BAOSHAN EAST HOPE SWINE FARM AWMS GHG MITIGATION PROJECT

Project title	Baoshan East Hope Swine Farm AWMS GHG Mitigation Project
Project ID	5431
Crediting period	25-June-2023 to 24-June-2033
Original date of issue	25-December-2024
Most recent date of issue	/
Version	1.0
***VCS Standard* Version**	VCS Standard v4.7
Prepared by	Xi'an Carbon Neutral Environmental Technology Co., Ltd.

CONTENTS

1 PROJECT DETAILS 4

1.1 Summary Description of the Project 4
1.2 Audit History 5
1.3 Sectoral Scope and Project Type 5
1.4 Project Eligibility 5
1.5 Project Design 8
1.6 Project Proponent 8
1.7 Other Entities Involved in the Project 8
1.8 Ownership 9
1.9 Project Start Date 9
1.10 Project Crediting Period 9
1.11 Project Scale and Estimated GHG Emission Reductions or Removals 10
1.12 Description of the Project Activity 10
1.13 Project Location 14
1.14 Conditions Prior to Project Initiation 16
1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks 16
1.16 Double Counting and Participation under Other GHG Programs 17
1.17 Double Claiming, Other Forms of Credit, and Scope 3 Emissions 18
1.18 Sustainable Development Contributions 18
1.19 Additional Information Relevant to the Project 19

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT 20

2.1 Stakeholder Engagement and Consultation 20
2.2 Risks to Stakeholders and the Environment 28
2.3 Respect for Human Rights and Equity 30
2.4 Ecosystem Health 33

3 APPLICATION OF METHODOLOGY 34

3.1 Title and Reference of Methodology 34
3.2 Applicability of Methodology 35
3.3 Project Boundary 43
3.4 Baseline Scenario 46

3.5 Additionality 52
3.6 Methodology Deviations 66

4 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS 66

4.1 Baseline Emissions 66
4.2 Project Emissions 74
4.3 Leakage Emissions 86
4.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals 91

5 MONITORING 99

5.1 Data and Parameters Available at Validation 99
5.2 Data and Parameters Monitored 111
5.3 Monitoring Plan 124

APPENDIX 1: COMMERCIALLY SENSITIVE INFORMATION 139

1 PROJECT DETAILS

1.1 Summary Description of the Project

Baoshan East Hope Swine Farm AWMS GHG Mitigation Project (hereinafter referred to as the Project) applies one animal waste management system (AWMS i.e. Enclosed Anaerobic Digester, the same below) to treat the manure from the swine farm in Baoshan City, Yunnan Province, which is owned by Baoshan East Hope Animal Husbandry Co., Ltd (hereinafter called the project owner). The purpose of the project activity is to treat the manure and wastewater to avoid methane emissions generated in the baseline uncovered anaerobic lagoons.

The specific treatment process of this AWMS is as follows: All the manure and wastewater are collected and then separated first. The solid will be treated in an aerobic composting system, and organic fertilizers will be produced. The fertilizer produced in this process will be distributed to local farmers for free, and the surplus will be sold in the domestic market. The organic fertilizers are distributed free of charge to local villagers. The liquid will be treated through anaerobic digestion, and the biogas generated during the treatment process will be captured for electricity generation. The sludge produced from anaerobic digestion will be treated through aerobic composting together with the solid. The effluent will be supplied to the farmers living around for free for agricultural irrigation.

The common practice for local swine farm owners to manage manure is to have uncovered anaerobic lagoons/ponds at their farms in the region. According to the "technical specification for sanitation treatment of livestock and poultry manure[1]" in China, the uncovered anaerobic lagoons are a manure treatment method recognized by the state. Additionally, since there are no legal regulations mandating livestock farm owners to implement anaerobic digestion, aerobic, or other biological treatment techniques, and to capture and/or utilize methane generated at their lagoons, the continuation of this common practice to treat manure, i.e., uncovered anaerobic lagoons, is the most economic, viable, and reasonable option for livestock farm owners.

This project is expected to generate approximately $6.04*10^4$ m^3 of biogas per year. This biogas will be collected and utilized for power generation. The electricity generated will only be used for the daily operation of AWMS and will not be provided to other users. For the sake of conservatism, the baseline emissions from electricity generation have been ignored.

The project activity will reduce GHG emissions in the atmosphere by avoiding methane emissions from anaerobic treatment of swine manure and wastewater. It is expected to achieve an annual emission reduction of 75,479 tCO_2e and a total emission reduction of 754,790 tCO_2e during the fixed 10-year crediting period.

[1] https://oss.baigongbao.com/2020/12/14/MRyhTKQcWC.pdf

1.2 Audit History

The project has not undergone an audit process at the moment.

1.3 Sectoral Scope and Project Type

Sectoral scope	1. Energy(renewable/non-renewable) 13. Waste handling and disposal 15. Livestock and manure management
Project activity type	The project type of this project belongs to Type III "Other project activities not included in Type I or Type II".

1.4 Project Eligibility

1.4.1 General eligibility

As per section 2.1.1 of VCS Standard (Version 4.7), the scope of the VCS Program includes:

1) The seven Kyoto Protocol greenhouse gases: The project activity treats manure wastes from one swine farm through installing AWMS and capturing the biogas for electricity generation, which can avoid methane (CH_4) emissions from uncovered anaerobic lagoons in the baseline scenario. Methane is one of the seven Kyoto Protocol greenhouse gases, so the project is eligible for this requirement.

2) Ozone-depleting substances (ODS): Not applicable. The project activity doesn't involve ODS.

3) Project activities supported by a methodology approved under the VCS Program through the methodology development and review process: Not applicable. The applied methodology is approved under the CDM Program and doesn't involve the methodology development and review process.

4) Project activities supported by a methodology approved under an approved GHG program: unless explicitly excluded (see the Verra website for exclusions): Eligible, the methodology applied for the project is ACM0010 (version 08.0) under the 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: Not applicable. The project is not a REDD+ project.

Meanwhile, the project does not belong to the projects excluded in Table 2.1 of the VCS Standard (Version 4.7). Thus, the project is eligible under the scope of the VCS program.

The construction date of the project is 2021.04.05, and it was put into operation on 2023.06.25.

For this non-AFOLU project, the requirement in section 3.8.1 of VCS Standard (Version 4.7) that non-AFOLU projects shall complete validation within two years of the project start date can be met.

According to 3.1 of the VCS Standard (Version 4.7), establishing a consistent and standardized certification process is critical to ensuring the integrity of VCS projects. Accordingly, certain high-level requirements must be met by all projects, as set out below.

Requirements of 3.1 of VCS standard (version 4.7)	Justification
3.1.1 Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1.	The project meets all applicable rules and requirements as set out under the VCS Program.
3.1.2 Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.14.1. The list of methodologies and their validity periods is available on the Verra website.	The project applies CDM approved methodology ACM0010 (version 08.0), which is an eligible VCS methodology, along with tools or modules as applicable. Refer to sections 3.1 and 3.2 of the PD below for more details.
3.1.3 Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.22 below. Projects shall update to the latest version of the methodology when reassessing the baseline or renewing a crediting period.	The project applies the latest version of ACM0010 (version 08.0), and type of ten years fixed period is selected. The methodology applied will be updated upon reassessing the baseline. It does not need to renew a fixed crediting period.
3.1.4 Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	Projects are in compliance with currently applicable laws. According to the approval of the Environmental Impact Assessment (EIA) of the project, the project complies with all Chinese relevant laws and regulations. Refer to section 1.15 of the PD below for more details.

3.1.5 Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program Definitions for the definition of model), the model shall meet the requirements set out in the VCS Methodology Requirements, and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or carbon dioxide removals).	Not applicable. There are no models that need to be chosen by the project proponent as per the applied methodology ACM0010 (version 08.0).
3.1.6 Where projects apply methodologies that permit the project proponent to choose a third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet the requirements set out in the VCS Methodology Requirements.	The default factor or standard applied in this project is all methodologically permissible, so the default factor or standard meets the requirements set out in the VCS Program document VCS Methodology Requirements.
3.1.7 Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence.	Not applicable.
3.1.8 Where projects apply methodologies from approved GHG programs, they shall conform with any specified capacity limits (see the VCS Program Definitions for the definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	Large-scale consolidated methodology ACM0010 was applied by the project, which is approved by CDM programs. The methodology has no specific requirements about the capacity limit. The application of the methodology and/or tools referenced by the methodology under the project activity is also applicable. Please refer to section 3 for more details. Therefore, it is applicable.
3.1.9 Where Verra issues new VCS Program rules, the effective dates of these requirements are set out in Appendix 3 Document History and Effective Dates or equivalent for other program documents,	This is the first crediting period of the project, and it has followed all the latest requirements of Verra.

and are listed in a companion Summary of Effective Dates document which corresponds with each update.	

