AN QIU BIOGAS UTILIZATION PROJECT

Document Prepared by South Pole Carbon Asset Management Ltd.

Project Title	An Qiu Biogas Utilization Project
Version	05
Date of Issue	01/07/2024
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1 PROJECT DETAILS

1.1 Summary Description of the Project

The An Qiu Biogas Utilization Project (hereafter referred to as the Project) is implemented by TTCA Co.,Ltd., located at No 27 Xin'an Street, An Qiu city, Shandong Province, China. The project activity uses anaerobic digesters to treat wastewater generated by the TTCA Co., Ltd industrial production including citric acid, corn flour, and protein production process. The generated biogas will be captured and used for electricity and steam generation for TTCA Co. Ltd. The project site includes two connected areas. The east area installs five IC anaerobic digesters (with designed volume capacity of 10,200m^3 of each IC anaerobic digester) and two generators, and the west area installs ten UASB anaerobic digesters (with designed volume capacity of 5,000m^3 of each UASB digester), two IC anaerobic digesters (with designed volume capacity of 2,000m^3 of each IC digester) and four generators. The total installed capacity of the project is about 18.714MW (4 units with each capacity of 3,119kW, 2 backup units with each capacity of 3,119kW). The 2 backup generators will be used when any of the other four generators is shut down in emergency situation. The annual net electricity supply is 80345MWh and the annual steam generation is 9000ton.

Prior to the project, the wastewater from TTCA Co. Ltd was treated through a series of deep open anaerobic lagoons without biogas recovery. There were two existing open anaerobic lagoons prior to the project. And the designed volume capacities of them are 50,000m^3 and 70,000m^3. The daily waste water volume is 24000m^3/day. The average COD of inflow wastewater to anaerobic digesters is 23000mg/L and the average COD of outflow wastewater of anaerobic digesters is 1000mg/L. The methane would have been released into the atmosphere. The equivalent electricity generated by the project (80,345MWh) would have otherwise been from North China Power Grid (NCPG) which is fossil fuel dominated. The equivalent steam (9000t steam) of the project has otherwise been from coal boiler.

The baseline scenario is the same with scenario prior to the project.

The project activity installs 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 steam generated will be used for the production of TTCA Co. Ltd. to replace those from NCPG and coal boilers. And the open lagoons in the baseline are not used in the project scenario. Therefore, the project would significantly reduce GHG emissions. For simplification and conservativeness, the project owner decided to desert the emission reduction caused by steam supply. There is an open flare in the project site. Only when there is shut down or excessive biogas generated would the biogas be flared through the flare. For simplification and conservativeness, the project owner decided to desert the emission reduction caused by the flared biogas. The annul emission reductions are expected to be 400,838tCO_2 and the total emission reductions in the crediting period are 4,008,380t tCO_2.

The project was constructed by two stages. Stage 1 (east area) started construction on 01/03/2021, and started operation on 28/04/2022. Stage 2 (west area) started construction on 18/05/2021, and started operation on 30/05/2022.

Audit Type	Period	Program	VVB Name	Number of years
Validation	01/07/2024	VCS	LGAI Technological Center S.A. (Applus+ Certification)	28/04/2022 - 27/04/2032
Total	This is the date of validation completed			

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 proposed project activity.

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

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

1.3 Project Eligibility

The project eligibility is demonstrated according to section 2.1 of VCS Standard (version 4.5). the analysis is conducted in following table.

The scope of the VCS Program includes:	Eligibility analysis
1) The seven Kyoto Protocol greenhouse gases:	The project installs anaerobic wastewater treatment system and biogas recover and utilization system to generate electricity and steam. The electricity could replace the same amount of electricity that would have been generated by the fossil fuel power plants and the steam could avoid the coal consumption from boilers. This could avoid the GHG emissions.
2) Ozone-depleting substances	It is not applicable to this project.
3) Project activities supported by a methodology approved under the VCS Program through the methodology	It is not applicable to this project.

approval process	
4) Project activities supported by a methodology approved under a VCS approved GHG program unless explicitly excluded under the terms of Verra approval	The methodology ACM0014 (Version 8.0) adopted by the project is a methodology approved under CDM Program, which is a VCS approved GHG program.
5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements	It is not applicable to this project.
The scope of the VCS Program excludes projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal, or destruction.	This is a new wastewater treatment and biogas utilization project. The wastewater is generated from the TTCA Co., Ltd which has been operated for many years. Therefore, it is not a project that generates GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction.

Thus, the project is eligible under the scope of VCS program as per VCS standard (version 4.5).

1.4 Project Design

This project is designed to include only one single location or installation. The project activity is not grouped project.

Eligibility Criteria

The project type is methane recovery and utilization from wastewater treatment of China, which is in line with the category requirement of verra.

It is a single project, not a grouped project.

1.5 Project Proponent

Organization name	TTCA Co., Ltd
Contact person	Yu Qing
Title	Director
Address	No. 27 Xin’an Street, Anqiu, Shandong, China
Telephone	+86 0536-4936918

Email	ttcatanjiaoyi@126.com

1.6 Other Entities Involved in the Project

Organization name	South Pole Carbon Asset Management 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

1.7 Ownership

The project ownership can be demonstrated by the approval of EIA (Environment Impact Assessment) and ERPA (Emission Reductions Purchasing Agreement).

1.8 Project Start Date

The project activity started operation on 28/04/2022, which is the date that generates emission reductions.

1.9 Project Crediting Period

The fixed crediting period is 10 years, from 28/04/2022 to 27/04/2032.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	
Large project	√

Year	Estimated GHG emission reductions or removals (tCO2e)
28/04/2022-31/12/2022 (248 days)	271,606

01/01/2023-31/12/2023	400,838
01/01/2024-31/12/2024	400,838
01/01/2025-31/12/2025	400,838
01/01/2026-31/12/2026	400,838
01/01/2027-31/12/2027	400,838
01/01/2028-31/12/2028	400,838
01/01/2029-31/12/2029	400,838
01/01/2030-31/12/2030	400,838
01/01/2031-31/12/2031	400,838
01/01/2032-27/04/2032 (118 days)	129,232
Total estimated ERs	4,008,380
Total number of crediting years	10
Average annual ERs	400,838

1.11 Description of the Project Activity

Technology description

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 TTCA for industrial production.

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 acetaldehyde 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

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 18.714 MW. Excess biogas, if any, will then be sent to flare to destroy methane gas as it is produced. The flaring system will be used only in the case of emergency.

The post-treatment

The wastewater will continue to flow from the anaerobic digesters to a series of open lagoons. Two lagoons are the baseline 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.

Flare

A 10m high open flare is installed. If biogas is excess to electricity generation, or emergency situation happens, the biogas will be sent to the open flare for flaring. However, the PO decided to not claim the emission reductions from the flaring.

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	J620 GS	3	Capacity: 3119kW Rated voltage:220V Lifetime: 20 years
Gas engine	J620 GS-F25	3	Capacity: 3119kW Rated voltage:220V Lifetime: 20 years
Steam boiler	HCRG-430/200-4BZ	1	Designed pressure: 0.8MPa Designed temperature: 175°C Lifetime: 20 years
	THXYNY-3	1	Designed pressure: 0.8MPa Designed temperature: 175°C Lifetime: 20 years

1.12 Project Location

The project activity is located *at* No 27 Xin'an Street, An Qiu City, Shandong Province, China. The project activity location is depicted in figure 1 and figure 2.

Project coordinates are 36°29'24.37" N, 119°12'4.44" E (east area).

36°29'4" N, 119°11'37" E (west area).

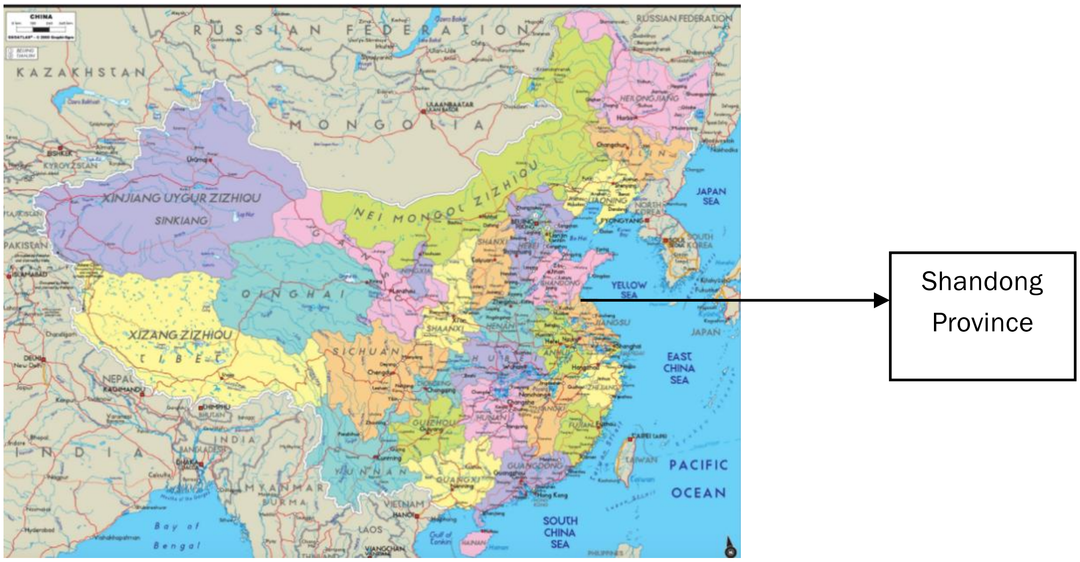


Figure 1. Location of Shandong province in China

Figure 2. Location of the project

1.13 Conditions Prior to Project Initiation

Prior to the project activity, the wastewater was treated through a series of deep open anaerobic lagoons with the condition of the anaerobic digestion of the organic content and the methane would have been released into the atmosphere. The same amount of electricity generated by this project would have been from fossil fuel power plants connect to NCPG. The heat would have been from coal fired boiler.

