t COD
Description	COD of the effluent in the period x
Source of data	The design COD inflow for COD in and the design effluent COD flow for COD out corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Value applied	3130 t/yr
Justification of choice of data or description of measurement methods and procedures applied	No measurement procedures are required. The project activity involves installation of new anaerobic wastewater treatment and biogas utilization as Greenfield facilities. As per ACM0014 (version 08), the value applied for Greenfield project shall be as per the design value in the lagoon system identified for the selection of the baseline scenario. The unit mg/l will be converted to t COD.
Purpose of Data	Calculation of baseline emissions.
Comments	-

Data / Parameter	COD _{in,x}
Data unit	t COD
Description	COD directed to the open lagoons (Scenario 1) in the period x
Source of data	The design COD inflow for COD in and the design effluent COD flow for COD out corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Value applied	172,150t/yr
Justification of choice of data or description of measurement methods and procedures applied	No measurement procedures are required. The project activity involves installation of new anaerobic wastewater treatment and biogas utilization as Greenfield facilities. As per ACM0014 (version 08), the value applied for Greenfield project shall be as per the design value in the lagoon system

	identified for the selection of the baseline scenario. The unit mg/l will be converted to t COD.
Purpose of Data	The design COD inflow for COD in and the design effluent COD flow for COD out corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Comments	-

Data / Parameter	ρ
Data unit	-
Description	Discount factor for historical information
Source of data	As per ACM0014, version 08, for the existing plants, if one year of historical data is available, $\rho = 1$.
Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	No measurement procedures are required. The value is applied as per ACM0014, version 08 for the Greenfield project.
Purpose of Data	Calculation of project emissions.
Comments	-

Data / Parameter	B_0
Data unit	t CH ₄ /tCOD
Description	Maximum methane producing capacity, expressing the maximum amount of CH ₄ that can be produced from a given quantity of chemical oxygen demand (COD)
Source of data	2006 IPCC Guidelines
Value applied	0.21
Justification of choice of data or description of measurement methods and procedures applied	No measurement procedures are required. The value is applied as per 2006 IPCC Guidelines.
Purpose of Data	Calculation of baseline and project emissions.

Comments	-
Data / Parameter	D
Data unit	m
Description	Average depth of the lagoons
Source of data	For project activity implemented in Greenfield facility, the data shall be as per the baseline lagoon design as identified for the selection of the baseline scenario.
Value applied	3.0
Justification of choice of data or description of measurement methods and procedures applied	No measurement is required. The project activity involves installation of new anaerobic wastewater treatment and biogas utilization facilities. As per ACM0014 (version 08), the value applied for Greenfield project shall be as per the design value in the lagoon system identified for the selection of the baseline scenario.
Purpose of Data	Calculation of baseline emissions.
Comments	-
Data / Parameter	GWP _{CH4}
Data unit	t CO ₂ e/t CH ₄
Description	Global warming potential for CH ₄
Source of data	IPCC Fourth Assessment Report (AR5)
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	IPCC default value
Purpose of Data	Calculation of baseline and project emissions
Comments	The data shall be updated according to any future COP/MOP decisions.
Data / Parameter	f _d
Data unit	-

Description	Factor expressing the influence of the depth of the lagoon or sludge pit on methane generation
Source of data	ACM0014, version 08 If the average depth of the lagoon or sludge pits (D) is greater than 2m, $f_d = 0.7$
Value applied	0.7
Justification of choice of data or description of measurement methods and procedures applied	Discount factor for Greenfield project as per ACM0014, version08 is applied.
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$EF_{EL,j,y}$ or $EF_{grid,CM,y}$
Data unit	tCO ₂ /MWh
Description	Emission factor for electricity generation for source j (NCPG) in year y.
Source of data	National public official data
Value applied	0.7119
Justification of choice of data or description of measurement methods and procedures applied	The data source is from China's DNA. And the $EF_{grid,CM,y}$ is calculated according to "Tool to calculate the emission factor for an electricity system-v7.0"
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	TDL _{k,y}
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity to NCPG in year y
Source of data	Default value from 'baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)'
Value applied	3

Justification of choice of data or description of measurement methods and procedures applied	Default value from 'baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)'
Purpose of Data	Calculation of baseline emissions
Comments	-