1.4.2 AFOLU project eligibility

The project is not an AFOLU project. Thus, this section is not applicable.

1.4.3 Transfer project eligibility

The project is not a transfer project. Thus, this section is not applicable.

1.5 Project Design

Indicate if the project has been designed as:

☒ Single location or installation

☐ Multiple locations or project activity instances (but not a grouped project)

☐ Grouped project

1.5.1 Grouped project design

The project is not a grouped project.

1.6 Project Proponent

Organization name	Baoshan East Hope Animal Husbandry Co., Ltd.
Contact person	Zexin Tian
Title	Project Manager
Address	Room 02-3, Basement 2, No. 1777, Century Avenue, China (Shanghai) Free Trade Zone Pilot Zone
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Email	tianzx186@easthope.cn

1.7 Other Entities Involved in the Project

Organization name	Xi'an Carbon Neutral Environmental Technology Co., Ltd.
Role in the project	VCS Consultant

Contact person	Xin Liu
Title	Project Manager
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1.8 Ownership

The project owner is Baoshan East Hope Animal Husbandry Co., Ltd., which possesses the legal authority to oversee and manage the project activity. The business license, Investment project record certificate, Environmental Impact Assessment (EIA), the equipment purchasing contract, and the construction contract serve as proof of ownership of the project and the carbon credits produced.

1.9 Project Start Date

Project start date	25-June-2023
Justification	As per section 3.8 of VCS Standard (Version 4.7), the project start date of a non-AFOLU project is the date on which the project began generating GHG emission reductions or carbon dioxide removals. The project activity is a non-AFOLU project, and the anaerobic animal manure management system was put into operation on 25th June 2023, which is the earliest date that the project started generating emission reductions. Thus, the project start date is 25th June 2023.

1.10 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☒ Ten years, fixed ☐ Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	25-June-2023 to 24-June-2033

1.11 Project Scale and Estimated GHG Emission Reductions or Removals

☒ < 300,000 tCO_2e/year (project)

☐ ≥ 300,000 tCO_2e/year (large project)

Calendar year of crediting period	Estimated GHG emission reductions or removals (tCO_2e)
25-June-2023 to 31-December-2023	39,290
01-January-2024 to 31-December-2024	75,479
01-January-2025 to 31-December-2025	75,479
01-January-2026 to 31-December-2026	75,479
01-January-2027 to 31-December-2027	75,479
01-January-2028 to 31-December-2028	75,479
01-January-2029 to 31-December-2029	75,479
01-January-2030 to 31-December-2030	75,479
01-January-2031 to 31-December-2031	75,479
01-January-2032 to 31-December-2032	75,479
01-January-2033 to 24-June-2033	36,189
Total estimated ERRs during the first or fixed crediting period	754,790
Total number of years	10
Average annual ERRs	75479

1.12 Description of the Project Activity

The project treats the manure and wastewater produced by Baoshan East Hope swine farm by installing an AWMS. The AWMS mainly comprises a solid-liquid separation system, black membrane anaerobic fermentation system, aerobic wastewater treatment system, and biogas recovery and utilization system. Pig manure and sewage are first fed into the collection tank. After solid-liquid separation, the liquid will be treated through anaerobic digestion in a black membrane anaerobic pond, and the biogas generated during the treatment process will be captured for electricity generation, with surplus biogas destroyed through flaring systems (if any). The solid will be treated in an aerobic composting system, and organic fertilizers will be produced.

The project is expected to avoid GHG emissions of methane through the recovery and destruction of biogas. The electricity generated by utilizing the captured biogas will be used for the AWMS itself. Thus, the emission reductions from this part will not be accounted for.

Baseline Scenario

Without this project, the manure and wastes from the swine farm would be left in an uncovered anaerobic lagoon so that the methane would be sent to the atmosphere without any recovery, thus leading to higher GHG emissions. After the implementation of the project activities, the uncovered anaerobic lagoon is replaced by AWMS, and the parameters of the anaerobic lagoons are shown in table 1-3.

Project Technology Description

The project aims to establish a centralized animal manure treatment system for collecting pig manure, urine, cleaning water, etc. The specific process is as follows: all manure and wastewater are first collected in a collection tank and then undergo solid-liquid separation. Solid materials are processed in an aerobic composting system to produce organic fertilizers, which are produced in this process will be distributed to local farmers for free, and the surplus will be sold in the domestic market. Liquid materials, as fermentation raw materials, will be sent to the plastic film biogas digester. During the anaerobic treatment process, biogas is produced. The generated biogas will be used for electricity generation through a biogas boiler and generator set. In case of a boiler or generator set failure or emergency, torch burning will be used. All energy generated during the burning process will be used only for AWMS. The sludge generated from anaerobic digestion will be treated together with solid materials in the aerobic composting system, and the resulting wastewater can be used for agricultural irrigation.

The estimated lifetime of the project is 20 years. And the project is expected to avoid methane GHG emissions by recycling and burning biogas. The specific process flow diagram of the project activities is shown in Figure 1-1.

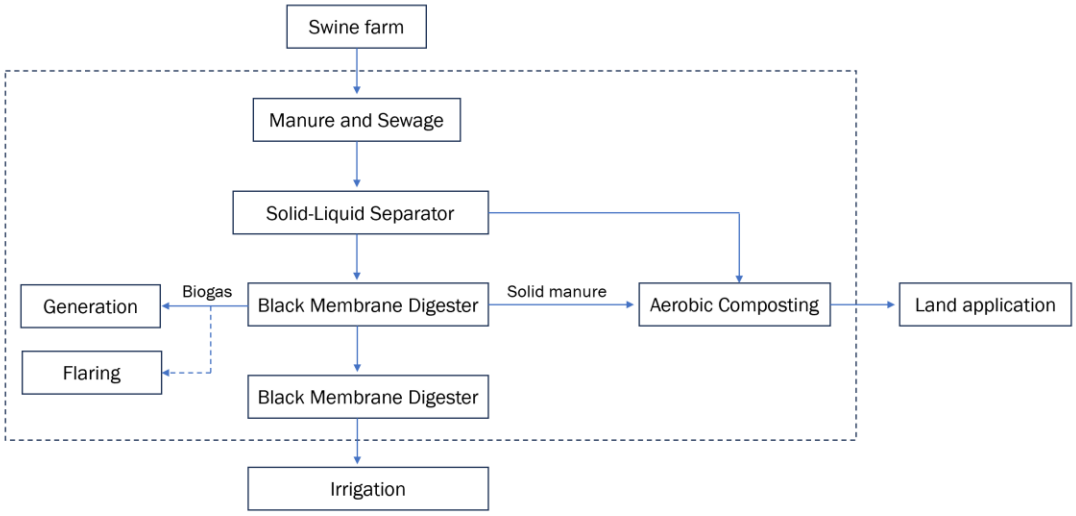

Figure 1-1 Process flow diagram of the project activity

- Solid-liquid separation

The project activity uses a flushing system to collect the manure automatically. All the manure and wastewater are collected and then separated first. For solid-liquid separation, it adopts a composite solid-liquid separator. The separated solids are treated in an aerobic composting system to produce organic fertilizer. Liquids are treated by anaerobic digestion, and the biogas produced during the treatment process is collected for electricity generation.

- Anaerobic digesters treatment process

Fully geomembrane-enclosed anaerobic lagoons are adopted to treat the manure anaerobically. High-density polyethylene (HDPE) geomembranes are integrated into the base and top membranes through anchor trenches, with anaerobic fermentation and gas storage functions. Therefore, fully geomembrane-enclosed anaerobic lagoons integrate fermentation and gas storage, and impermeable high-density polyethylene (HDPE) geomembrane is used to seal the entire anaerobic lagoon in order to capture greenhouse gases and maintain anaerobic conditions within the digester. The manure treatment principle is the same as other anaerobic fermentation processes, relying on the metabolic function of anaerobic bacteria to degrade the organic matter in the manure and produce biogas. In order to meet the safety production standards of enterprises and avoid a single anaerobic lagoon from being too large, the whole anaerobic lagoon is divided into a covered storage lagoon and a covered anaerobic lagoon. The liquid between the two parts of the lagoon is interconnected through pipes, sharing a biogas exhaust port, forming a complete anaerobic lagoon system.