The baseline scenario is the same with the scenario prior to the project. More details of the baseline scenario can refer to Section 3.4 Baseline Scenario.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project activity is in compliance with national laws and regulations, which can be demonstrated by the approval of EIA.

The main laws and regulations are summarized below:

Renewable Energy Law of the People's Republic of China;

Construction Law of the People's Republic of China;

Electricity Law of the People's Republic of China;

Energy-saving design code for machinery industry;

Environmental Impact Assessment Law of the People's Republic of China;

Regulations on Environmental Protection Management of Construction Projects;

Water Pollution Prevention Law of the People's Republic of China and Integrated Wastewater Discharge Standard of the People's Republic of China

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project has not been registered or is seeking registration under any other GHG programs.

1.15.2 Projects Rejected by Other GHG Programs

According to Section 1.15.1, the project has not been rejected under by any other GHG programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The GHG emissions from this project is not included in emissions trading program or other binding limits on GHG emissions.

China has a national emissions trading system. After checking the name list of 2019-2020 China's carbon emission trading quota management[1], it is confirmed that this project owner is

[1] http://mee.gov.cn/xxgk2018/xxgk/xxgk03/202012/t20201230_815546.html

not included in the name list. Therefore, the emission reductions of this project is and will not included in emissions trading program or other binding limits on GHG emissions.

1.16.2 Other Forms of Environmental Credit

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

Supply Chain (Scope 3) Emissions

The project activity installs anaerobic digesters to treat wastewater generated in citric acid, corn flour, and protein production process. The biogas from wastewater treatment process will be recovered for electricity and heat generation, which will be used for the production process of TTCA Co.,Ltd.

PP decided to not claim the emission reductions from heat generation. For the project activity, the GHG emission reductions of this project include avoiding methane emissions of the wastewater in open lagoons of baseline scenario, and avoiding CO_2 emissions from those fossil fuel power plants connected to the national power grid. The project does not include emission reductions of supply chain 3. Therefore, this section is not applicable for this project.

1.17 Sustainable Development Contributions

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

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

Environment:

• Provide clean energy. The project activity will achieve obvious greenhouse gas (GHG) emission reductions by recovery methane that would have been released into atmosphere and replacing the electricity of fossil fuel power plants. The heat generated by this project will be provided for citric acid, corn flour, and protein production to replace the heat generated by 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 point, the project could improve local air condition.

Overall, the project has positive impacts on the local environment by improving air quality. This can in turn improve the standard of living of the local population.

• Provide decent work. The project provides employment opportunities related to the operation and maintenance of the biogas recover and power generation, 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 CH_4 and CO_2 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 the project site. 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).

1.18 Additional Information Relevant to the Project

Leakage Management

This part is not applicable.

Commercially Sensitive Information

The project has no commercially sensitive information included in the public version of the project description. Thus, this is not applicable.

Further Information

This part is not applicable.

2 SAFEGUARDS

2.1 No Net Harm

The project will not bring any negative environmental and socio-economic impact. The project is a renewable energy biogas based electrical and thermal generation activity. The project follows the local and national regulation in order to maintain and prevent the environmental impact.

2.2 Local Stakeholder Consultation

The stakeholder consultation was held in office of TTCA Co.,Ltd. on 14/03/2023. The stakeholder consultation was conducted by the project proponent TTCA Co.,Ltd. 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 gate outside of the plant. 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 TTCA Co.,Ltd .
- Description of the background of the project implementation
- Description of the project and environmental impacts
- Questions and Answers session
- Completing questionnaires

Compilation of comments received

The survey was conducted through distributing and collecting responses to the questionnaire. 39 questionnaire were sent and 39 responses were collected.

The questionnaires mainly focus on following:

- What do you think is the possible environment issue that the project may generate?

- What do you think is the effect of the project on local environment?

- Are you satisfied about the environment protection measures that the project has taken?

- What do you think is the impact of the project on local economy?

- Are you agree or disagree with the construction of the project?

- Do you have any suggestions on this project?

The project activity and its environmental impacts were described to the stakeholders during the meeting. Stakeholders thought that the development of the project could 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 2. Interviewee statistics

Basic information	Classified items	Number of persons	Percentage
Age	Younger than 30	7	18%
	30~40	20	51%
	40~50	11	28%
	>50	1	3%
Gender	Male	19	49%
	Female	20	51%
Education	Primary school	0	0%
	Middle school	3	8%
	Collage and above	36	92%
Occupation	Worker	34	87%
	Farmer	3	8%
	Supervisor	1	2.5%
	Other	1	2.5%

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.

- 95% people (37 participants) think the proposed project has good impact on local economy. 5% (2 participants) think the project has no 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 through the filled questionnaires by participants, the stakeholders have a positive opinion about the project activity. Therefore, this project activity is perceived as an environment friendly project, which can improve the life quality of the surrounding community. The project activity is expected to deliver multiple benefits in respect of sustainable development including environmental, social and economic benefits.

Besides, a grievance book is put in the gate office of the company. Anyone can put his comment on the book. The project information was put on the wall outside the gate for public comment.

2.3 Environmental Impact

The “Report on the Environmental Impact Assessment of the project” was completed in 2020, and has been approved by local EPA in 2020. A brief overview of environmental impacts related to the proposed project activity is summarised here.

1. Atmosphere

The major air pollution during the construction phase is dust. Some measures are taken to minimize the air pollution. Paddock is set up around the construction site. Wheel washing machine and dust barrier are used to reduce dust generation. The vehicles are not overloaded so as to prevent the material from falling down.

Water is frequently sprinkled on the construction site to reduce the dust.

Garbage and soil is not permitted on the road.

The daily life garbage is transported to An Qiu city garbage treatment plant.

The dust, SO_2 and NO_x emission are the major atmospheric pollutants during the operation phase.

The flue gas generated in the biogas generator is cleaned with a set of purification equipment to reduce the NO_x, and the final gas is emitted by an high chimney. The SO_2, NO_x and dust concentration comply with local air pollutants emission standard.

2. Wastewater

During the construction period, the wastewater is mainly domestic sewage. The wastewater is treated by the wastewater treatment center of the project site and the final water is in line with national discharge standard.

In the operation period, wastewater mainly comes from desulfurization wastewater, boiler and domestic sewage. All the wastewater are treated in the wastewater treatment center of the project site to comply with national standard for discharge.

3. Noise

The noise mainly from biogas generator and pumps. Measures have been taken to control and mitigate the noise of the project. During the operation period, silencer is installed to mitigate the noise impacts. The project owner outfits the working staff with the relevant noise reducing equipment. The noise impact on the surrounding residents is acceptable.

4. Solid waste

In construction period, solid waste mainly includes construction solid waste and daily life garbage. In the operation period, the solid waste is mainly daily life garbage and sulphur. The construction waste and daily life garbage is transported to solid waste disposal site by garbage truck of environmental sanitation department. The sulphur amount is quite small and the sulphur is transported to professional company for recovery treatment. In absence of the project, the small amount of H_2S in the biogas is emitted into the atmosphere. While in the project scenario, the H2S is transformed into suphur and will be transported to professional company to recovery for industry use. This is environment friendly. The transportation records will be used for crosscheck.

In conclusion, the project does not bring significant impacts on the environment during the construction period and operation period.

2.4 Public Comments

The public comment period is from 24/08/2023 to 23/09/2023. No comment was received during the public comment collecting period.

2.5 AFOLU-Specific Safeguards

The project activity is not AFOLU project. Thus, this section is not required.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The following methodology is applicable to the project activity:

ACM0014 "Treatment of wastewater" (version 08.0)

The latest version of 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)
- "Determining the baseline efficiency of thermal or electric energy generation systems" (version 02)
- "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (version 03)
- "Investment analysis (version 12.0)"

3.2 Applicability of Methodology

ACM0014 Treatment of wastewater (version 08) is applicable to the project activity. The project activity is applicable to scenario 1 of table B2 of ACM0014, (version 08).

The scenario prior to the project (also the baseline scenario) is that the wastewater was treated through a series of deep open anaerobic lagoons with the condition of the anaerobic digestion of the organic content.

In the project activity, the anaerobic digester is installed. There are no solid materials separated before directing wastewater to the covered lagoon system. The biogas captured from the system is utilized in gas engines and boiler for electricity and heat generation. In case of emergency or excessed biogas, the biogas will be flared in the flaring system. For the sludge, it is not expected to generate a large amount from the wastewater treatment process. In case a large amount of sludge is generated, it will be used for seeding sludge or combusting by other plants.

The project meets applicability conditions of ACM0014 and the analysis is listed below:

Table 3. Applicability analysis of ACM0014

Applicability criteria	Project situation
Scope: This methodology applies to project activities that include: (a) Treatment of wastewater in a new anaerobic digester with subsequent capture and flaring or utilizing of the generated biogas for electricity or heat generation; or (b) Treatment of wastewater in the same treatment plant as in the baseline situation but treatment of the sludge from primary and/or secondary settler either in a new anaerobic digester or treatment of sludge under clearly aerobic conditions; or (c) Dewatering of sludge and application to land.	This project installs anaerobic digesters to capture and utilize biogas for electricity and heat generation. Therefore, scenario (a) is applicable.
Paragraph 5(a) of ACM0014 The average depth of the open lagoons or sludge pits in the baseline scenario is at least 1m	In the baseline scenario, the wastewater was treated through a series of deep open anaerobic lagoons with the depth of 3 meters under anaerobic condition. Therefore, this term is applicable.
Paragraph 5(b) of ACM0014 The residence time of the organic matter in the open lagoon or sludge pit system should be at least 30 days	As per the design of the baseline lagoon, and historical data, the residence time of the organic matter is at least 40 days.
Paragraph 5(c) of ACM0014 Inclusion of solid materials in the project activity is only applicable where: (i) Such solid materials are generated by the facility producing the wastewater; and (ii) The solid materials would be generated both in the project and in the baseline scenario	N/A. The solid materials in not included in the project activity.
Paragraph 5(d) of ACM0014 The sludge produced during the implementation of the project activity is not stored onsite before land application to avoid any possible methane emissions from anaerobic degradation.	It is not expected to generate much from the wastewater treatment process. In case a great amount of sludge is generated, it will be used for seeding sludge or combusting by other plants, not for land application. Therefore, this criteria is not relevant.