Data / Parameter	$TDL_{j,y}$
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	Default value from 'baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)'
Value applied	20
Justification of choice of data or description of measurement methods and procedures applied	Default value from 'baseline, project and or leakage emissions from electricity consumption and monitoring of electricity generation (v03.0)'
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$F_{ww,CH4,default}$
Data unit	Fraction
Description	Default factor representing the remaining CH ₄ production capacity of liquid digestate
Source of data	Default value as per the tool
Value applied	0.05 for UASB
Justification of choice of data or description of measurement methods and procedures applied	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.
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	EF _{CH₄,default}
Data unit	t CH ₄ leaked / t CH ₄ produced
Description	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester
Source of data	IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value applied	0.05
Justification of choice of data or description of measurement methods and procedures applied	The project involves with the installation of UASB. The choice of data is based on the tool of project and leakage emissions from anaerobic digesters.
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	R _u
Data unit	Pa.m ³ /kmol.K
Description	Universal ideal gases constant
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03)
Value applied	8,314
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	MM _i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas i (CH ₄)
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03)

Value applied	16.04
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of baseline and project emission
Comments	

Data / Parameter	P _n
Data unit	Pa
Description	Total pressure at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03)
Value applied	101,325 Pa
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions
Comments	-

Data / Parameter	T _n
Data unit	K
Description	Temperature at normal conditions
Source of data	Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03)
Value applied	273.15
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline and project emissions

Comments	-
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4.2 Data and Parameters Monitored

Data / Parameter	FPJ,dlg,m					
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					
Source of data	Water flow meter					
Description of measurement methods and procedures to be applied	Flow meter is installed at the inlet of digester for measurement of the influent wastewater. The flow of wastewater is monitored and recorded continuously . The data are aggregated monthly.					
Frequency of monitoring/recording	The monitoring is done continuously and aggregated monthly					
Value monitored	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					
Monitoring equipment	Flow meter for wastewater					
	Name	Type	Accuracy	Serial Number	Calibration date	Valid till
	Electromagnetic flowmeter	YL-LDE-DN65	0.5%	202011106	12/06/2019	11/06/2020
					01/06/2020	31/05/2021
					14/05/2021	13/05/2022
QA/QC procedures to be applied	The flow meter is calibrated in accordance with the national standard.					
Purpose of the data	Calculation of baseline and project emissions					
Calculation method	/					
Comments	/					

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
Source of data	Measurements

Description of measurement methods and procedures to be applied	The COD content is analyzed using a national standard by the inhouse laboratory of the treatment plant. The results will be logged by the operators in the plant. Average value will be calculated.					
Frequency of monitoring/recording	The COD is analyzed daily and aggregated monthly.					
Value monitored	20/09/2019-31/12/2019: 0.054807 tCOD/m³ 01/01/2020-31/12/2020: 0.055015 tCOD/m³ 01/01/2021-11/10/2021: 0.054456 tCOD/m³					
Monitoring equipment	The COD is analyzed by qualified lab of Jinyimeng company using laboratory equipment, including balance, acid burette and drying cabinet. The information of analytical instruments are shown as follows:					
		Type	Serial number	Accuracy	Calibration date	Valid till
	Electronic balance	AB204-S	1129150058	qualified	12/06/2019	11/06/2020
					01/06/2020	31/05/2021
					14/05/2021	13/05/2022
	Acid burette	50ml	SD310602	qualified	12/06/2019	11/06/2020
					01/06/2020	31/05/2021
					14/05/2021	13/05/2022
	Drying oven	DHG-9075A	3806004	qualified	12/06/2019	11/06/2020
					01/06/2020	31/05/2021
14/05/2021					13/05/2022	
QA/QC procedures to be applied	Sampling and analysis process is carried out by plant technicians adhering to internationally recognized procedures.					
Purpose of the data	Calculation of baseline and project emissions					
Calculation method	/					
Comments	/					
Data / Parameter	T _{2,m}					
Data unit	K					
Description	Average temperature at the project site in month m					
Source of data	National or regional weather statistics					

Description of measurement methods and procedures to be applied	National or regional weather statistics ²																								
Frequency of monitoring/recording	Continuously, aggregated in monthly average values																								
Value monitored	The local average temperature is as follows: <table><tr><td>Jan.</td><td>Feb.</td><td>Mar.</td><td>Apr.</td><td>May</td><td>Jun.</td></tr><tr><td>273.65</td><td>280.15</td><td>283.15</td><td>286.65</td><td>294.15</td><td>298.15</td></tr><tr><td>Jul.</td><td>Aug.</td><td>Sep.</td><td>Oct.</td><td>Nov.</td><td>Dec.</td></tr><tr><td>297.65</td><td>299.65</td><td>295.65</td><td>288.15</td><td>283.15</td><td>274.65</td></tr></table>	Jan.	Feb.	Mar.	Apr.	May	Jun.	273.65	280.15	283.15	286.65	294.15	298.15	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	297.65	299.65	295.65	288.15	283.15	274.65
Jan.	Feb.	Mar.	Apr.	May	Jun.																				
273.65	280.15	283.15	286.65	294.15	298.15																				
Jul.	Aug.	Sep.	Oct.	Nov.	Dec.																				
297.65	299.65	295.65	288.15	283.15	274.65																				
Monitoring equipment	/																								
QA/QC procedures to be applied	/																								
Purpose of the data	Calculation of baseline emissions																								
Calculation method	In case of the temperature is available in Celsius, it shall be calculated as follows: $T_{2,m} \text{ (K)} = 273.15 \text{ K} + T_{2,m} \text{ (Celsius)}$																								
Comments	/																								