The anaerobic digester is one of the few manure treatment options that reduces the environmental impact of manure and generates energy. Given that the biogas at the top of the digester has an insulation effect and the digester is a semi-buried structure, it has the characteristic of maintaining a relatively constant temperature in winter. The temperature of the manure and wastewater in the digester is less affected by the outside environment, so insulation is not needed in winter. Therefore, it can be stated that the external environment does not affect digester treatment, meaning it operates independently from meteorological factors.

- Comprehensive utilization of biogas

The biogas produced by the anaerobic fermentation system is a mixed gas containing saturated steam. In addition to CH_4 and CO_2, it also contains H_2S and suspended particulate impurities. Therefore, desulfurization and other purification treatments are required. The purified biogas can enter the generator system for power generation.

- Aerobic composting process

The biogas residue after solid-liquid separation is transported to the aerobic composting workshop to be mixed with high-efficiency microbial fermentation bacteria.

The project uses fermentation to treat feces and sludge. The stacked static composting process is a common aerobic fermentation system that involves stacking and composting mixed raw materials into long strips or stacks, and carrying out natural decomposition under aerobic conditions.

Table1-2 The main technical parameters of equipment involved in this project

Swine Farm Name	Wangzhai Swine Farm
Livestock population	Market Swine:50,000
Treatment of capacity of AWMS(m^3/a)	30000
Baseline anaerobic lagoon	
Size of baseline anaerobic lagoon (m^3)	45900
Technical life	Not less than 20 years
Covered storage lagoon	
Total size of anaerobic lagoon (m^3)	77750
Number of lagoons	10
Technical life	Not less than 20 years
Covered anaerobic lagoon	
Design capacity (m^3)	30000
Anaerobic technology	Black membrane biogas digester
Stay time (day)	30
Fermentation temperature (℃)	25
Equipment Quantity	2
Equipment technical life	Not less than 20 years
Flared system	
Treatment capacities (m^3/h)	50
Height (m)	3
Equipment Quantity	1
Equipment technical life	Not less than 20 years
Generator sets	

Rated power	200kw
Design power generation efficiency	92%
Equipment Quantity	1
Equipment Technical life	Not less than 20 years

1.13 Project Location

The project is located at Wangzhai Village, Xiyi Township, Longyi District, Baoshan City, Yunnan Province, P.R. China. The central geographical coordinates of the project site are longitude 99°16′ 32″ E and latitude 24°56′ 15″ N. Figure 1.1 shows the location of the Project.

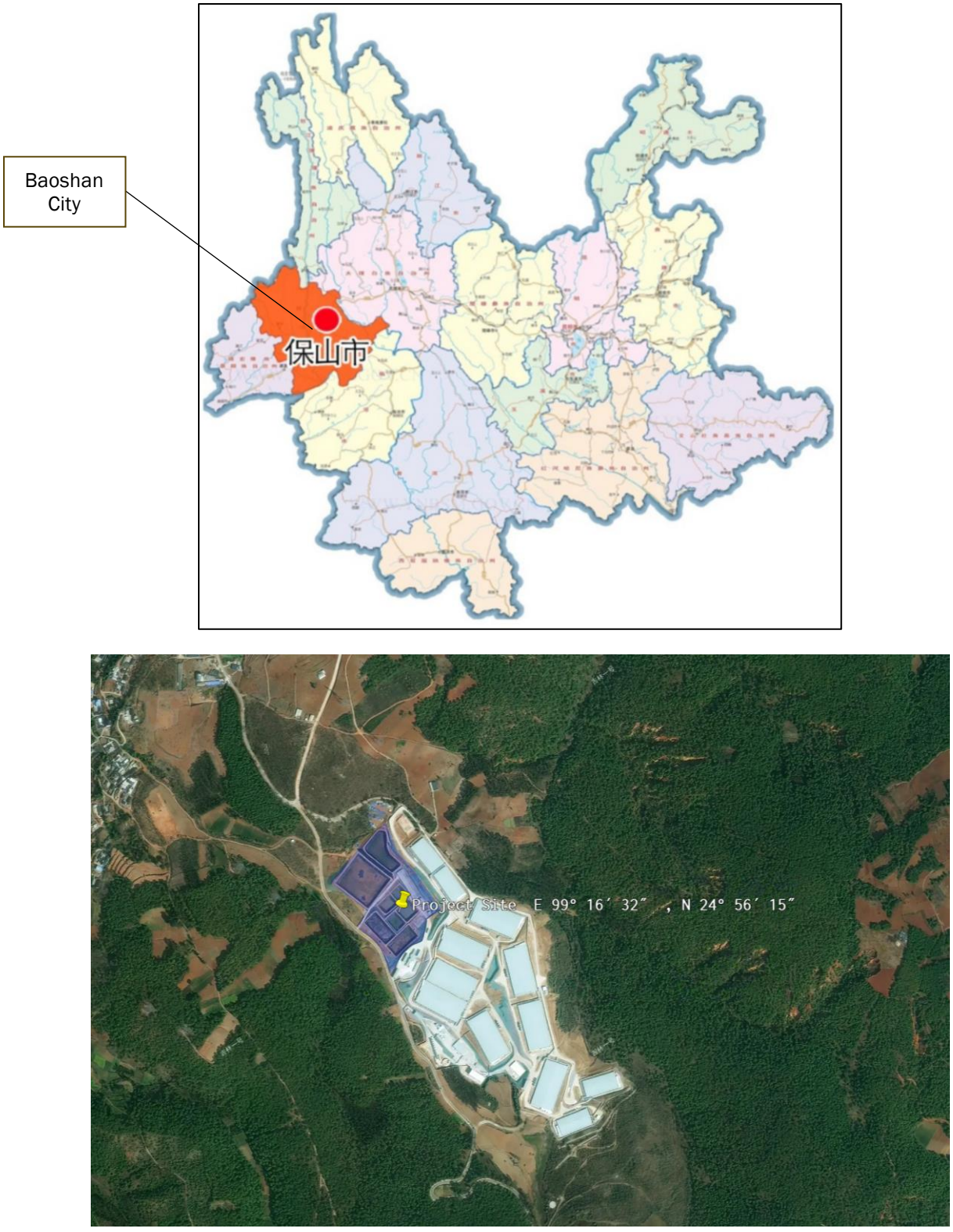

Figure 1-2 The geographic location of the project

1.14 Conditions Prior to Project Initiation

The project is a Greenfield project. There are no project activities at the project sites before the construction of the proposed project activities.

In absent of the project implementation, the animal manure waste would be left to decay in anaerobic manure management system (uncovered open lagoon) at the livestock farm and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. The baseline scenario is the same as the conditions assumed without the project initiation. Refer section 3.4 of the PD for detailed baseline scenario.

1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project complies with all Chinese relevant laws and regulations, which mainly includes:

No.	Laws and Regulations	Laws and Regulations
1	Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution.	Clause 65 of the Law stipulates, "Those engaged in large-scale livestock and poultry breeding shall promptly collect, store, utilize, or dispose of solid waste such as livestock and poultry manure generated in the breeding process to avoid environmental pollution." The project is to build a centralized animal waste treatment system, which fully complies with the Law.
2	Regulations on the prevention and control of pollution from large-scale livestock and poultry breeding.	The regulation requires the implementation of effective measures, such as scientific feeding methods and waste treatment technologies, to reduce the amount of waste generated by livestock and poultry farming and the amount of pollutants discharged into the environment. This project utilizes a black membrane anaerobic digester to treat pig farm manure, which fully complies with regulatory requirements.
3	Catalog for the Guidance of Industrial Structure Adjustment (2013 revision).	The Guidance encourages the construction and operation of large-scale biogas projects using waste from animal farms as raw materials. This project uses black film anaerobic digesters to treat pig manure in pig farms and recovers the biogas for energy utilization, which fully complies with the requirements of the Guidance.
4	Environmental Protection Law of the	According to the requirements of the Environmental Protection Law of the People's Republic of China for construction projects, environmental impact assessment must be carried out for

	People's Republic of China.	construction projects, and environmental protection measures must be taken in strict accordance with the evaluation results. In addition, construction projects must obtain approval from environmental protection authorities and strictly comply with relevant environmental protection laws and regulations. The project has completed the environmental impact assessment according to the regulations and strictly implemented the environmental protection measures required by the EIA document. Construction of the project has also been approved by the local environmental protection bureau.
5	Law of the People's Republic of China on Environmental Impact Assessment.	According to the Environmental Impact Assessment Law of the People's Republic of China, the provisions on construction projects mainly include the following: construction projects must carry out an environmental impact assessment in accordance with the law; Construction units must submit environmental impact assessment reports in accordance with regulations and accept the review and supervision of relevant departments; Environmental impact assessment reports must be made public and subject to public supervision and participation; Construction projects must be designed, constructed, and operated in accordance with the conclusions of the environmental impact assessment to ensure that the project does not have a serious impact on the environment. Environmental impact assessment has been carried out, and the project has been approved by the local ecological environment bureau. Environmental impact assessment documents were made public prior to approval. The project is designed, constructed, and operated in accordance with the conclusions of the EIA document.