Applicability of related tools are as follows:

The applicability and analysis for tool of 'Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)' is shown as follows:

Table 3. Applicability conditions of 'Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)'

Applicability criteria	Project situation
Scope: Depending on their specific scope, methodologies which refer to this tool should: (a) Specify clearly which sources of project, baseline and leakage electricity consumption should be calculated with this tool; and/or (b) Provide the procedures to determine the most likely baseline scenario for each source of baseline electricity consumption; and/or (c) Provide the procedures to determine the most likely baseline scenario for electricity generated and supplied by the project power plant to the grid or consumers; and (d) Provide the procedures to determine the baseline CO_2 emission factors for the electricity generated and supplied by the project power plant ($EF_{BL,grid,CO2,y}$ and $EF_{BL,facility,CO2,i,y}$).	The baseline is electricity would have been from NCPG, the project electricity consumption is also from NCPG. This is described in section 3.4 of this PDD. Therefore, this scope is applicable.
If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption: (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer; (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or (c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.	During the operation period, some electricity may be imported from national power grid. Therefore, scenario A is applicable.

This tool can be referred to in methodologies to provide procedures to monitor amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated: (a) Scenario I: Electricity is supplied to the grid; (b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.	The electricity generated by the project is consumed by TTCA Co., Ltd. Therefore, scenario II is applicable.
This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO_2 emissions.	No captive renewable power stations are installed to provide electricity in baseline scenario, or project activity. Therefore, this tool is applicable for this project.

The applicability and analysis for tool of 'Project and leakage emissions from anaerobic digesters (version 02.0)' is shown as follows:

Table 4. Applicability conditions of 'Project and leakage emissions from anaerobic digesters (version 02.0)'

Applicability criteria	Project situation
Scope: This tool provides procedures to calculate project and leakage emissions associated with anaerobic digestion in an anaerobic digester. The tool is not applicable to other systems where waste may be decomposed anaerobically, for instances stockpiles, SWDS or un-aerated lagoons.	This project installs anaerobic digesters. Therefore, this tool is applicable to this project.
The following sources of project emissions are accounted for in this tool: (a) CO_2 emissions from consumption of electricity associated with the operation of the anaerobic digester; (b) CO_2 emissions from consumption of fossil fuels associated with the operation of the anaerobic digester; (c) CH_4 emissions from the digester (emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester); and (d) CH_4 emissions from flaring of biogas.	The CO_2 emissions from consumption of electricity associated with the operation of the anaerobic digester will be counted. Therefore, a) is included, This project does not consume fossil fuel, therefore, b) is not included. In the case of unscheduled events; such as the engine failure or malfunction, result in biogas being unable to be sent to the gas engines, or if there is an excess of biogas, the open flaring system will be used for such emergency case. c) CH_4 emissions from the digester will be calculated. However, the project owner decided not to claim the emission reductions from biogas flaring. Therefore, both $BE_{flare,y}$, and $PE_{flare,y}$ will not be calculated, and d) is not included.
The following sources of leakage emissions are accounted for in this tool: (a) CH_4 and N_2O emission from composting of	There is no composting in this project. Therefore, a) is not applicable. It is not expected to generate sludge, if a

digestate; (b) CH_4 emissions from the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage, such as in a stabilization pond.	large amount of sludge is generated, it will be transported to other plants for seeding sludge or combusting. Before transportation, the sludge (if generated) is stored in the aerobic pond. Therefore, b) is not applicable. However, $LE_{storage,y}$ is calculated for conservativeness.

The applicability and analysis for tool of 'Tool to calculate the emission factor for an electricity system (version07.0)' is shown as follows:

Table 5. Applicability conditions of 'Tool to calculate the emission factor for an electricity system (version07.0)'

Applicability criteria	Project situation
This tool may be applied to estimate the OM, BM and/or CM when calculating baseline emissions for a project activity that substitutes grid electricity that is where a project activity supplies electricity to a grid or a project activity that results in savings of electricity that would have been provided by the grid (e.g. demand-side energy efficiency projects).	This project results in savings of electricity that would have been provided by the grid. Therefore, this tool is applicable for the project.
Under this tool, the emission factor for the project electricity system can be calculated either for grid power plants only or, as an option, can include off-grid power plants. In the latter case, two sub-options under the step 2 of the tool are available to the project participants, i.e. option IIa and option IIb. If option IIa is chosen, the conditions specified in "Appendix 1: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	Only grid power plants are calculated.
In case of CDM projects the tool is not applicable if the project electricity system is located partially or totally in an Annex I country.	This project is located in China, not Annex I country. Therefore, this tool is applicable.
Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.	This project does not consume biofuel.

Table 6. Applicability conditions and analysis of 'Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03)'

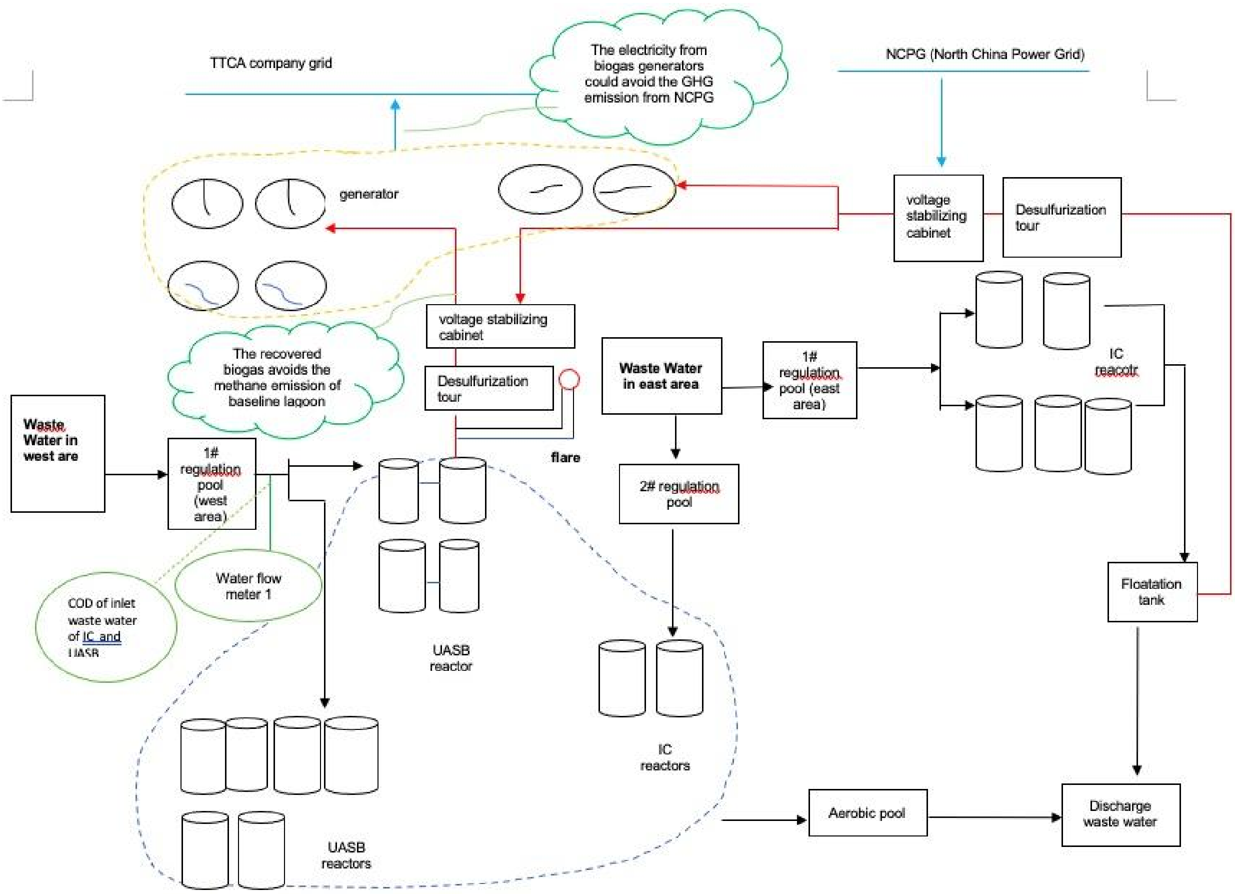
Applicability criteria	Project situation
Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.	The flow of methane should be determined for baseline emissions and project emissions. Therefore, this tool is applicable.
Methodologies where CO_2 is the particular and only gas of interest should continue to adopt material balances as the means of flow determination and may not adopt this tool as material balances are the cost effective way of monitoring flow of CO_2.	CO_2 is not the particular and only gas of interest of this project.
The underlying methodology should specify: (a) The gaseous stream the tool should be applied to; (b) For which greenhouse gases the mass flow should be determined; (c) In which time intervals the flow of the gaseous stream should be measured; and (d) Situations where the simplification offered for calculating the molecular mass of the gaseous stream (equations (3) or (17)) is not valid (such as the gaseous stream is predominantly composed of a gas other than N2).	ACM0014 has specified: (a) $F_{biogas,y}$ is determined using the tool; (b) CH_4 is the greenhouse gas for which the mass flow should be determined; (c) The flow of the biogas should be calculated on an hourly basis for each hour h in year y; (d) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool).