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
Source of data	Electricity meters
Description of measurement methods and procedures to be applied	Net quantity of electricity generated is monitored by the electricity meter (meter 1, meter 2). Meter 1 and meter 2 are bidirectional meters which are used to monitor both exported electricity to Jinyiment company and imported electricity from Jinyimeng company.
Frequency of monitoring/recording	Continuous measurement and monthly recording
Value monitored	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
Monitoring equipment	Electricity meter

² <https://www.tianqi24.com/linyi2/history202005.html>

	Name	Accuracy	Type	Serial Number	Calibration date	Valid until
	Electricity meter 1	0.2S	DTSD34 1	170841 708500 0001	11/06/2019	10/06/2020
					03/03/2020	02/03/2021
					25/02/2021	24/02/2022
	Electricity meter 2	0.2S	DTSD34 1	170841 708500 0002	12/06/2019	11/06/2020
					04/03/2020	03/03/2021
26/02/2021					25/02/2022	
QA/QC procedures to be applied	The electricity meter is calibrated according to national standard.					
Purpose of the data	Calculation of baseline emissions					
Calculation method	/					
Comments	/					

Data / Parameter	EC _{PJ, J, y}
Data unit	MWh/year
Description	Net quantity of grid electricity consumed by the project in year y
Source of data	Record from the project owner
Description of measurement methods and procedures to be applied	The electricity consumption is based on the grid electricity imported by the project. The value is continuously measured by the electricity meter (meter 1, meter 2, meter 3, meter 4). Meter 1 and meter 2 are bidirectional meters which are used to monitor both exported electricity to Jinyimeng company and imported electricity 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. Meter 3 and meter 4 are not used any more since February 2021. Therefore, from 20/09/2019- 02/2021, the total electricity consumption by this project is meter 1+meter 2+(meter 3-meter 4) After February 2021, the total electricity consumption by this project is meter 1+meter 2
Frequency of monitoring/recording	Continuous measurement and monthly recording
Value monitored	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					
Monitoring equipment	Electricity meter					
	Name	Accuracy	Type	Serial Number	Calibration date	Valid until
	Electricity meter 1	0.2S	DTSD341	1708417 0850000 01	11/06/2019	10/06/2020
					03/03/2020	02/03/2021
					25/02/2021	24/02/2022
	Electricity meter 2	0.2S	DTSD341	1708417 0850000 02	12/06/2019	11/06/2020
					04/03/2020	03/03/2021
					26/02/2021	25/02/2022
	Electricity meter 3	0.2S	DTSD341	1706409 5370000 03	12/06/2019	11/06/2020
					04/03/2020	03/03/2021
					26/02/2021	25/02/2022
	Electricity meter 4	2.0	DT862	1023924 17	12/06/2019	11/06/2020
					04/03/2020	03/03/2021
26/02/2021					25/02/2022	
QA/QC procedures to be applied	The electricity meters are calibrated as per national standard.					
Purpose of the data	Calculation of project emissions					
Calculation method	/					
Comments	/					

Data / Parameter	F _{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					
Source of data	Measured by Volumetric flow meter (V cone flowmeter)					
Description of measurement methods and procedures to be applied	Two V cone flowmeters are installed at the inlet of generator, outlet to the digester, after desulfurization. The volumetric gas flow rate is monitored and recorded continuously and aggregated monthly. The monitored volume is automatically converted into volume of standard condition in the DCS system based on the biogas temperature and pressure.					
Frequency of monitoring/recording	Parameter monitored continuously but aggregated monthly for calculations.					
Value monitored	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					
Monitoring equipment	Gas flow meter					
	Equipment	Accuracy	Type	Serial Number	Calibration date	Valid until
	V cone flowmeter 1	0.5	FFM61S300A10RFM2N	F61-2005-0725	11/06/2019	10/06/2020
					03/03/2020	02/03/2021
25/02/2021					24/02/2022	