The project obtained the EIA approval from governmental authorities: Baoshan Ecological Environment Bureau. The approval well demonstrates that the local government permits the construction of the project. Consequently, the project is in compliance with laws, statutes, and other regulatory frameworks.

1.16 Double Counting and Participation under Other GHG Programs

1.16.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

1.16.2 Registration in Other GHG Programs

Has the project registered under any other GHG programs?

☐ Yes ☒ No

Is the project active under the other program?

☐ Yes ☒ No

1.16.3 Projects Rejected by Other GHG Programs

Has the project been rejected by any other GHG programs?

☐ Yes ☒ No

1.17 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.17.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ No

1.17.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

1.17.3 Supply Chain (Scope 3) Emissions

Do the project activities specified in Section 1.12 affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

1.18 Sustainable Development Contributions

The project activity implemented by the project owner is beneficial to the environment, society, and economy by avoiding GHG emissions of methane through the recovery and destruction of

biogas. Thus, it contributes to achieving the United Nations Sustainable Development Goals (SDGs). The specific analysis is as follows:

SDG Goal 7: Affordable and Clean Energy

The biogas generated during the treatment process is captured for electricity generation. The electricity generated is used entirely for AWMS. By recycling and combusting biogas, the project can achieve emission reduction and provide clean energy. The biogas production is estimated to be $6.04*10^4$ m^3 annually. This contributes to one of China's actions for promoting sustainable development: "By 2030, increase the share of non-fossil fuels in primary energy consumption to about 20 percent."

SDG Goal 8: Decent Work and Economic Growth

Some temporary and permanent job opportunities are created during the construction and operation period of the project. Of these, 40 are permanent jobs for local residents. Hence, the project not only brings local residents decent work and income, but also brings the owner revenue from carbon credits.

SDG Goal 13: Climate Action

The project activity will reduce GHG emissions in the atmosphere by avoiding methane emissions from the anaerobic treatment of swine manure. If the project is not implemented, the animal manure waste would be left to decay in an uncovered open lagoon at the livestock farms, and methane would be emitted directly into the atmosphere without any methane recovery and destruction facility. It is estimated that 75513 tCO_2e emission reductions can be produced annually.

1.19 Additional Information Relevant to the Project

1.19.1 Leakage Management

The leakage involved in this project includes the leakage of anaerobic digestion in a digester and the leakage of organic fertilizer into the soil. The project participants have no authority, intervention, or control over the leakage of organic fertilizer into the soil. Moreover, this leakage has been included in the emission reductions calculation as per the applied methodology and tool.

1.19.2 Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description report.

1.19.3 Further Information

Not applicable.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification

The stakeholders have been identified as individuals who will be directly or indirectly impacted due to the project activity. Direct stakeholders are those deemed to either have a direct influence on the project or be directly influenced by the project, including but not limited to the original staff of the swine farms and local residents. The indirect stakeholders mainly include the consultant and other third-party agencies of the project.

Stakeholder Description:

Stakeholder Category	Direct/Indirect Affected Direct	Relevance to the Project Activity
The staff of the swine farm	Direct	The project provided jobs for them.
Local residents around the project site	Direct	It can provide them with new jobs and organic fertilizer.
Local government, including the Development and Reform Commission, the Ecological Environment Bureau, and the Agriculture and Rural Affairs Bureau.	Direct	Approval for construction and operation of the AWMSs. Daily supervision of the normal operation of the swine farms.

Legal or customary tenure/access rights

The project is located in rural areas. According to the Land Administration Law of the People's Republic of China, the land in rural areas and urban suburbs is owned collectively by peasants,

	except for those owned by the state as stipulated by law. The village committee is the legal representative of the peasants' collective land owners. The project land is leased by the villagers to the project owner in the project location by signing a lease agreement with a term of 20 years, as evidenced by the land lease agreement signed by the project supporter and the local village committee. All the villagers are informed and agree to this, and the attached lease contract contains a written document signed by the villager representative recommended by the local villagers, as well as a document of the contract farmers involved in the project land agreeing to the village committee to lease the project contractor. There is no uncertainty or change in land tenure arrangements, resource access rights, community-based property rights and customary rights, access rights, or land ownership.
Stakeholder diversity and changes over time	Stakeholder diversity: The staff of the swine farm, the local residents around the project site, and the local government are affected by the project activity directly. Farm employees are mainly from the project area, and they have different levels of education and skills, and income levels may vary. The farmers around the project live in different villages, and they may have different social networks and ways of interacting. The economic situation of farmers is greatly affected by the type of crop grown and the quality of the harvest. Workers in government departments may come from different backgrounds and have different expertise and experience. Government authorities are responsible for regulating and approving the operation of pig farms and AWMS, and different government authorities may have different policies and regulations. Over time, the members of each group will adjust, but their groups will not change much in terms of society, economy, culture, etc.
Expected changes in well-being	The implementation of the project is expected to have a positive impact on the well-being and other characteristics of stakeholders. Relative to the baseline scenario of an open anaerobic pond, the project will bring about the following changes: Villagers' well-being: As the project will provide organic fertilizers to be sent to the surrounding villagers free of charge, it will help

	improve the yield and quality of crops and enhance the ecosystem of croplands. Social welfare: The implementation of the project will promote local economic development, provide employment opportunities, increase agricultural production, and contribute to the prosperity of the rural economy. Environmental well-being: This project activity reduces methane emissions in the atmosphere by capturing and destroying methane, thereby reducing the impact of greenhouse gases on the climate.
Location of stakeholders	This project is a pig manure treatment project located in a rural area, not in a town or urban residential area. It is expected that nearby pig farms and villages will be affected by the project, including Wangzhai Village, Xiyi Township, Longyi District, Baoshan City, Yunnan Province, China. The stakeholders, IPs (Indigenous Peoples), LCs (Local Communities), and customary right holders in the project area are primarily located in Wangzhai Village, Xiyi Township, Longyi District, Baoshan City, Yunnan Province, P.R. China. These individuals and groups have a direct interest in the management of fecal waste in the area and will be directly impacted by the project. Additionally, there are areas outside the project area that are predicted to be impacted by the project. These may include neighboring villages, agricultural lands, water sources, and ecosystems that could be affected by the management of fecal waste in Wangzhai Village. It is important for the project to consider and mitigate any potential impacts on these areas.
Location of resources	The location of territories and resources which stakeholders own or to which they have customary access are located in Wangzhai Village, Xiyi Township, Longyi District, Baoshan City, Yunnan Province, P.R. China.

2.1.2 Stakeholder Consultation and Ongoing Communication

Date of stakeholder consultation	10-February-2021

Stakeholder engagement process	In advance of the meeting, public announcements and telephone invitations were carried out to inform the stakeholders of project information, contact information, meeting notice, etc. The date of the stakeholder meeting is February 10, 2021. The language used in the meeting is Mandarin and its dialect so that stakeholders can clearly understand and fluently communicate with each other. The participants who attend the meeting, depending on their positions rather than gender, are both men and women. During the meeting, the project proponent explained the potential risks, costs, and benefits the project may bring to stakeholders. They also discussed the project design and implementation, FPIC, and the VCS validation and verification process. In addition, a questionnaire survey was conducted among local residents. The survey was conducted by distributing and collecting responses to a questionnaire. The questionnaire investigated the impact of the project on the local area from the aspects of the environment, economy, and employment, as well as whether the surveyed people supported the project construction. About 30 people participated, and gender sensitivity was ensured by the equal participation of men and women in the questionnaire. The questionnaires were returned with a 100% response rate.
Consultation outcome	The overall response to the project from all invited stakeholders was encouraging and positive for local communities, seen as improving socio-economic conditions. There were no adverse reactions, comments, or clarifications received during the stakeholder consultation process. There were also no comments or issues raised regarding the need to make any changes to the project design. The outcomes of the survey, summarized as follows, also indicate this point.