3.3 Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Wastewater treatment processes	CO_2	Excluded	CO2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	The major source of emissions in the baseline.
		N_2O	Excluded	Excluded for simplification.
	Electricity generation	CO_2	Included	Electricity is consumed from the grid in the baseline scenario.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.
	Thermal energy generation	CO_2	Excluded	The project owner decided to not claim the emission reductions from thermal energy generation. Therefore, it is excluded for conservativeness and simplification.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

Source		Gas	Included?	Justification/Explanation
Project	Wastewater treatment processes	CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	Main source of emissions
		N_2O	Excluded	This project does not involve land application of sludge.
	On-site electricity use	CO_2	Included	Electricity consumed for the operation of the project activity will be supplied from the grid.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification
	On-site fossil fuel consumption	CO_2	Excluded	The project activity does not consume fossil fuels.
		CH_4	Excluded	Excluded for simplification.
		N_2O	Excluded	Excluded for simplification.

The project boundary, including the equipment and energy flow is shown as follows:



Note :

6 generators installed, among which, 4 generators are for operation and 2 generators for backup.

The red line is the flow of biogas

The black line is the flow of waste water

3.4 Baseline Scenario

Baseline for methane avoidance component

ACM0014 (version 08) outlines the procedure for the identification of the most plausible baseline scenario following steps.

Step 5.2.1 Simplified procedures to identify the baseline scenario and demonstrate additionality

The project activity does not fall under any of technologies listed under the "Tool 32: Positive lists of technologies", therefore, this Step is not applicable.

Step 5.2.2 Procedure for the identification of the most plausible baseline scenario

The most plausible baseline scenario is determined through the application of the following steps:

Step 1: Identification of alternative scenarios

Wastewater (W):

The plausible alternative scenarios for the treatment of wastewater (W) for this project include:

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

W2: Direct release of wastewater to a nearby water body;

W3: Aerobic wastewater treatment facilities (e.g. activated sludge or filter bed type treatment);

W4: Anaerobic digester with methane recovery and flaring;

W5: Anaerobic digester with methane recovery and utilization for electricity or heat generation;

W6: Wastewater is directed to land application without dewatering;

W7: Wastewater is dewatered and directed to land application/used as fuel in energy applications.

W8: Wastewater is not treated.

Table 4. Identification of alternative scenarios of W

	Alternative Scenarios of wastewater treatment	Applicability Analysis
W1	The use of open lagoons for the treatment of the wastewater	This project is implemented in the existing plant and there are existing open lagoons. Therefore, this project does not need to design new lagoons and the requirement of para.24 of ACM0014 is not applicable. Wastewater treated in open lagoons is complied with Chinese regulations and is most commonly used in practice. Therefore, the scenario of W1 is the plausible baseline scenario.
W2	Direct release of wastewater to a nearby water body;	As the alcohol wastewater is high concentrated organic wastewater, it is forbidden to discharge directly basis on "The People's Republic of China Water Pollution Prevention Law" and "The People's Republic of China Integrated Wastewater Discharge Standard". So, the scenario of W2 is not the plausible baseline scenario
W3	Aerobic wastewater treatment facilities (e.g. activated sludge or filter bed	Aerobic treatment is applied only when the

	type treatment);	concentration of wastewater organic matter is low[2] [3]. As the organic matter of the project is high, aerobic treatment is not appropriate in view of the technology[4]. Therefore, the scenario of W3 is not the plausible baseline scenario.
W4	Anaerobic digester with methane recovery and flaring;	There are no laws and regulations to forbid methane emission from wastewater treatment facilities. So there is no incentive for the project owner of industrial facility to install such system. And the anaerobic digester needs higher investment and operation and management cost than anaerobic open lagoons. Therefore, this option is unlikely to occur compared to W1 and thus the scenario W4 is not the plausible alternative scenario.
W5	Anaerobic digester with methane recovery and utilization for electricity or heat generation;	The reason is same with W4, and W5 is not the plausible alternative scenario. This scenario is the project activity undertaken without being registered as a VCS project activity. The investment barrier results for the high investment and operational cost. It is encouraged as well as complying with China's regulations. Therefore, it is an alternative scenario.
W6	Wastewater is directed to land application without dewatering;	As the wastewater is high concentrated organic wastewater, it is not complied with standards for irrigation water quality. Therefore, W6 is not plausible alternative scenario.
W7	Wastewater is dewatered and directed to land application/used as fuel in energy applications.	Same with the analysis of W6, W7 is not plausible alternative scenario.
W8	Wastewater is not treated.	The analysis is same with W2. Therefore, W8 is not plausible alternative scenario.

Through above analysis, the plausible baseline scenario is W1, which is also the scenario prior to the project activity.

The treatment of sludge (S):

The project activity is not applicable to scenario 2, the plausible alternative scenarios for the treatment of sludge (S1-S6) are not considered.

[2] https://www.dowater.com/jishu/2008-12-25/3273.html

[3] https://zhuanlan.zhihu.com/p/407829265

[4] "Organic industry wastewater treatment theory and technology", P24, Yangjian, Feijuan Zhang and Rongzhi Yu, Chemical Industry Press.

The generation of electricity (E):

As the project activity involves the generation of electricity using biogas from the covered lagoon system, plausible alternative scenarios from the generation of electricity have been determined. These include following plausible alternatives:

Table 5. Identification of alternative scenarios of E

	Alternative Scenarios of wastewater treatment	Applicability Analysis
E1	Power generation using fossil fuels in a captive power plant;	The installation of a captive power plant based on fossil fuel is not required as the grid power can be easily accessed within the local area. The grid electricity is commonly used at the project site. Therefore, E1 is not plausible alternative.
E2	Electricity generation in the grid;	This scenario does not require additional investment and is a common practice for industrial facilities that demand for electricity consumption. Therefore, E2 is plausible alternative.
E3	Electricity generation using renewable sources.	Compared with national grid power, electricity generation using renewable sources require additional and substantial investment cost together with annual operation cost. Plus, a 14 MW renewable power plant needs enough renewable resource. The project site is in an industrial area of An qiu city, with many industrial plants. There is not enough space to build solar power plant. And there is not enough solar energy in the project area to build such large scale power plant[5]. There is not enough wind energy for a 14MW wind power plant in the project area[6]. And the unit electricity generation cost of a biomass power plant is higher than the same scale coal power plant[7]. Geothermal resource usually locates in Tibet and Guangdong province. No geothermal resource is found in Shandong province till now[8]. Therefore, E3 is not plausible alternatives.

Through above analysis, the plausible baseline scenario for electricity is E2, which is also the scenario prior to the project activity, i.e in absence of the project, the equivalent electricity was from NCPG.

The generation of heat (H):

[5] https://www.sohu.com/a/293922336_468672

[6] http://sourcedb.igsnrr.cas.cn/zw/lw/200906/P020090625752299751150.pdf

[7] http://www.guolushengwuzhi.com/news/hy-1138.html

[8] https://news.bjx.com.cn/html/20120313/347598.shtml

As the project activity involves heat generation with biogas, plausible alternative scenarios for the generation of heat should been determined. These include following alternatives:

Table 6. Identification of alternative scenarios of H

	Alternative Scenarios of wastewater treatment	Applicability Analysis
H1	Co-generation of heat using fossil fuels in a captive cogeneration power plant	H1 is eliminated as the Chinese regulation “Transitional provision for control of combined heat and power generation projects” (NDRC, No. 141[2007]) prohibits construction of a cogeneration plant which is not included in provincial/local development plan. It means that a private company cannot freely install a cogeneration plant. Therefore, scenario H1 is excluded.
H2	Heat generation using fossil fuels in a boiler	This is possible baseline scenario.
H3	Heat generation using renewable sources	Same reason with E3. Heat generation using renewable sources need additional and substantial investment cost together with annual operation cost. And renewable heat power plant needs enough renewable resource, the project area does not have enough wind, solar energy or waste biomass for a same capacity heat power plant. Therefore, E3 is not plausible alternatives.

In absence of the project, the same equivalent heat was from coal boiler. Therefore, H2 is the plausible alternative.

The treatment of solid materials (SM):

The project activity does not involve generation of any solid materials, which need to be treated or disposed. Thereby, the plausible alternative scenarios for the treatment of solid materials (SM1-SM4) are not considered.

From above analysis, the plausible baseline scenario is W1, W5, E2, H2.

Alternative of scenarios	Alternative baseline scenario			Description of the scenario
	Wastewater treatment	Electricity generation	Heat generation	
1	W1	E2	H2	Keep on using the existing open lagoons system. Continue to use electricity from national power grid and use coal fired boilers for heat generation.
2	W5	W5	W5	Construct the anaerobic reactor to recover methane generated from the anaerobic treatment. The recovered methane is used to

				generate electricity and heat. This scenario is same to the project but is not a VCS project activity

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

Through the analysis in step 1, the plausible alternatives include scenario 1 and 2. These two scenarios are both compliance with applicable laws and regulations.

Therefore, the remaining combinations of alternatives to be considered in the next steps are

Alternative of scenarios	Alternative baseline scenario			Description of the scenario
	Wastewater treatment	Electricity generation	Heat generation	
1	W1	E2	H2	This is the scenario prior to the project. Keep on using the existing open lagoons system. Continue to use electricity from national power grid and use coal fired boilers for heat generation.
2	W5	W5	W5	Construct the anaerobic reactor to recover methane generated from the anaerobic treatment. The recovered methane is used to generate electricity and heat. This scenario is same to the project but is not a VCS project activity

Step 3: Eliminate alternative that face prohibitive barriers:

As analyzed in following Section 3.5, the project activity is not financially attractive without the VCS revenues. It can be concluded that in the absence of VCS income, the project is not financially attractive to the project owner. Hence scenario W5 is eliminated. The detail analysis of W5 is shown in following section 3.5.

In conclusion, the baseline scenario for the proposed project is:

- For wastewater treatment: W1
- For power generation: E2
- For heat generation: H2

3.5 Additionality

Regulatory surplus

According to public research, no regulation prohibits the wastewater treatment in open lagoons. The 'Water Pollution Prevention and Control law of the People's Republic of China' states that the waste water must be pretreated before discharging into centralized sewage treatment facilities. But whether treated in open lagoon or other treatment facilities are not regulated. Besides, open lagoons are the common treatment method for most industry factories of China. And there is no mandatory regulation to use anaerobic reactor for waste water treatment.