	V cone flowmeter 2	0.5	FFM61S300A10RFM2N	F61-2005-0726	12/06/2019	11/06/2020	
					04/03/2020	03/03/2021	
						26/02/2021	25/02/2022
	Temperature meter						
		Accuracy	Type	Serial Number	Calibration date	Valid until	
	Temperature meter 1	±0.5°C	644HAK5J6M5	3650022	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	±0.5°C	644HAK5J6M5	3650023	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						
		Accuracy	Type	Serial Number	Calibration date	Valid until	
	Pressure gauge 1	0.065 class	-10~50Kpa	7917305	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	0.065 class	-10~50Kpa	7917306	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		
QA/QC procedures to be applied	The meters are calibrated as per national standard.						
Purpose of the data	Calculation of baseline and project emissions						
Calculation method	/						
Comments	/						

Data / Parameter	WCH ₄ ,biogas,y (VCH ₄ ,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																		
Source of data	Measured																		
Description of measurement methods and procedures to be applied	A gas analyzer (methane detector) records the methane content in the biogas. It is monitored and recorded continuously in the DCS system. The data is summarized monthly by operator.																		
Frequency of monitoring/recording	Monitored and recorded continuously, summarized monthly.																		
Value monitored	20/09/2019-31/12/2019: 57.23%*0.716 kgCH ₄ /m ³ CH ₄ =0.4098 kg CH ₄ /m ³ biogas 01/01/2020-31/12/2020: 56.64%*0.716 kgCH ₄ /m ³ CH ₄ =0.4055 kg CH ₄ /m ³ biogas 01/01/2021-11/10/2021: 55.92%*0.716 kgCH ₄ /m ³ CH ₄ =0.4004 kg CH ₄ /m ³ biogas																		
Monitoring equipment	Gas analyzer <table><tr><td>Equipment</td><td>Accuracy</td><td>Serial Number</td><td>Calibration date</td><td>Valid until</td></tr><tr><td rowspan="3">Methane detector</td><td rowspan="3">3%</td><td rowspan="3">20190813 0E01195</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>					Equipment	Accuracy	Serial Number	Calibration date	Valid until	Methane detector	3%	20190813 0E01195	31/08/2019	30/08/2020	13/08/2020	12/08/2021	02/08/2021	01/08/2022
Equipment	Accuracy	Serial Number	Calibration date	Valid until															
Methane detector	3%	20190813 0E01195	31/08/2019	30/08/2020															
			13/08/2020	12/08/2021															
			02/08/2021	01/08/2022															
QA/QC procedures to be applied	The methane detector is calibrated as per national standard.																		
Purpose of the data	Calculation of baseline and project emissions																		
Calculation method	/																		
Comments	/																		

4.3 Monitoring Plan

1. Monitoring Management

The required monitoring equipment is installed by the technology provider. Monitoring meters are regularly calibrated according to recognized procedures by the plant operator and sampling is carried out by the onsite chief of the wastewater monitoring department according to appropriate industrial standards.

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

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

2. Quality Assurance and Quality Control

The plant manager monitors overall performance of the plant, ensures proper and timely calibration, data acquisition and storage.

A monitoring team is built, consisted with team manager, monitoring staff, data verifier.