No.	Question	Answer	Amount
1	Do you support this project?	Yes	30
		No	0
		Don't care	0
2	Do you think this project has a negative	Yes	0
		No	30

		impact on the local environment?	No idea	0
	3	What do you think is the impact of implementing this project on the lives of local people?	Positive	30
			Negative	0
			None	0
	4	What impact do you think the proposed project will have on local employment?	Positive	30
			Negative	0
			None	0
	5	Do you think the proposed project will benefit the local economy?	Yes	30
			No	0
			No idea	2
	6	Do you think other regions should also vigorously promote this type of technology?	Yes	29
			No	0
			No idea	1
	7	In general, what is your attitude towards the Project construction?	Supportive	30
			Against	0
			Indifferent	0
	8	Do you think other regions should also vigorously promote this type of project?	Yes	29
			No	0
			No idea	1
Ongoing communication	Except for introducing the project information, the grievance mechanism was also explained during the local stakeholder consultation meeting. A grievance expression book will be placed in the project office, which will be used to collect stakeholders' views about the project.			

	The project proponent will regularly check the comments in the book and record responses. The project information, along with contact information, has also been posted on the announcement board at and near the project site. Every stakeholder can make comments either through the grievance expression book or by telephone. The project proponent will respect the views of stakeholders and suggest alternative solutions or compromises whenever possible. Regular communication with local stakeholders will occur through stakeholder consultation meetings, where the project operation, benefit distribution and sharing mechanism, communication and cooperation mechanism, monitoring and evaluation mechanism, etc., will be fully discussed. During this process, stakeholders can raise any problems existing in the project. In response to the problems raised by stakeholders, the two sides can exchange solutions and improvement measures, and determine improvement measures and action plans.
Stakeholder input	The project did not receive any major negative input during the consultation. The project would actually facilitate the development of the local economy and increase the income of local residents. All stakeholders were pleased with the development of the project.

2.1.3 Free Prior and Informed Consent

Obtaining consent	In order to obtain consent and reach a transparent agreement from the stakeholders involved in the implementation of the project activities in Wangzhai Village, Xiyi Township, Longyang District, Baoshan City, Yunnan Province, China, including IPs, LCs, and customary rights holders, we conducted a comprehensive and transparent consultation process. This included holding community meetings, individual discussions, and soliciting input from relevant community leaders and representatives. Before project construction and implementation, all stakeholders expressed their approval for the construction and implementation of the project. During these consultations, PP provided detailed information about the project, including the nature, scale, speed, reversibility, and scope of the proposed project or activity; the reason or purpose of the project and/or activity; duration of project activities; locations that will be affected; and a preliminary assessment of economic, social, cultural, and environmental impacts, including potential risks and fair and equitable benefit-sharing, respecting the precautionary

	principle. In addition, we actively listen to concerns and feedback from our stakeholders and address any questions or concerns raised. Through this process, we were able to reach a transparent agreement with the community on the implementation of project activities. In addition, PP has been monitoring the situation in the community to identify any ongoing or unresolved conflicts that may be affected by the project. We take active steps to ensure that projects do not exacerbate or influence the outcome of these conflicts. This includes ongoing dialogue with communities and a commitment to adapt our approach as needed to avoid any negative impact on local dynamics.
Outcome of FPIC	The land used for this project is agricultural land, which does not occupy villagers' residential land or permanent basic farmland, nor is it located in prohibited breeding areas as stipulated by laws and regulations. It has been approved by the Agricultural and Rural Bureau of Longyang District, Baoshan City. Therefore, this project does not involve land encroachment, involuntary resettlement of residents, or forced relocation. Prior to the commencement of the project, adequate communication was conducted with the local villagers, including the key project schedule, project details, environmental protection, carbon development, risks, benefits, etc. These have been disclosed and fully communicated in advance. All relevant arrangements are made with the free, prior, and informed consent of stakeholders. All stakeholders expressed full support for the project.

2.1.4 Grievance Redress Procedure

Development process	In order to resolve complaints related to the project, we have developed a complaint resolution process with stakeholders to ensure fair, transparent, and timely processing. Here are the grievance resolution steps we have developed in partnership with our stakeholders: 1. Receiving Complaints: Any complaints related to the project will be received and recorded. The project owner has placed a comment book in the front office of the company and posted the contact person's name and contact information for stakeholders to submit complaints, either in writing, orally, or through a designated contact person.

	2. Hearing: Once a complaint is received, we will schedule a hearing or meeting so that stakeholders can express their views and concerns. This will provide an open platform to ensure that all relevant information is fully considered. 3. Response: Following the hearing or meeting, we will provide a written response confirming that we have understood and documented the stakeholder's complaint and explaining the actions we will take. This will ensure transparency and continuity of communication. 4. Resolution of Complaints: We will use our best efforts to resolve complaints within a reasonable period of time. This may include adopting appropriate conflict resolution methods, such as mediation, negotiation, or other suitable solutions. We will work with stakeholders to ensure they are satisfied with the solution. These complaint resolution steps will ensure that we are able to address any project-related complaints in a timely and fair manner while respecting the rights and concerns of our stakeholders.
Grievance redress procedure	The procedure for resolving complaints is as follows: 1. The Project Proponent shall first attempt to proactively communicate and solve the problems of stakeholders through friendly negotiation and provide a culturally appropriate written reply after both parties have reached an agreement on the solution. 2. Any problem that cannot be settled through friendly negotiation shall be mediated by a third party, such as the village committee. 3. If no settlement can be reached through third-party mediation, it shall be submitted to arbitration to the extent permitted by the law of the relevant jurisdiction or to the competent court of the relevant jurisdiction, without prejudice to the ability of a party to submit a complaint to a competent supranational adjudication body (if any).

2.1.5 Public Comments

The project is going to open for public comment on the VERRA website

Comments received	Actions taken
N/A	N/A

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

Shanghai East Hope Animal Husbandry Co., Ltd. is a modern livestock breeding company that supplies over one million market swine each year. They operate numerous swine breeding farms in China, some of which utilize black membrane anaerobic biogas technology to treat swine manure. The company's employees possess extensive management experience. The project initiator, Baoshan East Hope Animal Husbandry Co., Ltd., is a wholly-owned subsidiary of Shanghai East Hope Animal Husbandry Co., Ltd. Consequently, the team has a wealth of professional knowledge in the operation and maintenance of AWMS for similar projects.

2.2.2 Risk Assessment

	Risks identified	Mitigation or preventative measure(s) taken
Natural and human-induced risks to stakeholders' wellbeing	No risk identified	The implementation of the proposed project can not only avoid the emission of methane into the atmosphere and provide free liquid digestate for the villagers but also provide job opportunities and contribute to the local economy. Therefore, it doesn't involve risks to stakeholders' well-being.
Risks to stakeholder participation	No risk identified	According to the project land lease contract, the project leased land conforms to the local environmental protection planning, is not in the forbidden zone, restricted zone, environmental red line planning area, and does not contain basic farmland. And The owner of the project paid enough rent. As a result, the project has no impact on food security, land loss, yield loss, livelihoods of the local population and climate change.
Working conditions	No risk identified	The project has strictly implemented national and industry regulations and standards on labor safety and health, as well as Chinese labor law and local requirements. Mitigation measures have been undertaken as per the approved EIA, and regular occupational health and safety testing is carried out every year to ensure a safe and healthy working environment.
Safety of women and girls	No risk identified	This program does not admit underage girls.