Therefore, this project is not mandated by any law, stature, or any systematically enforced law.

As required by ACM0014, step 2 (investment analysis) from the *"Tool for the demonstration and assessment of additionality (version 07)"* is applied to eliminate alternatives that face prohibitive barriers.

The investment analysis tool recommends three analysis methods, namely simple cost analysis (Option I), investment comparison analysis (Option II) and the benchmark analysis (Option III).

Since the project can save cost from avoid buying electricity and heat, and can also receive revenue from VER. So, Option I isn't appropriate.

The Option II is only applicable when alternatives are also investment projects. However, the alternative baseline scenario of the project (W1+E2+H2) is not a new investment project, so the Option II isn't appropriate.

According to the above, this PDD will use the benchmark analysis (Option III) to analyse whether the proposed project is less economically or financially attractive than the alternatives without the revenue from VER.

The project adopts project IRR as the financial indicator. According to 'Notice on the update of financial benchmark rate of return for some construction projects by National Development and Reform Commission, Ministry of Housing and Urban-Rural Development (fagaitouzi[2013]586)[9], the financial benchmark for Project IRR (before-tax) of 11% for organic chemical feedstock and intermediates production is applicable. And this is the latest government published benchmark when the FSR was completed.

The project IRR is calculated according to the basic parameters from feasibility study report (FSR) of the project, the basic parameters are shown as follows:

Table 7. Main financial parameters

Parameter	Value	Unit	Source of data
Total investment	27,650	10,000RMB	FSR

[9] https://www.doc88.com/p-4532190660192.html

Total static investment	26,700	10,000RMB	FSR
- Construction investment	4,320	10,000RMB	FSR
- Equipment and installation investment	21,980	10,000RMB	FSR
- Other cost	400	10,000RMB	FSR
Working capital	1,400	10,000RMB	FSR
Operation cost	2,531	10,000RMB	FSR
- Labor cost and welfare	460	10,000RMB	FSR
- Management cost	300	10,000RMB	FSR
- Maintenance cost	950	10,000RMB	FSR
- Equipment insurance	121	10,000RMB	FSR
- Material cost	700	10,000RMB	FSR
Annual financial revenue (without Carbon revenue)	5,779	10,000RMB	FSR
Net annual power generation	80,345	MWh/yr	FSR
Electricity tariff (including VAT)	0.6984	RMB/kWh	FSR
Annual steam generation	9,000	t/yr	FSR
steam tariff (including VAT)	187	RMB/t	FSR
Construction Period	Year	2	FSR
Operation Period	Year	20	FSR
Depreciation period	Year	20	FSR
Rate of residual value	%	5	FSR
VAT rate (equipment, material, maintenance)	%	17	FSR
VAT (electricity, steam, water)	%	13	FSR
Income tax rate	%	25	FSR
Urban maintenance and construction tax	%	5	FSR
Surtax for education	%	3	FSR

The comparison of the project IRR with and without VER are shown below:

	Without VER income	With VER income	Benchmark
Project IRR (%)	7.91%	12.58%	11%

From the calculation, it can be seen that without considering VER revenue, the project IRR is 7.91%, lower than the benchmark of 11%. With VER carbon revenue, the financial status of the project is obviously improved.

Sensitivity analysis

According to para.27 of investment analysis-v12.0, "*Variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation (all parameters varied need not necessarily be subjected to both negative and positive variations of the same magnitude)*"

1) Electricity tariff

2) Electricity generation

3) Static total investment

4) Maintenance cost

Table 8. Sensitivity analysis result

Parameters	-10%	-5%	0	5%	10%
Electricity tariff	5.63%	6.82%	7.91%	8.95%	9.96%
Electricity generation	5.63%	6.82%	7.91%	8.95%	9.96%
Static total investment	9.22%	8.54%	7.91%	7.33%	6.78%
Maintenance cost	8.31%	8.11%	7.91%	7.71%	7.50%

It can be seen that when electricity tariff, electricity generation, static total investment, maintenance cost change within ±10%, the project IRR (before tax) of the project is always lower than benchmark IRR.

From above analysis, it can be concluded that without the VER revenues the project is not economically and financially attractive.

It is calculated that under the following variations of the above parameters, the project IRR will reach benchmark.

Parameters	Variation of IRR reach benchmark
Electricity tariff	+15.4%
Electricity generation	+15.4%
Static total investment	-21.3%
Maintenance cost	-81.0%

Justification why the above variations of each parameter is unlikely in the realistic practice:

As for electricity tariff and electricity generation

The electricity generated by this project is for the self-use of TTCA Co., Ltd, which replaces the electricity from grid connected power plants. Therefore, the project revenue comes from electricity saving, which depends on the purchase price of grid electricity. The electricity purchase price is determined by China's government. It is stable and will not increase 15.4% in 10 years based on past years' experience.

As for the static total investment

When the Static total investment decreases more than 21.3%, the IRR would reach benchmark. According to statistical data issued by National Bureau of Statistics of China, the prices of construction materials kept increasing in the construction period of the project. And the actual investment cost is larger than the value of FSR.

As for the maintenance cost

When the maintenance cost decrease more than 81%, the IRR would reach benchmark. However, as the material price and labor cost is increasing, the maintenance cost is increasing year by year. And the actual investment cost in 2022 is much higher than the value of FSR.

Step 4. Common practice analysis

In line with the "*Tool of common practice (version 03.1)*", four types of measures are currently covered in the framework:

(a) Fuel and feedstock switch (example: switch from naphtha to natural gas for energy generation, or switch from limestone to gypsum in cement clinker production);

(b) Switch of technology with or without change of energy source including energy efficiency improvement as well as use of renewable energies (example: energy efficiency improvements, power generation based on renewable energy);

(c) Methane destruction (example: landfill gas flaring);

(d) Methane formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation).

As a wastewater treatment for methane recovery project, the proposed project is not a first-of-its kind project in China and belongs to the type (c) of measures above.

The common practice analysis is conducted by section 5 of "tool of common practice (version 03.1)".

Step 1: Calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity.

The total design capacity of the Project Activity is 18.714MW, therefore the applicable output range is 9.357MW to 28.071MW.

Step 2: identify similar projects (both CDM and non-CDM) which fulfill all of the following conditions:

(a) The proposed projects are located in the applicable geographical area;

(b) The proposed projects apply the same measure as the proposed project activity;

(c) The proposed projects use the same energy source/fuel and feedstock as the project activity, if a technology switch measure is implemented by the proposed project activity;

(d) The plants in which the proposed projects are implemented produce goods or services with comparable, properties and applications areas (e.g., clinker) as the proposed project plant;

(e) The capacity or output of the proposed projects is within the applicable capacity or output range calculated in Step 1;

(f) The proposed projects started commercial operation before the proposed project design document (CDM-PDD) is published for global stakeholder consultation or before the start date of proposed project activity, whichever is earlier for the proposed project activity.

In China, the regulatory framework and investment climate for biogas projects are only similar and comparable in the same Province/Autonomous Region. Because each province has its unique economic and cultural environment. So, Shandong province is chosen for the project geographical province.

The project is a biogas recovery project in citric acid wastewater treatment. Therefore, only biogas recovery project in citric acid wastewater treatment projects are considered.

The project activity construction start date is in 01/03/2021. Therefore, only projects which started commercial before 01/03/2021 are considered.

Therefore, all biogas recovery for power generation in citric acid wastewater treatment plants, located in Shandong Province which are delivering the capacity within the applicable output range between 9.357MW and 28.071MW and starting commercial operation before 01/03/2021 are identified as the similar projects.

Step 3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

After research UNFCCC/ Verra/ Gold Standard/CCER related websites, no similar project is existed.

Therefore, N_{all}=0

Step 4: within similar projects identified in Step 2, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

After research UNFCCC/ Verra/ Gold Standard/CCER related website, no similar project is existed.

Step 5: Calculate factor F=1-Ndiff/Nall representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.

Since N_{all}=N_{diff}=0. F=1- N_{diff}/N_{all} = can not be calculated.

The project activity is a “common practice” within a sector in the applicable geographical area if the factor F is greater than 0.2 and N_{all}-N_{diff} is greater than 3.

Through above N_{all}-N_{diff}=0<3.

Therefore, this project is not a common practice.

Through the above analysis, without VER revenue, the project IRR is less than the benchmark. When the sensitive factors vary with ±10%, the project IRR is still less than the benchmark. And the project is not a common practice. Therefore, the project is additional.

3.6 Methodology Deviations

There are no methodology deviations for the project activity.

Thus, this section is not applicable.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The 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:

$$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y}. \qquad (1)$$

Where,

BE_y	=	Baseline emissions in year y (t CO_2e/yr)
$BE_{CH4,y}$	=	Methane emissions from anaerobic treatment of the wastewater in open lagoons (Scenario 1) or the anaerobic treatment of sludge in sludge pits (Scenario 2) or the suppressed demand scenario (Scenario 3) in the absence of the project activity in year y (t CO_2e/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 (t CO_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 (t CO_2/yr).

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

$BE_y = BE_{CH4,y} + BE_{EL,y} + BE_{HG,y}$

$= BE_{CH4,y} + BE_{EL,y}$ (2)

Table 10. Calculation result of BE_y

Parameter	$BE_{CH4,y}$	$BE_{EL,y}$	BE_y
Unit	tCO_2/yr	tCO_2/yr	tCO_2/yr
Value	442,234	58,922	501,156

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

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.

$BE_{CH4,y} = \min \{Q_{CH4,y} ; BE_{CH4,MCF,y}\}$ (3)

Table 11. Calculation result of $BE_{CH4,y}$

Parameter	$Q_{CH4,y}$	$BE_{CH4,MCF,y}$	$BE_{CH4,y}$
Unit	tCO_2/yr	tCO_2/yr	tCO_2/yr
Value	505,204	442,234	442,234

Methane produced

Projects proponent shall use Step 1" Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)"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 ($Q_{CH4,y}$).