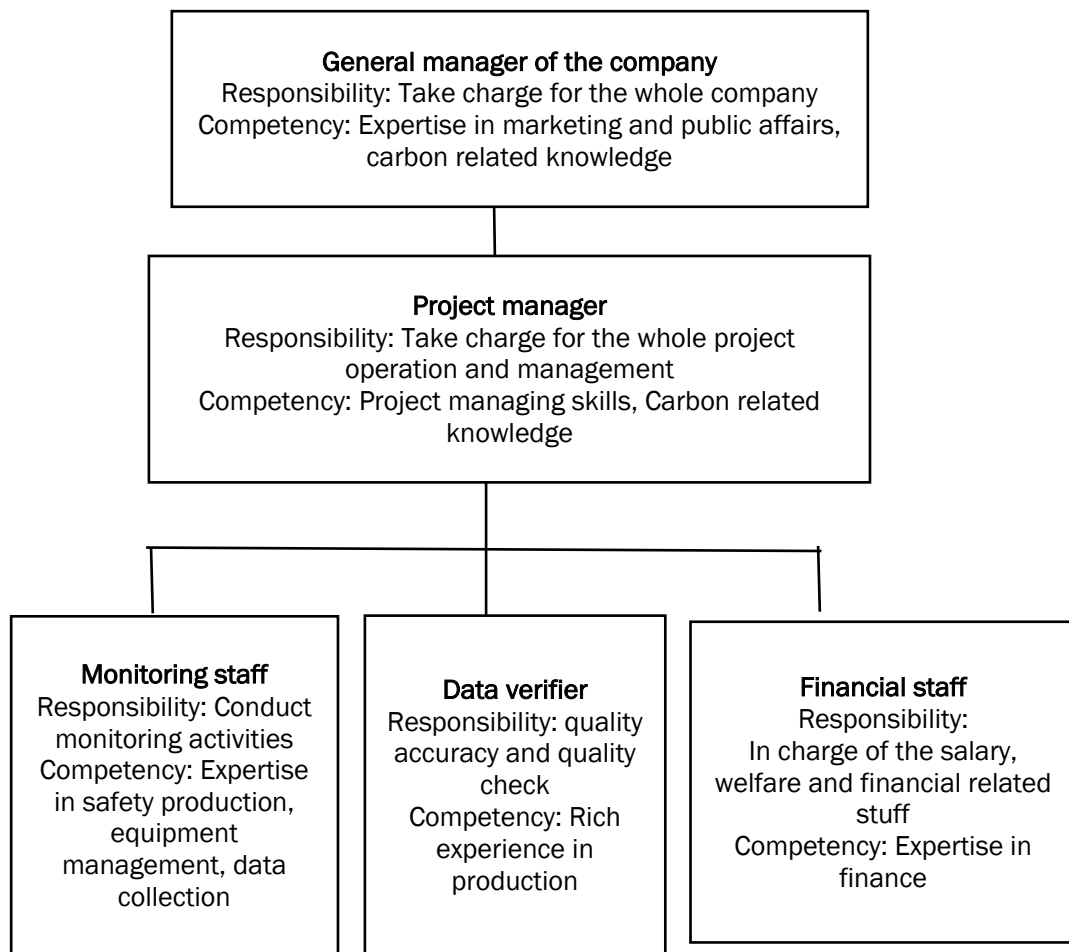


Figure 4. Monitoring structure

3. Data record and Storage

All relevant data is are stored manually in operational log sheets or electronically in a computer unit. All parameters monitored under the monitoring plan will be kept for at least two years after the end of the crediting period or the last issuance of VERs for the project activity, whichever occurs later.

4. Emergency preparedness

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

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

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

The proposed project activity involves the installation of new anaerobic digester for the treatment of wastewater. This corresponds to scenario 1 of ACM0014 and therefore all data and terms used in the calculation of the baseline and project activity emissions relate to scenario 1.

Baseline emissions are calculated using the following formula:

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

where

BE_y = Baseline emissions in year y (t CO₂e/yr)

$BE_{CH_4,y}$ = Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) in the absence of the project activity in year y (t CO₂e/yr)

$BE_{EL,y}$ = 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 (t CO₂/yr)

$BE_{HG,y}$ = CO₂ emissions associated with fossil fuel combustion for heating equipment that is displaced by the project in year y (t CO₂/yr).

This project does not consider the emission reductions of heating section for simplification. Therefore, $BE_{HG,y}=0$

$$BE_y = BE_{CH_4,y} + BE_{EL,y} + BE_{HG,y} = BE_{CH_4,y} + BE_{EL,y} \quad \text{Equation (2)}$$

Step 1: Calculation of baseline emissions from anaerobic treatment of the wastewater ($BE_{CH_4,y}$)

$$BE_{CH_4,y} = \min \{ Q_{CH_4,y} ; BE_{CH_4,MCF,y} \} \quad \text{Equation (3)}$$

Where

$Q_{CH_4,y}$ = Methane produced after the implementation of the proposed project activity

$BE_{CH_4,MCF,y}$ = Methane conversion factor method for the estimation of methane emissions from open lagoons

Determination of $Q_{CH_4,y}$

The process to determine $Q_{CH_4,y}$ is as follows:

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 ($Q_{CH_4,y}$).

To be clear, the unit $Q_{CH_4,y}$ is converted to tCO_2 by multiplication of GWP_{CH_4} .

$$Q_{CH_4,y} = GWP_{CH_4} * F_{CH_4,t}$$

The proposed project is a large scale project. Therefore, option 1 (Procedure using monitoring data) of the “Project and leakage emissions from anaerobic digesters (v2.0)” 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:

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

As per paragraph 13 of the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (v03.0)”, the mass flow of methane ($F_{CH_4,t}$) can be determined through measurement of the flow and volumetric fraction of the gaseous stream.

The proposed project proponent chooses the ‘measurement option A (volume flow)’ as per table 2 of ‘Tool to determine the mass flow of a greenhouse gas in a gaseous stream (v03.0)’. The volume flow and the volumetric fraction of the gaseous stream will be determined according to the option A under option 2 “simplified calculation without measurement of the moisture content”.