		In the design phase of the project, the safety of women was taken into account, and corresponding preventive measures were taken. For example, safe sanitation facilities were established to ensure that women are not subjected to gender discrimination or gender-based violence in the management of their feces. During the implementation of the project, all personnel involved in the project are regularly trained in gender sensitivity, including awareness of gender discrimination and gender-based violence, and how to prevent and respond to these issues. The project has established effective monitoring and reporting mechanisms so that women can report any safety issues or acts of gender discrimination, ensuring that their voices are adequately addressed and protected.
Safety of minority and marginalized groups, including children	No risk identified	Project activities will provide equal job opportunities, will not discriminate against marginalized groups, and will try to provide social support and assistance for local marginalized groups. The project does not recruit child workers. Therefore, the project does not pose a risk to marginalized groups, including children.
Pollutants (air, noise, discharges to water, generation of waste, and release of hazardous materials and chemical pesticides and fertilizers)	No risk identified	According to the EIA report, the proposed project may involve air pollutants, noise pollutants, and water pollutants. However, all of these satisfy the relevant regulations and laws. **Air pollution** To cover and seal the pre-treatment area of the sewage treatment plant, and to collect and import the waste gas into the harmless treatment equipment, a "spray + biofilter" deodorization system is used for treatment, and it is discharged through a 15m high exhaust pipe. In addition, deodorants are regularly sprayed around the sewage treatment system and evergreen shrubs are planted to reduce the spread of odor. The composting workshop is housed in a semi-enclosed building and utilizes biological strains such as Bacillus and Actinobacteria to minimize

		the generation of foul odors. Additionally, measures such as spraying deodorizers are implemented to reduce the emission of unpleasant smells from the composting workshop. **Noise pollution** Noise during the construction period is mainly generated by the construction machineries and vehicles. Use advanced low-noise equipment as much as possible, and construction is prohibited at night. Corresponding noise reduction, sound insulation, and shock absorption measures shall be adopted for noise sources. **Water waste** The wastewater during the construction period of the project is mainly generated from the domestic sewage of construction workers, groundwater during foundation excavation, and rinsing water after pouring concrete. Oil separation and sedimentation tanks should be set up on the construction site so that the production wastewater can be reused for construction after oil separation and sedimentation. The groundwater and rinsing water will be intercepted and treated centrally. The domestic sewage can be collected in a septic tank and treated centrally, and then used as fertilizer for the surrounding farmland after precipitation and clarification. Therefore, the wastewater generated during the construction of the project has little impact on the surrounding environment.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

	Risks identified	Mitigation or preventative measure(s) taken
Discrimination	No risk identified.	Any discrimination based on any ground such as race, nation, ethnic group, sex, or religion is prohibited in the job market by the Labor Law of

		the People's Republic of China. The project abides by the rules of equality and does not involve, nor is it complicit in, any form of discrimination. To prevent discrimination, every employee receives anti-discrimination training prior to entry.
Sexual harassment	No risk identified.	Sexual harassment is prohibited. China has published the "Women's Rights Protection Law," which could prevent such phenomena. The company has a policy against sexual harassment, and there are penalties for such behavior.
Equal pay for equal work	No risk identified.	The salaries of employees are related to the position and level. Equal pay for equal work can be proven by the employees' pay slips provided.
Gender equity in labor and work	No risk identified.	The project has both male and female employees of different genders. There are no significant gender differences between female employees and male employees in terms of salary, promotion opportunities, and welfare benefits. Employees of different genders have equal opportunities to obtain training and development resources. In regular employee satisfaction surveys, all employees feel that the project treats them equally in terms of gender and pay.
Forced labor	No risk identified.	The project proponent strictly abides by labor laws, established reasonable labor safeguards to protect the working environment and hours of employees, and ensure that employees are not forced to work. The project is supervised by local labor authorities.
Child labor	No risk identified.	China has published protection laws on minors. Employment regulations are described in this law. The project requires skilled employees to operate, maintain, and manage the power plant. Therefore, the project does not employ and is not complicit in any form of child labor. According to the employee list, it can be confirmed that the project does not employ any child labor.

Human trafficking	No risk identified.	The project proponent strictly abides by the labor law. The project proponent will verify the identity of the employees, and if unidentified workers are found, the project proponent will report to the local police.

2.3.2 Human Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	Human rights protection is formally embodied in the regulations in China. China fully recognizes international human rights law, including the United Nations Declaration on the Rights of Indigenous Peoples and ILO Convention 169 on Indigenous and Tribal Peoples. China has its own legislation prohibiting the violation of human rights principles, and it actively enforces compliance with such principles. China has ratified two UN human rights treaties: the International Covenant on Civil and Political Rights and the International Covenant on Economic, Social, and Cultural Rights. China has published relevant regulations and practices in line with the treaties, such as the Labor Law. This project does not discriminate with regards to participation and inclusion. The project abides by the rules of equality accordingly and does not involve, nor is it complicit in any form of discrimination. Specific to gender equality, detailed enforcement rules are regulated in the "Women's Rights Protection Law" to provide support and benefits to women. The project proponent and its activities are strictly regulated by local and national regulations, which obligate the project activities to be in line with international human rights law and conventions. The legal approval by authorities demonstrates that the project does not and will not violate the regulations. According to the relevant provisions of the Labor Law and Women's Rights Protection Law of China, the project continues to recognize, respect, and promote the protection of the rights of IPs, LCs, and customary rights holders.

2.3.3 Indigenous Peoples and Cultural Heritage

Risks identified	Mitigation(s) or preventative measure taken

No risk identified.	According to the EIA report, no indigenous peoples present in or within the area of influence of the project. And the project area does not include sites, structures, or objects with historical, cultural, artistic, traditional or religious values or intangible forms of culture.

2.3.4 Property Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified.	This project has received approval from the local government. The project will not generate any risks related to the protection and maintenance of intellectual property rights, limited liability companies, and customary rights holders' property rights, as well as the protection of territorial, property, and resource rights/usage rights.

2.3.5 Benefit Sharing

Process used to design the benefit sharing plan	Not applicable, as the project does not impact any property rights.
Summary of the benefit sharing plan	Not applicable, as the project does not impact any property rights.
Approval and dissemination of benefit sharing plan	Not applicable, as the project does not impact any property rights.

2.4 Ecosystem Health

	Risks identified	Mitigation or preventative measure(s) taken
Impacts on biodiversity and ecosystems	No risk identified.	According to EIA, the project does not involve impacts on biodiversity and ecosystems.
Soil degradation and soil erosion	No risk identified.	According to the EIA, the project has no significant impact on the soil.

Water consumption and stress	No risk identified.	According to the EIA, the project has no significant impact on water stress.

2.4.1 Rare, Threatened, and Endangered Species

Is the project located in or adjacent to habitats for rare, threatened, or endangered species?

☐ Yes ☒ No

2.4.2 Introduction of Species

Species introduced	Classification	Justification for use	Adverse effects and mitigation
N/A	N/A	N/A	N/A

Existing invasive species	Mitigation measures to prevent the spread or continued existence of invasive species
N/A	N/A

	Risks identified	Mitigation or preventative measure(s) taken
Invasive species	No risk identified.	N/A

2.4.3 Ecosystem Conversion

	Risks identified	Mitigation or preventative measure(s) taken
Ecosystem conversion	No risk identified.	Not applicable as the project is not a ARR, ALM, WRC or ACoGS project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version

Methodology	ACM0010	ACM0010: GHG emission reductions from manure management systems[2]	8.0
Tool	Tool 02	Tool 02: Combined tool to identify the baseline scenario and demonstrate additionality[3]	7.0
Tool	Tool 05	Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation[4]	3.0
Tool	Tool 06	Tool 06: Project emissions from flaring[5]	4.0
Tool	Tool 07	Tool 07: Tool to calculate the emission factor for an electricity system[6]	7.0
Tool	Tool 08	Tool 08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream[7]	3.0
Tool	Tool 14	Tool 14: Project and leakage emissions from anaerobic digesters[8]	2.0
Tool	Tool 24	Tool 24: Common practice[9]	03.1

3.2 Applicability of Methodology

Methodology ID	Applicability condition	Justification of compliance
ACM0010	This methodology applies to project activities that include destruction of	For this project, the AWMS was installed in a swine farm in order to