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 ($Q_{CH4,y}$). For small scale projects, project participants may choose between Option 1 (procedure using monitored data) or Option 2 (procedure using a default value).

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

According to option 1, $Q_{CH4,y}$ shall be measured using the "Tool to determine the mass flow of greenhouse gas in a gaseous stream". When applying the tool, the following applies:

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

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and

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

As per 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 ($F_{CH4,t}$) can be determined through measurement of the flow and volumetric fraction of the gaseous stream. The project proponent chooses the measurement option A as per table 2 (measurement options). 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”. In line with option A (b) of the tool, the dry gaseous stream shall be demonstrated. Therefore, it is necessary to present that the temperature of the gaseous stream is less than 60ºC at the flow measuring point. $F_{CH4,t}$ is determined as following equation of the tool;

$$F_{CH4,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t} \qquad (4)$$

Where

$F_{CH4,t}$	=	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)
$v_{CH4,t,db}$	=	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)
$\rho_{CH4,t}$	=	Density of greenhouse gas CH_4 in the gaseous stream in minute m (0.716 kg/m^3) at reference conditions

As mentioned above, the mass flow of greenhouse gas CH_4 ($F_{CH4,t}$) in the gaseous stream in the time interval t (kg) will be converted in ton CH_4/year unit of the quantity of methane produced in the digester ($Q_{CH4,y}$).

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

$$\rho_{CH4,t} = (P_t \times MM_{CH4}) / (R_u \times T_t) \qquad (5)$$

Where

$\rho_{CH4,t}$	=	Density of greenhouse gas (CH_4) in the gaseous stream in time interval t (kg/m^3).
P_t	=	Absolute pressure of the gaseous stream in time interval t (Pa). 101,325
MM_{CH4}	=	Molecular mass of CH_4 (kg/kmol) . 16.04
Ru	=	Universal ideal gases constant (Pa.m3/kmol.K). 8314
T_t	=	Temperature of the gaseous stream in time interval t(K) . 273.15

$\rho_{CH4,t} = (P_t \times MM_{CH4}) / (R_u \times T_t)$

=101,325*16.04/8314/273.15=0.716

Table 12. Calculation result of $Q_{CH4,y}$

Parameter	$v_{t,db}$	$v_{CH4,t,db}$	$\rho_{CH4,t}$	GWP_{CH4}	$Q_{CH4,y}$
Unit	m^3	/	$kgCH_4/m^3CH_4$	tCO_2e/tCH_4	tCO_2
Value	42,000,000	60%	0.7160	28	505,204
Data source	FSR	FSR	Calculation	IPCC fifth assessment report	Calculation

Methane conversion factor

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 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:

$$BE_{CH4,MCF,y} = GWP_{CH4} * MCF_{BL,y} * B_o * COD_{BL,y} \quad (6)$$

Where:

GWP_{CH4} = Global Warming Potential of methane valid for the commitment period (tCO_2e/tCH_4)

Bo = Maximum methane producing capacity, expressing the maximum amount of CH_4 that can be produced from a given quantity of chemical oxygen demand ($tCH_4/tCOD$)

$MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year y, representing the fraction of ($COD_{PJ,y}$ x 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)

Table 13. Calculation result of $BE_{CH4,MCF,y}$

Parameter	GWP_{CH4}	$MCF_{BL,y}$	Bo	$COD_{BL,y}$	$BE_{CH4,MCF,y}$
Unit	tCO_2e/tCH_4	/	$tCH_4/tCOD$	tCOD/yr	tCO_2/yr
Value	28	0.3835	0.25	164,736	442,234
Data source	IPCC fifth assessment report	Calculation	Default value of ACM0014_v8.0	Calculation	Calculation

Determination of $COD_{BL,y}$

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

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

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:

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

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* (m^3/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/m^3)
m	=	Months of year *y* of the crediting period

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 fd, 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:

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

Where:

$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year *y*, representing the fraction of ($COD_{PJ,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity
f_d	=	Factor expressing the influence of the depth of the lagoon on methane generation
$f_{T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year *y*
0.89	=	Conservativeness factor

Table 14. Calculation result of $MCF_{BL,y}$

Parameter	f_d	$f_{T,y}$	$MCF_{BL,y}$

Unit	/	/	/
Value	0.7	0.6156	0.3835
Data source	Default value of ACM0014_v8.0	Calculation	Calculation

Determination of f_d

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

$$f_d = \begin{cases} 0;\ if\ D < 1\,m \\ 0.5;\ if\ 1m \leq D < 2m \\ 0.7;\ if\ D \geq 2m \end{cases} \tag{10}$$

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, 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:

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

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)

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

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

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

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

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* (m^3/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/m^3)

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

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

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:

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

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

$f_{T,y}$=0.6156 , the calculation process is shown in the ER calculation sheet.

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

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:

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

Where,

$BE_{EL,y}$ = 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* (t CO_2/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 CO_2/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 CO_2/MWh).

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

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

$$= (EG_{PJ,y} \times EF_{PJ,EL,y}) \quad (17)$$

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

Table 14. Calculation result of $BE_{EL,y}$

Parameter	$EG_{PJ,y}$	$EF_{grid.CM,y}$	$BE_{EL,y}$
Unit	MWh/yr	tCO_2e /MWh	tCO_2/yr
Value	80,345	0.72075	59,646
Data source	FSR	Calculation based on national default value	Calculation

<u>**Determination of $EF_{PJ,EL,y}$ ($EF_{grid,CM,m}$)**</u>

$EF_{grid,CM,y}$ is calculated using “Tool to calculate the emission factor for an electricity system (version 07.0)”.

Through “2021 Baseline Emission Factors for Regional Power Grids in China[10]” published data by China’s DNA, $EF_{grid,CM,y}$=0.72075.

Table 15. Calculation result of $EF_{CM,y}$

Parameter	$EF_{OM,y}$	$EF_{BM,y}$	$EF_{CM,y}$
Unit	tCO_2/MWh	tCO_2/MWh	tCO_2/MWh
Value	0.9714	0.4701	0.72075
Data source	2021 Baseline Emission Factors for Regional Power Grids in China[11]		Calculation

4.2 Project Emissions

[10] https://ccer.cets.org.cn/notice/noticeDetail?bulletinInfoId=1175122354980917248

[11] https://ccer.cets.org.cn/notice/noticeDetail?bulletinInfoId=1175122354980917248

4.2.1 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 aerobic pool as secondary treatment. The sludge is not expected to be generated with significant amount in the anaerobic digester. In case of excess sludge, it may be used for seeding sludge or combusting of other plants. 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 12 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:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y} \quad (18)$$

Where,

$PE_{AD,y}$	=	Project emissions associated with the anaerobic digester in year y (t CO_2e)
$PE_{EC,y}$	=	Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO_2e)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with the anaerobic digester in year y (t CO_2e)
$PE_{CH4,y}$	=	Project emissions of methane from the anaerobic digester in year y (t CO_2e)
$PE_{flare,y}$	=	Project emissions from flaring of biogas in year y (t CO_2e)

These parameters are determined through the steps outlined below.

Step 1: Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

As per Project and leakage emissions from anaerobic digesters (v2.0)", for large scale project, only Option 1: Procedure using monitored data shall be used for determination of the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). In order to apply the Option 1, the $Q_{CH4,y}$ shall be measured using “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. When the applying the tool, the following applies:

(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 determination shall be applied the same approach for the baseline determination of methane produced. The quantity of methane produced in the digester ($Q_{CH4,y}$) is referred to the determination of the mass flow of methane ($F_{CH4,t}$), which is determined as following equation of the tool;

$$Q_{CH4,y}=F_{CH4,t} = V_{t,db} * v_{CH4,t,db} * \rho_{CH4,t} \qquad (19)$$

Where,

$F_{CH4,t}$	=	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)
$v_{CH4,t,db}$	=	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)
$\rho_{CH4,t}$	=	Density of greenhouse gas CH_4 in the gaseous stream in minute m (0.716 kg/m^3) at reference conditions

As mentioned above, the mass flow of greenhouse gas CH_4 ($F_{CH4,t}$) in the gaseous stream in the time interval t (kg) will be converted in ton CH_4/year unit of the quantity of methane produced in the digester ($Q_{CH4,y}$).

Step 2: Determination of 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:

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \qquad (20)$$

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)
$EF_{CH4,defaut}$	=	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 an IC digesters, the $EF_{CH4,default}$ is determined as 0.05.

Table 16. Calculation result of $PE_{CH4,y}$

Parameter	$Q_{CH4,y}$	$EF_{CH4,defaut}$	GWP_{CH4}	$PE_{CH4,y}$
Unit	*t*	/	tCO_2e/tCH_4	tCO_2
Value	18,043	0.05	28	25,261
Data source	Calculation based value from FSR.	Default value from Tool of "Project and leakage emissions from anaerobic digesters-v2"	IPCC fifth assessment	Calculation

Step 3: Determination of project emissions from electricity consumption ($PE_{EC,y}$)

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 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:

$$PE_{EC,y} = \Sigma_j EC_{PJ,j,y} \times EF_{EL,j,y} \times (1 + TDL_{j,y}) \qquad (21)$$

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, $FE_{EL,j,y}$=$EF_{grid,CM,y}$=0.72075tCO_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.

The project activity may consume electricity from the national grid when in emergency. $PE_{EC,y}$ is 0 for ex-ante estimation, and the actual will be monitored and calculated according to "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

Step 4: 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 CO_2 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).

The project activity is designed to not consume fossil fuel. Therefore, $PE_{FC,y}$=0

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

In the case of unscheduled events; such as the engine failure or malfunction, result in biogas being unable to be sent to the gas engines, or if there is an excess of biogas, the open flaring system will be used for such emergency case.