There are two ways in option A:

- Measure the moisture content of the gaseous stream ($C_{H_2O,t,db,n}$) and demonstrate that this is less or equal to $0.05 \text{ kg H}_2\text{O}/\text{m}^3$ dry gas; or
- Demonstrate that the temperature of the gaseous stream (T_t) is less than 60°C (333.15 K) at the flow measurement point.

Option (b) is chosen because the temperature of the gaseous stream is less than 60°C at the flow measuring point. $F_{CH_4,t}$ is determined as following equation of the tool;

$$F_{CH_4,t} = V_{t,db} * V_{CH_4,t,db} * \rho_{CH_4,t} \quad \text{Equation (4)}$$

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 the gaseous stream in time interval t on a dry basis (m^3 dry gas)
 $V_{CH_4,t,db}$ = 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 time interval t ($kgCH_4/m^3CH_4$)

Density of methane ($\rho_{CH_4,t}$) is determined at the normal condition in line with below equation.

$$\rho_{CH_4,t} = (P_t \times MM_{CH_4}) / (R_u \times T_t) \quad \text{Equation (5)}$$

Where:

- $\rho_{CH_4,t}$ = Density of greenhouse gas (CH_4) in the gaseous stream in time interval t ($kgCH_4/m^3CH_4$).
 P_t = Absolute pressure of the gaseous stream in time interval t (Pa). 101,325
 MM_{CH_4} = Molecular mass of CH_4 (kg/kmol) . 16.04
 R_u = Universal ideal gases constant (Pa.m³/kmol.K). 8314
 T_t = Temperature of the gaseous stream in time interval t (K). 273.15

According to the default value in 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream (v03.0)'.

$$\rho_{i,t} = (P_t \times MM_{CH_4}) / (R_u \times T_t) = 101325 \times 16.04 / 8314 / 273.15 = 0.716$$

The monitoring data for $V_{t,db}$ and $v_{CH_4,t,db}$ are shown in following table

Table 1. Monitoring value of $V_{t,db}$ and $v_{CH_4,t,db}$

month	$V_{t,db}$ (m^3 biogas)	$v_{CH_4,t,db}$	$\rho_{CH_4,t}$ ($kgCH_4/m^3CH_4$)	$F_{CH_4,t}$ (t CH_4)	$Q_{CH_4,y}$ (t CO_2)
20/09/2019-31/12/2019	2,676,618	57.23%	0.716	1097	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 $BE_{CH_4,MCF,y}$

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

$$BE_{CH_4, MCF,y} = GWP_{CH_4} * MCF_{BL,y} * B_0 * COD_{BL,y} \quad \text{Equation (6)}$$

where

- GWP_{CH_4} = Global Warming Potential of methane valid for the commitment period (t CO_2e/tCH_4)
- B_0 = Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand (t $CH_4/tCOD$)
- $MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year y, representing the fraction of ($COD_{PJ,y} \times B_0$) 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 $COD_{BL,y}$

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 CODPJ should be adjusted by an adjustment factor which relates the COD supplied to the lagoon with the COD in the effluent.

$$COD_{BL,y} = \rho * (1 - (COD_{out,x}/COD_{in,x})) \times COD_{PJ,y} \quad \text{Equation (7)}$$

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:

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,dig,m} \times COD_{dig,m} \quad \text{Equation (8)}$$

where

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

Table 2. Monitoring value of $F_{PJ,dig,m}$ & $COD_{PJ,y}$

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)
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

Determination of $MCF_{BL,y}$

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

$$MCF_{BL,y} = f_d * f_{T,y} * 0.89 \quad \text{Equation (9)}$$

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.

$$f_d = \begin{cases} 0; & \text{if } D < 1 \text{ m} \\ 0.5; & \text{if } 1\text{m} \leq D < 2\text{m} \\ 0.7; & \text{if } D \geq 2\text{m} \end{cases} \quad \text{Equation (10)}$$

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. In the baseline scenario, the depth of open lagoon is 3 meters. Therefore, 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:

$$COD_{available,m} = COD_{BL,m} + (1 - f_{T,m-1}) * COD_{available,m-1} \quad \text{Equation (11)}$$

where

$COD_{available,m}$ = 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)

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

m = Months of year y of the crediting period

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

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

$$COD_{BL,y} = (1 - (COD_{out,x}/COD_{in,x})) * COD_{PJ,m} \quad \text{Equation (12)}$$

Where

- $COD_{out,x}$ = 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)
 $COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month m (t COD/month)
 x = Representative historical reference period