[2] https://cdm.unfccc.int/methodologies/DB/99QRTE6N5QJEBOV2XP374B25SSIXBB

[3] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-v7.0.pdf

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-v3.0.pdf

[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-v4.0.pdf

[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-07-v7.0.pdf

[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-v3.0.pdf

[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v2.pdf

[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf

	methane emissions and displacement of a more GHG intensive service in manure management of livestock farms by introducing a new animal waste management system or a combination of animal waste management systems that result in less GHG emissions.	treat the manure and wastewater from the swine farm, avoiding methane emissions generated in the baseline uncovered anaerobic lagoon. The biogas generated during the treatment process will be collected for electricity generation. All the electricity will be used for the operation of the AWMS and will not be used outside of the project boundary.
ACM0010	This methodology is applicable to manure management on livestock farms where the existing anaerobic manure treatment system, within the project boundary, is replaced by one or a combination of more than one animal waste management systems (AWMSs) that result in less GHG emissions compared to the existing system. The methodology is also applicable to Greenfield facilities.	It is a Greenfield project; one set of AWMS was installed on a swine farm in order to treat the manure and wastewater, which avoids methane emissions generated in the baseline uncovered anaerobic lagoon.
ACM0010	This methodology is applicable to manure management projects under the following conditions: (a) Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions; (b) Farms where manure is not discharged into natural water resources (e.g., rivers or estuaries); (c) In case of anaerobic lagoons treatments systems, the depth of the lagoons used for manure management under the baseline scenario should be at least 1 m; (d) The annual average ambient temperature at the site where the anaerobic manure treatment facility	(a) The owner of the project is a professional large-scale pig breeding enterprise. The swine farm of the project has obtained the Animal Epidemic Prevention Certificate issued by the local government, and the livestock housing layout must be reasonable as per the requirements of this license. Therefore, all swine are managed under confined conditions. (b) The wastewater in the production process of this project will be treated and used for irrigation after meeting the relevant standards in the Discharge Standard of Pollutants in Livestock and Poultry Industry (GB18596-2001) and the Water Quality Standard for Farmland Irrigation (GB5084-2005)

	in the baseline existed is higher than 5 ℃; (e) In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is greater than one month; (f) The AWMS(s) in the project case results in no leakage of manure waste into ground water, for example the lagoon should have a non-permeable layer at the lagoon bottom.	and will not be discharged into natural water bodies. (c) The open anaerobic lagoons in the baseline scenario are designed for deep storage and have a depth of 3-5 meters in accordance with the "Design Code for Wastewater Stabilization Ponds" (GJJ/T54-93)[10]. (d) The annual average ambient temperature at the site is 17 ℃ , which is higher than 5℃. (e) According to the latest Notice on the Issuance of Technical Guidelines for the Construction of Manure Treatment Facilities for Livestock and Poultry Farms (Households) (Nong ban mu [2022] No. 19), the minimum retention time of manure waste in the open anaerobic lagoons is not less than 180 days[11]. So, at baseline, the minimum retention time of manure waste in the anaerobic treatment system is greater than one month. (f) In this project case, the related equipment built in AWMS includes closed anaerobic digestion tanks, as well as other facilities such as impermeable film anaerobic biogas tanks, aerobic reaction tanks, effluent tanks, and sludge stacking yards. All of them incorporate leak prevention techniques and impermeable materials. Therefore, it is impossible for manure and waste to leak into groundwater.
Tool 02	The tool is applicable to all types of proposed project activities. However,	The project is included in all types of proposed project activities.

[10] http://www.weboos.cn/assets/basicStandard/std_770.pdf

[11] http://www.moa.gov.cn/nybgb/2022/202209/202210/t20221010_6412911.htm

	in some cases, methodologies referring to this tool may require adjustments or additional explanations as per the guidance in the respective methodologies. This could include, inter alia, a listing of relevant alternative scenarios that should be considered in Step 1, any relevant types of barriers other than those presented in this tool and guidance on how common practice should be established.	Alternative scenarios, barrier analysis, investment analysis, and common practice analysis will be carried out based on Tool 02.
Tool 05	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	The project uses electricity from the China Southern Power Grid (CSPG), which falls under scenario A of Tool 05 (Version 03.0). Therefore, emissions related to electricity consumption need to be calculated based on Tool 05.

	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.	
Tool 05	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: Scenario I: Electricity is supplied to the grid; Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.	This methodological tool is applied for calculating project emissions by electricity consumption in project activity. However, the electricity used for the operation of AWMS is generated from the recovered biogas, and the emission is not accounted for. Therefore, this criterion is not relevant.
Tool 05	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.	Tool 05 is only used to calculate project emissions of electricity consumption supplied by CSPG. Only CO_2 emissions will be accounted.
Tool 06	This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.	For this project, one enclosed flare is constructed in AWMS.
Tool 06	This tool is applicable to the flaring of flammable greenhouse gases where:	For this project, the source of the residual biogas is gas from a

	(a) Methane is the component with the highest concentration in the flammable residual gas; and (b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g., biogas, landfill gas or wastewater treatment gas).	biogenic source (Anaerobic treatment process). According to the EIA report of the project, methane accounts for 60% of the biogas, which is the highest concentration in the flammable residual gas.
Tool 06	The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare.	No auxiliary fuels are used by the flaring system. According to the EIA report for the project, methane accounts for 60% of the biogas, which has sufficient flammable gas.
Tool 07	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).	The project activity consumes electricity that would have been provided by the grid. Therefore, this tool is applied to estimate the OM, BM, and CM for power emissions.
Tool 07	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	There is no off-grid power plant in China, so the emission factor for the project electricity system is calculated only for the grid power plants, which satisfies this applicability criterion.

	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.	
Tool 07	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.	The project is not the CDM project, nor located in an Annex I country.
Tool 07	Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.	No biofuels involved in the calculation of CO_2 emission factor of the grid.
Tool 08	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 amount of biogas produced from anaerobic digestion will be collected and monitored.
Tool 08	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.	The biogas generated during the treatment process includes CH_4, H_2S, CO_2, etc. Therefore, this tool is adopted for determining the mass flow of greenhouse gases.
Tool 08	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;	a) $Q_{CH4,y}$ is determined using the tool; b) CH_4 is the greenhouse gases for which the mass flow should be determined. The mass flow is determined in the monitoring plan.

	(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 N_2).	c) The flow of the gaseous stream is measured continuously. d) The gaseous stream is dry, equation (18) and (19) are used to calculate the mass flow of greenhouse gas.
Tool 14	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.	Electricity will be used during the operation of the anaerobic digester, and the anaerobic digestion process of this project does not involve the use of fossil fuels. As the biogas produced in the AWMS will all be collected for electricity, part of the biogas will only be discharged after burning through the flare in the event of a boiler system failure. So there's no methane burning in the calculation. During the monitoring period, the amount of biogas burned will be monitored to calculate emissions (if any). Hence the project considers the emission source of (a), (c), (d)
Tool 14	The following sources of leakage emissions are accounted for in this tool: (a) CH_4 and N_2O emission from composting of 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.	All the biogas produced during the treatment process will be captured for electricity without leakage. After anaerobic digestion, the fermented sludge is treated in an aerobic composting system and used as fertilizer. No additional sewage treatment plant or compost was used to store the sludge. Therefore, anaerobic digester-related leakage emissions ($LE_{AD,y}$) should not be considered in this project.

Tool 14	Emission sources associated with N_2O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid digestate and land application of the digestate are neglected because these are minor emission sources or because they are accounted in the methodologies referring to this tool.	Emission sources associated with N_2O emissions from physical leakages from the digester, transportation of feed material and digestate, or any other on-site transportation, piped distribution of the biogas, anaerobic treatment of liquid digestate, and land application of the digestate are neglected because these are minor emission sources.
Tool 24	This methodological tool is applicable to project activities that apply the methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality.	The latest version of the Combined tool to identify the baseline scenario and demonstrate additionality is applied to identify the baseline scenario by the project.
Tool 24	In case the applied approved baseline and monitoring methodology defines approaches for the conduction of the common practice test that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	The latest version of the combined tool to identify the baseline scenario and demonstrate additionality is referred to as methodology ACM0010.

3.3 Project Boundary

The greenhouse gases included or excluded from the project boundary are summarized in table 3-1 below.

Table 3-1 Emissions sources included in or excluded from the project boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from the waste treatment processes	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Yes	The major source of emissions in the baseline.
		N_2O	Yes	Direct and indirect N_2O emissions are accounted.
	Emissions from electricity consumption/ generation	CO_2	No	The anaerobic lagoon does not consume electricity.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
	Emissions from thermal Energy generation	CO_2	No	The anaerobic lagoon does not consume thermal energy.
		CH_4	No	Excluded for simplification. This is conservative.
		N_2O	No	Excluded for simplification. This is conservative.
Project	Emissions from the Waste treatment processes	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Yes	The emission from anaerobic digester and aerobic treatment.
		N_2O	Yes	Direct and indirect N_2O emissions are accounted.
	Emissions from on-site electricity consumption	CO_2	Yes	May be an important emission source. If electricity is consumed from the grid company.
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.
		CO_2	No	Excluded for simplification. This project does not use thermal energy.