The biogas flow meters are installed in the inlet to the generators to monitor the biogas amount for electricity generation. The flare is in another pipe. The monitored biogas for emission reductions only means the amount into the generators, not including the biogas to the flare.

The project owner decided not to claim the emission reductions from biogas flaring for simplification. However, for conservativeness, $PE_{flare,y}$ will be calculated as per "project emissions from flaring (version 04.0)".

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

Where,

$PE_{flare,y}$ = Project emissions from flaring of the residual gas in year y (tCO2e)

GWP_{CH4} = Global warming potential of methane valid for the commitment period (tCO2e/tCH4)

$F_{CH4,RG,m}$ = Mass flow of methane in the residual gas in the minute m (kg)

$\eta_{flare,m}$ = Flare efficiency in the minute m

As per the "project emissions from flaring (version 04.0)", in the case of open flares, the flare efficiency in the minute m ($\eta_{flare,m}$) is 50% when the flare is detected in the minute m ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%.

This project chooses 0 for $\eta_{flare,m}$ for simplification and conservativeness.

$$\sum_{m=1}^{525600} F_{CH4,RG,m=V_{RG,y}} \times fc_{CH4,RG,y} \times \rho_{CH4}$$

Where

$V_{RG,y}$ = Volume of the residual gas to the flare in year y (Nm^3/yr)

$fc_{CH4,RG,y}$ = Fraction of methane in residual gas in year y (%)

ρ_{CH4} = Density of methane at reference conditions ($kgCH_4/Nm^3CH_4$). The default value is 0.716 as per the tool.

For ex-ante estimation, $PE_{flare,y}$=0. And the ex-post calculation will be based on the monitoring of $v_{RG,y}$ and $fc_{CH4,RG,y}$

<u>For Condition (b) In the case of project activities that introduce a treatment of sludge or land application of wastewater</u>

Not applicable.

Table 17. Calculation result of $PE_{AD,y}$

Parameter	$PE_{EC,y}$	$PE_{FC,y}$	$PE_{CH4,y}$	$PE_{flare,y}$	$PE_{AD,y}$
Unit	tCO_2/yr	tCO_2/yr	tCO_2/yr	tCO_2/yr	tCO_2/yr
Value	0	0	25,261	0	25,261

4.2.2 Leakage emissions

As per 'project and leakage from anaerobic digester_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.

It is not expected to generate sludge, if a large amount of sludge is generated, it will be stored in *the* aerobic pond and then transported to other plants for seeding sludge or combusting. *So,* there will be no emissions due to the storage. However, for conservativeness, storage *emissions are calculated in section 4.2.*

According to 'project and leakage from anaerobic digester_v2.0', the leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. They include emissions associated with storage and composting of the digestate and are determined as follows:

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

This project does not include composting. . Therefore, $LE_{comp,y}$=0.

$LE_{AD,y}=LE_{storage,y}$

As per ‘project and leakage from anaerobic digester_v2.0’, there are two options to calculate $LE_{storage,y}$. Option 2 is chosen to calculate the $LE_{storage,y}$, and the calculation process is as follows:

$LE_{storage,y} = F_{ww,CH4,default} \times Q_{CH4,y} \times GWP_{CH4}$

where,

$F_{ww,CH4,default}$ = 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

GWP_{CH4} = Global Warming Potential of methane

Table 18. Calculation result of $LE_{storage,y}$

Parameter	$F_{ww,CH4,default}$	$Q_{CH4,y}$	GWP_{CH4}	$LE_{storage,y}$
Unit		tCH_4	tCO_2/tCH_4	tCO_2/yr
Value	0.15	18,043	28	75,781

Table 19. Calculation result of PE_y

	$PE_{AD,y}$	$LE_{storage,y}$	PE_y
Unit	tCO_2/yr	tCO_2/yr	tCO_2/yr
Value	25,261	75,781	101,042

4.3 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 emissions due to the storage of digestate is calculated in section 4.2.

4.4 Net GHG Emission Reductions and Removals

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

$$ER_y = BE_y - PE_y - LE_y \quad (27)$$

Where,

ER_y = Emissions reductions in year *y* (tCO_2e/year)

BE_y = Baseline emissions in year *y* (tCO_2e/year)

PE_y = Project emissions in year *y* (tCO_2e/year)

LE_y = Leakage emissions in year *y* (tCO_2e/year)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
28/04/2022-31/12/2022 (248days)	340,072	68,466	0	271,606
2023	501,880	101,042	0	400,838
2024	501,880	101,042	0	400,838
2025	501,880	101,042	0	400,838
2026	501,880	101,042	0	400,838
2027	501,880	101,042	0	400,838
2028	501,880	101,042	0	400,838
2029	501,880	101,042	0	400,838
2030	501,880	101,042	0	400,838
2031	501,880	101,042	0	400,838
01/01/2032-27/04/2032 (118days)	161,808	32,576	0	129,232
Total	5,018,800	1010,420	0	4,008,380

5 MONITORING

5.1 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 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	7,488tCOD/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 corresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario.
Value applied	172,224tCOD/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	ρ
Data unit	-
Description	Discount factor for historical information
Source of data	As per ACM0014, version 08, for greenfield projects, $\rho = 1$.
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_o
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	2019 IPCC Guidelines
Value applied	0.25
Justification of choice of data or description of measurement methods and procedures applied	No measurement procedures are required. The value is applied as per 2019 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	No measurement is required. The project activity involves installation of new anaerobic wastewater treatment and biogas utilization facilities. As per

and procedures applied	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_2e/t CH_4
Description	Global warming potential for CH_4
Source of data	IPCC Fifth Assessment Report
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	AR5
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	2021 Baseline Emission Factors for Regional Power Grids in China published by Ministry of Ecology and Environment and National Bureau of Statistics [12]"
Value applied	0.72075
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	$EF_{CH4,default}$
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

[12]https://ccer.cets.org.cn/notice/noticeDetail?bulletinInfoId=1175122354980917248

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_t
Data unit	Pa

Description	Absolute pressure of the gaseous stream in time interval t
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	Default value
Purpose of Data	Calculation of baseline and project emission
Comments	/

Data / Parameter	T_n
Data unit	K
Description	Temperature of the gaseous stream in time interval t
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	Default value
Purpose of Data	Calculation of baseline and project emission
Comments	/

5.2 Data and Parameters Monitored

Data / Parameter	$F_{PJ,dig,m}$
Data unit	m^3/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	In east project area, one flow meter will be installed at the inlet of the 5 anaerobic digesters to monitor the inflow water volume. In west project area, one flow meter will be installed at the inlet water flow of 12 anaerobic digesters to monitor the inflow water volume. The waste water flow volume will be monitored continuously. The monthly aggregated value will be recorded by the operators.
Frequency of monitoring/recording	Monitored continuously and aggregated monthly.
Value applied	624,000
Monitoring equipment	Wastewater flow meter
QA/QC procedures to be applied	The flow meter will be calibrated in accordance with Verification Regulation of Electromagnetic Flowmeters JJG1033-2007 at least two years a time. And the accuracy is 0.5 class.
Purpose of 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 will be analyzed using a national standard by the inhouse laboratory of the treatment plant. The results will be recorded by the operators in the plant. Average value will be calculated.
Frequency of monitoring/recording	The monitoring and recording will be conducted each day and averaged monthly.
Value applied	0.023
Monitoring equipment	The monitoring equipment is in line with the requirement of national standards.
QA/QC procedures to be	/

applied	
Purpose of 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	Regional weather statistics[13]
Frequency of monitoring/recording	Continuously, aggregated in monthly average values
Value applied	The average monthly temperature is shown in following table:
Monitoring equipment	/
QA/QC procedures to be applied	/
Purpose of data	Calculation of baseline emissions

Month	Temperature (°C)	Temperature (K)	Month	Temperature (°C)	Temperature (K)
January	-1	272.15	July	28.5	301.65
February	1	274.15	August	27.5	300.65
March	8.5	281.65	September	22.5	295.65
April	15.5	288.65	October	16	289.15
May	22	295.15	November	7.5	280.65
June	25.5	298.65	December	1	274.15

[13] https://www.tianqi.com/qiwen/city_anqiu/

Calculation method	The national or regional weather statistics is applied. In case of the temperature is available in Celsius, it shall be calculated as follows: $T_{2,m}$ (K) = 273.15 K + $T_{2,m}$ (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 meter
Description of measurement methods and procedures to be applied	Net quantity of electricity generated is monitored by the electricity meter.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	80,345 for ex-ante ER estimation and the actual will be monitored.
Monitoring equipment	Electricity meter
QA/QC procedures to be applied	Two-way electricity meter is installed. The electricity meter will be calibrated according to Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy (JJG 596-2012) at least six years a time. And the accuracy for the exported electricity to grid is 0.5S.
Purpose of data	Calculation of baseline emissions
Calculation method	/
Comments	/

Data / Parameter	EC_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 imported grid electricity by the project. It will be monitored continuously by the electricity meter.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	0 for ex-ante estimation. And the actual will be monitored.
Monitoring equipment	Electricity meter
QA/QC procedures to be applied	Two-way electricity meter is installed. The electricity meter will be calibrated according to Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy (JJG 596-2012) at least six years a time. And the accuracy for imported electricity from grid is 2 class.
Purpose of 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 at reference conditions in year y
Source of data	Measured
Description of measurement methods and procedures to be applied	Flow meter will be installed at the inlet to the gas engine. The gas flow rate will be monitored continuously and aggregated monthly.
Frequency of monitoring/recording	Parameter monitored continuously and aggregated monthly.
Value applied	42,000,000 for ex-ante ER estimation and the actual data will be monitored.
Monitoring equipment	Gas flow meter
QA/QC procedures to be applied	The biogas flow meters will be calibrated as per Verification regulation of Thermal Mass Gas Flowmeter JJG1132-2017. The calibration frequency will be at least two years a time. The accuracy of biogas flow meters is 0.5 class.