And

$$COD_{PJ,m} = F_{PJ,dig,m} * COD_{dig,m} \quad \text{Equation (13)}$$

where

- $COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or in the project activity in month m (t COD/month)
 $F_{PJ,dig,m}$ = Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (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:

$$f_{T,m} = \begin{cases} 0 & \text{if } T_{2,m} < 278K \\ e^{\left(\frac{E \times (T_{2,m} - T_1)}{R \times T_1 \times T_{2,m}}\right)} & \text{if } 278K \leq T_{2,m} \leq 302.5K \\ 0.95 & \text{if } T_{2,m} > 302.5K \end{cases} \quad \text{Equation (14)}$$

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:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}} \quad \text{Equation (15)}$$

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

Table 3. Monitoring value of $BE_{CH4,MCF,y}$

	$MCF_{BL,y}$	B_0 (tCH ₄ /tCOD)	$COD_{BL,y}$ (tCOD)	GWP_{CH4} (tCO ₂ /tCH ₄)	$BE_{CH4,MCF,y}$ (tCO ₂)
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

Table 4. Monitoring value of $BE_{CH4,y}$

Monitoring period	$BE_{CH4,MCF,y}$ (tCO ₂ /yr)	$Q_{CH4,y}$ (tCO ₂ /yr)	$BE_{CH4,y} = \min(BE_{CH4,MCF,y}, Q_{CH4,y})$
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

Step 2: Baseline emissions from generation and/or consumption of electricity ($BE_{EL,y}$)

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.

$$BE_{EL,y} = (EC_{BL} \times EF_{BL,EL,y}) + (EG_{PJ,y} \times EF_{PJ,EL,y}) \quad \text{Equation (16)}$$

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 (t CO₂/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 (t CO₂/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 (t CO₂/MWh).

For simplification, project participants neglect (a). Therefore, $EC_{BL}=0$

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

The electricity prior to the project was from NCPG. Therefore, $EF_{PJ,EL,y}=EF_{grid,CM,y}$

$$BE_{EL,y} = EG_{PJ,y} \times EF_{grid,CM,y}$$

According to the “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation(v03.0)”,

$$BE_{EL,y} = EG_{PJ,y} \times EF_{grid,CM,y} \times (1+TDL_{k,y}). \quad \text{Equation (17)}$$

Where

$F_{grid,CM,y}$ = Emission factors of NCPG

$TDL_{k,y}$ = Average technical transmission and distribution losses for providing electricity to source k in year y

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

$EF_{grid,CM,y}$ is calculated using “Tool to calculate the emission factor for an electricity system (version 07.0)”. The source of data is referred to China’s DNA .

Through the national published data by China’s DNA, $EF_{grid,CM,y}=0.7119tCO_2/MWh$

Table 5. Monitoring value of BE_{EL,y}

Vintage	EG _{PJ,y} (MWh)	EF _{grid,CM,y} (tCO ₂ /MWh)	TDL _{k,y}	BE _{EL,y} (tCO ₂)
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	160517.400			117,701

Table 6. Calculation results of BE_y

Vintage	BE _{EL,y} (tCO ₂)	BE _{CH₄,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

5.2 Project Emissions

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

The project activity introduces the anaerobic digester for the treatment of wastewater. The treated wastewater will be sent to the open lagoon system as secondary treatment. The sludge is not expected to be generated with significant amount under the project activity. In case of excess sludge, it may be used for soil application under aerobic conditions. As per paragraph 63 of the applied methodology, the emissions attributed to the project activity for scenario 1 involves following conditions.

- (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 (v2.0)” to calculate project emissions; and
- (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 step below,

For Condition (a) In the case of project activities that introduce an anaerobic digester for the treatment of wastewater, solid materials or sludge

In case of project activity under scenario 1, the introduction of anaerobic digester for the treatment of wastewater. The calculation as per the latest approved version of the tool “Project and leakage emissions from anaerobic digesters” shall be applied for project emissions estimation.

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

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH_4,y} + PE_{flare,y} \quad \text{Equation (18)}$$

where

$PE_{AD,y}$	=	Project emissions associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{EC,y}$	=	Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with the anaerobic digester in year y (t CO ₂ e)
$PE_{CH_4,y}$	=	Project emissions of methane from the anaerobic digester in year y (t CO ₂ e)
$PE_{flare,y}$	=	Project emissions from flaring of biogas in year y (t CO ₂ e)

These parameters are determined through the steps outlined below.