Purpose of data	Calculation of baseline and project emissions
Calculation method	/
Comments	/

Data / Parameter	$w_{CH4,biogas,y}$ ($V_{CH4,t,db}$)
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
Source of data	Measured
Description of measurement methods and procedures to be applied	The methane concentration will be monitored by the gas analyzer
Frequency of monitoring/recording	The methane concentration will be monitored continuously and recorded monthly.
Value applied	60%*0.716=0.4296kgCH_4/m^3 for ex-ante estimation. And the actual concentration will be monitored.
Monitoring equipment	Gas analyzer
QA/QC procedures to be applied	The gas analyzer will be calibrated as per Verification regulation of Calibration procedures for catalysis combustion Type methane Measuring Device JJG678-2007 or similar regulation. The accuracy of gas analyzer is 0.5 class. And the calibration frequency is annually.
Purpose of data	Calculation of baseline and project emissions
Calculation method	/
Comments	/

Data / Parameter	The treatment of sulphur
Data unit	/
Description	The sulphur will be transported to professional company.
Source of data	Transportation/treatment records

Description of measurement methods and procedures to be applied	The sulphur will be transported to professional company to recover. And the transportation records will be kept by the project owner.
Frequency of monitoring/recording	Monthly
Value applied	/
Monitoring equipment	/
QA/QC procedures to be applied	/
Purpose of data	Safeguards and environmental protection.
Calculation method	/
Comments	/

Data / Parameter	$V_{RG,y}$
Data unit	Nm^3/yr
Description	Volume of the residual gas to the flare in year y
Source of data	Measured
Description of measurement methods and procedures to be applied	The amount of biogas flared will be monitored by the gas flowmeter at the inlet of flare.
Frequency of monitoring/recording	This parameter will be monitored continuously and recorded accumulated annually.
Value applied	0 for ex-ante estimation and the actual data will be monitored in the monitoring period.
Monitoring equipment	Gas flow meter
QA/QC procedures to be applied	The gas flow meter will be calibrated as per Verification regulation of Thermal Mass Gas Flowmeter JJG1132-2017. The accuracy of gas flow meter is 0.5 class. And the calibration frequency is at least two years a time.
Purpose of data	Calculation of project emissions
Calculation method	/

Comments	/

Data / Parameter	$fc_{CH4,RG,y}$
Data unit	%
Description	Fraction of methane in residual gas in year y
Source of data	Measured
Description of measurement methods and procedures to be applied	The methane concentration will be monitored by the gas analyzer at the inlet of flare.
Frequency of monitoring/recording	The methane concentration will be monitored continuously and averaged anunally.
Value applied	0 for ex-ante estimation. And the actual concentration will be monitored.
Monitoring equipment	Gas analyzer
QA/QC procedures to be applied	The gas analyzer will be calibrated as per Verification regulation of Calibration procedures for catalysis combustion Type methane Measuring Device JJG678-2007 or similar regulation. The accuracy of gas analyzer is 0.5 class. And the calibration frequency is annually.
Purpose of data	Calculation of project emissions
Calculation method	/
Comments	/

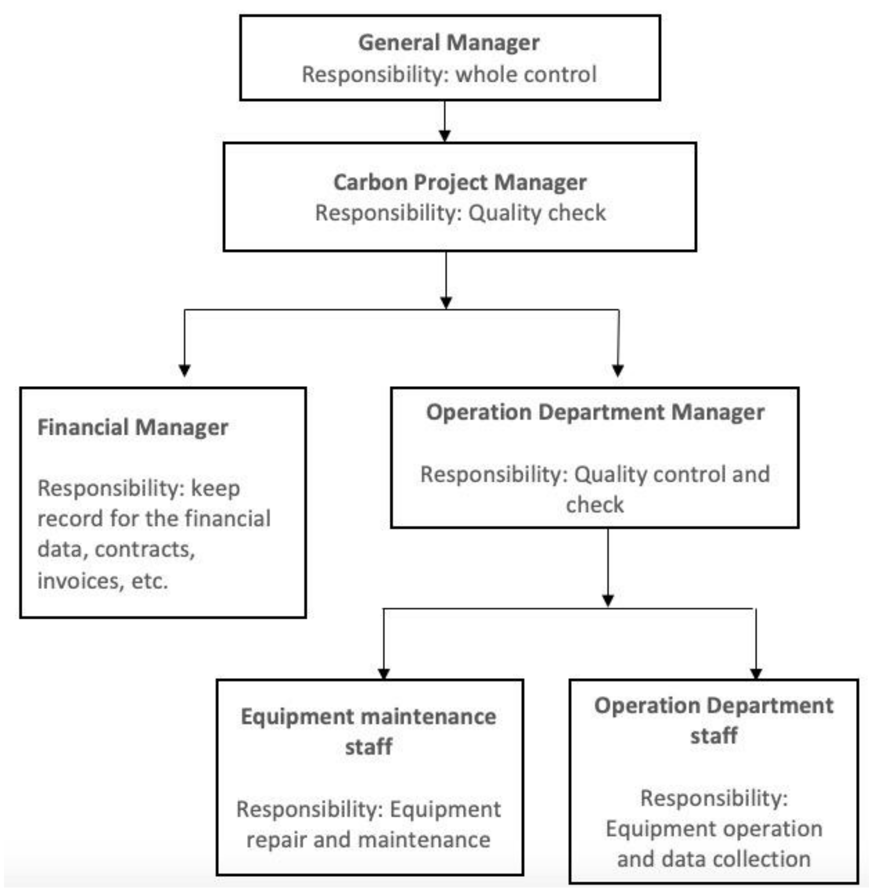
Data / Parameter	$\eta_{flare,m}$
Data unit	%
Description	Flare efficiency in minute m
Source of data	Default value
Description of measurement methods and procedures to be applied	As per “project emissions from flaring (v04.0”), for the open flare, the efficiency is either 50% or 0. For simplification and conservativeness, 0 is chosen for this project.

Frequency of monitoring/recording	Annually
Value applied	0
Monitoring equipment	NA
QA/QC procedures to be applied	*NA*
Purpose of data	Calculation of project emissions
Calculation method	/
Comments	/

5.3 Monitoring Plan

1. Monitoring structure

The operational and management structure of the project is summarized as below.



2. Monitoring parameters

The monitoring parameters and related equipment is shown as follows:

Parameters	Unit	Description	Monitoring equipment/monitoring method
$F_{PJ,dig,m}$	m^3/moth	Quantity of wastewater that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m	2 Electromagnetic flow meters The accuracy of water flow meter is 0.5 class and the calibration frequency is at least two years a time. The calibration will be conducted as per Verification Regulation of Electromagnetic Flowmeters JJG1033-2007.
$COD_{dig,m}$	t COD/m^3	Chemical oxygen demand in the wastewater that is treated in the anaerobic digester in the project activity in month m	Monitor in the laboratory of the TTCA Co., Ltd.
$T_{2,m}$	K	Average temperature at the project site in month m	Public data from local weather bureau statistics
$EG_{PJ,y}$	MWh/year	Net quantity of electricity generated in year y with biogas from the new anaerobic biodigester	Electricity meter The accuracy of electricity meter for exported electricity is 0.5s and the calibration frequency is six years a time. The calibration will be conducted as per the Verification Regulation of Electrical Meters for Measuring Alternating-current Electrical Energy (JJG 596-2012).
EC_y	MWh/year	Net quantity of grid electricity consumed by the project in year y	Electricity meter The accuracy of electricity meter for exported electricity is 2.0s and the calibration frequency is six years a time.
$F_{biogas,y}$ ($V_{t,db}$)	m^3/yr	Total amount of biogas collected in the outlet of the new digester at reference conditions in year y	Biogas flow meter The accuracy of biogas flow meter is 0.5 class and the calibration frequency is at least two years a time. The calibration will be conducted as per the Verification regulation of Thermal Mass Gas Flowmeter JJG1132-2017.
$w_{CH4,biogas,y}$ ($V_{CH4,t,db}$)	kg CH_4/m^3	Concentration of methane in the total biogas supply in the outlet of the new digester at reference conditions	gas analyzer The accuracy of gas analyzer is 0.5 class and the calibration frequency is annually. The calibration will be conducted as per Verification regulation of Calibration procedures for catalysis combustion Type methane Measuring Device JJG678-2007 or similar regulation.

$V_{RG,y}$	Nm^3 /yr	Volume of the residual gas to the flare in year y	Biogas flow meter The accuracy of biogas flow meter is 0.5 class and the calibration frequency is at least two years a time. The calibration will be conducted as per the Verification regulation of Thermal Mass Gas Flowmeter JJG1132-2017.
$fc_{CH4,RG,y}$	%	Fraction of methane in residual gas in year y	Gas analyzer The gas analyzer will be calibrated as per Verification regulation of Calibration procedures for catalysis combustion Type methane Measuring Device JJG678-2007 or similar regulation. The accuracy of gas analyzer is 0.5 class. And the calibration frequency is annually.
$\eta_{flare,m}$	%	Flare efficiency in minute m	0 is used for calculation. This is also conservative. No equipment is needed.

3. Data collection

The required monitoring equipment is installed by the project owner. The monitoring data of each parameter, including the biogas flow, wastewater flow, electricity amount are collected and recorded by the operation staff, while COD of wastewater monitored and recorded each day by on-site environmental laboratory.

The collected data is crosschecked by the operation department manager who is in charge of data processing.

All the paper record and electric record are archived and well kept in the office of the plant.

4. Quality Assurance and Quality Control

The monitoring equipment, such as water flow meter, biogas flow meter, electricity meter, gas analyzer are calibrated according to national standard to make sure that their accuracy. The calibration reports of the equipment are archived and kept in the office of the plant. The data record is checked and confirmed by the operation department manager.

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.

5. Emergency preparedness

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

If there is shut down in the piping or digester, operator shall notice the supervisor immediately to take measures, such as repair etc. And the time span of repairment will be recorded for crosscheck.