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

The project emissions from electricity consumption ($PE_{EC,y}$) shall be determined using the “Baseline, project and/or leakage emission from electricity consumption and monitoring of electricity generation(v03.0)”. The approach is complied with the Option 1: Procedure using monitored data of the tool “Project and leakage emissions from anaerobic digesters”. In the generic approach, 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:

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

Where

$PE_{power,y}$	=	Project emissions from electricity consumption in year y (t CO 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 (t CO ₂ /MWh).
		Through the national published data by China’s DNA, and calculation in appendix I, $EF_{grid,CM,y}=0.7119tCO_2/MWh$
$TDL_{j,y}$	=	Average technical transmission and distribution losses for providing electricity to source j in year y. A default value of 20% shall be assumed as conservative assumption as per applied tool.
j	=	Source of electricity consumption in the project

For the project activity, the electricity from the national grid is consumed.

Table 7. Monitoring value of $EC_{PJ,j,y}$ and Calculation result of $PE_{EC,y}$

Vintage	$EC_{PJ,j,y}$	$EF_{EF,grid,y}$	$TDL_{j,y}$	$PE_{EC,y}$
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	(MWh)	(tCO _{2e} /MWh)		(tCO ₂)
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

Project emissions of methane from the anaerobic digester (PE_{CH₄,y})

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 (t CO _{2e})
Q _{CH₄,y}	=	Quantity of methane produced in the anaerobic digester in year y (t CH ₄)
EF _{CH₄,default}	=	Default emission factor for the fraction of CH ₄ produced that leaks from the anaerobic digester (fraction)
GWP _{CH₄}	=	Global warming potential of CH ₄ (t CO ₂ /t CH ₄)

For the EF_{CH₄,default}, as the project activity installs three phase anaerobic treatment equipment, including UASB, the EF_{CH₄,default} is determined as 0.05.

Table 8. Calculation result of Q_{CH₄,y} and PE_{CH₄,y}

Vintage	Q _{CH₄,y} (tCH ₄)	EF _{CH₄,default}	GWP _{CH₄} (tCO ₂ /tCH ₄)	PE _{CH₄,y} (tCO ₂)
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			42,824

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

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.

Therefore, the baseline emission and project emission due to flaring will not be calculated.

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

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.

Table 9. Calculation result of $PE_{AD,y}$

Vintage	$PE_{EC,y}$ (tCO ₂)	$PE_{CH_4,y}$ (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 ($LE_{storage,y}$)

The proposed project activity introduces an anaerobic digester for the treatment of wastewater. As per ACM0014, the latest approved version of the tool “Project and leakage emissions from anaerobic digesters (v2.0)” is applied to calculate leakage emissions

As per “Project and leakage emissions from anaerobic digesters (v2.0)”, If the storage of digestate or the composting of digestate is occurring within the project boundary, these emissions will be considered as project emissions.

The proposed project does not contain composting. The storage of digestate is occurring within the project boundary. Therefore, 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)

As per the tool, the leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. In the project activity, the effluent treated is the liquid digestate. Therefore, the leakage emission is associated with storage of digestate ($LE_{storage,y}$). In order to determine $LE_{storage,y}$ for liquid digestate, the Option 2 of procedure using a default value is chosen as following equation.

$$LE_{AD,y} = LE_{storage,y} = F_{ww,CH_4,default} \times Q_{CH_4,y} \times GWP_{CH_4}$$

Where

$LE_{AD,y}$	=	Leakage emissions associated with the anaerobic digester in year y (tCO ₂ e/yr)
$LE_{storage,y}$	=	Leakage emissions associated with storage of digestate in year y (tCO ₂ e/yr)
$F_{ww,CH_4,default}$	=	Default factor representing the remaining methane production capacity of liquid digestate (fraction)
$Q_{CH_4,y}$	=	Quantity of methane produced in the digester in year y (tCH ₄)
GWP_{CH_4}	=	Global warming potential of CH ₄ (t CO ₂ e/t CH ₄)

Table 10. Calculation result of $LE_{AD,y}$

Vintage	$F_{ww,CH_4,default}$	$Q_{CH_4,y}$ (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

Table 11. Calculation result of PE_y

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

5.3 Leakage

As per “Project and leakage emissions from anaerobic digesters (v2.0)”, If the storage of digestate or the composting of digestate is occurring within the project boundary, these emissions will be considered as project emissions.

The storage of digestate is occurring within the project boundary. Therefore, these emissions will be considered as project emissions.

No leakage is included in the project. Therefore, $LE_y=0$

5.4 Net GHG Emission Reductions and Removals

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

The annual emission reductions in the registered PD are 359,691tCO₂. This monitoring period is from 20/09/2019 to 11/10/2021 (752days), and the ER ex-ante estimation for this monitoring period is $359691/365 \times 752 = 710,513\text{tCO}_2$. The actual ER is 5.95% higher than the ex-ante. This is because the GWP in this monitoring period is 28 while the value in the PD is 25.

APPENDIX X: <TITLE OF APPENDIX>

N/A