Source		Gas	Included?	Justification/Explanation
	Emissions from thermal energy use	CH_4	No	Excluded for simplification. This project does not use thermal energy.
		N_2O	No	Excluded for simplification. This project does not use thermal energy.
	Emission sources from open flare system onsite	CO_2	Yes	CO_2 emissions from flaring of biogas. (The torch is only used in emergency in case of boiler failure and shutdown.)
		CH_4	No	Excluded for simplification.
		N_2O	No	Excluded for simplification.

As per ACM0010, the spatial extent of the project boundary encompasses the site of the AWMS, including the flare or energy and/or electricity generation equipment, and the power/heat source.

The proposed project boundary considers the GHG emissions that come from AWMSs, including the GHG emissions from anaerobic digestion, GHG emissions from sludge treatment by aerobic composting, GHG emissions from the electricity generation equipment, emissions generated by electricity consumption from the grid, and GHG emissions from the flaring system in the swine farm. The baseline boundary is shown in Figure 3-1 below.

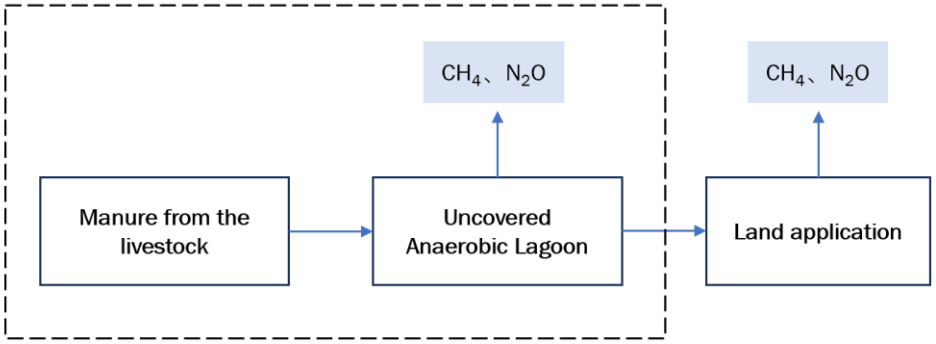

Figure 3-1 The baseline boundary

The project activity boundary is defined as figure 3-2 below:

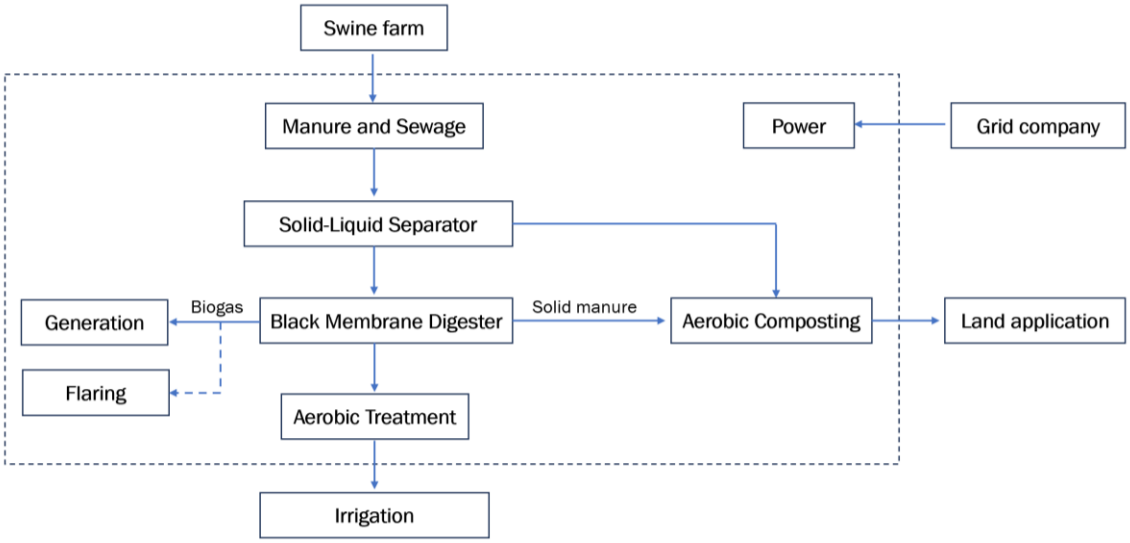

Figure 3-2 The project boundary

3.4 Baseline Scenario

Baseline scenario has been identified using the methodological tool 02 “Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)”.

The most plausible baseline scenario is identified in the following steps:

Step 0. Demonstration that a proposed project activity is the First-of-its-kind;

Step 1. Identification of alternative scenarios;

Step 2. Barrier analysis;

Step 3. Investment analysis (if applicable);

Step 4. Common practice analysis.

Step 0: As per TOOL 02 "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0), this step is optional. Therefore, it is not necessary to analyze this step.

Step1: Identification of alternative scenarios

Step 1a: Define alternative scenarios to the project activity

Without this project, all manure waste produced from the swine farm would have been left to decay in an uncovered anaerobic lagoon, and methane would be emitted directly into the atmosphere without any methane recovery and destruction facility. With the implementation of

the project, one set of AWMS was enabled in the swine farm. Therefore, it now belongs to the existing facilities.

According to the methodology, baseline alternatives for managing the manure shall take into consideration, among other things, the complete set of possible manure management systems listed in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10, Table 10.17).

The baseline and available alternatives for the manure management are listed as below table as 2019 Refinement to the 2006 IPCC Guidelines.

No.	IPCC Alternatives	Applicability	Justification
1	The manure is collected from the pasture /Range /Paddock	Not Applicable	The swine in this project is bred in confined barns rather than pasture/range/paddock, so this alternative is excluded.
2	Daily spread: Manure removed from confinement and applied to pasture within 24 hours of excretion.	Not Applicable	For a large-scale swine farm, it is highly labor-intensive that manure is routinely removed from a confinement facility and applied to cropland or pasture within 24 hours of excretion. Therefore, this alternative is not an economically attractive prospect. So, this alternative is excluded.
3	Solid Storage: The manure is disposed of by solid storage.	Not Applicable	This alternative involves the storage of manure, typically for a period of several months, in unconfined piles or stacks. It is only a storage method for manure, not a disposal method. In addition, it is suitable for small family farms. The proposed project involves a large-scale swine farm and the use of a scraping and flushing approach to remove manure that has large volumes of water. Therefore, this manure management system is not a potential alternative baseline scenario.
4	Dry lot	Not Applicable	Dry lot usually applies in an open confinement area. However, the swine in the project are housed in confined

			barns, which means the infrastructure to implement dry lot is not available. Therefore, this alternative is not applicable to the conditions of the farm in the project. So, this alternative is excluded.
5	The manure is disposed of as liquid/slurry.	Not Applicable	This method is only a storage method for manure, not a disposal method. Since the amount of discharged manure is very large on a daily basis, storing the liquid manure in a tank to distribute it to the farmland requires a lot of labor. Therefore, it is unrealistic to implement this task for farms competing in the market. Thus, this alternative is excluded.
6	Uncovered anaerobic lagoon	Applicable	As per the "Technical specification for sanitation treatment of livestock and poultry manure [12] ," an uncovered anaerobic lagoon is a type of harmless manure treatment that can meet this regulation. Since there is no legal requirement mandating livestock farm owners to utilize anaerobic digestion, aerobic, or other biological treatment methods, or to capture and/or utilize the methane produced at these lagoons, the uncovered anaerobic lagoon serves as an alternative baseline scenario.
7	Pit storage below animal confinements, <1month	Not Applicable	The farm involved in this project is a large-scale livestock farm, and the quantity of manure produced is too large to implement a pit storage structure under the barns. Additionally, removing the manure stored below animal confinements within 1 month

[12] https://oss.baigongbao.com/2020/12/14/MRyhTKQcWC.pdf

			requires a lot of labor work. Therefore, this scenario is excluded.
	Pit storage below animal confinements,>1month	Not Applicable	The farm involved in this project is a large-scale livestock farm and the manure quantity produced is too large to implement pit storage structure under the barns. In addition, the excreted volume accumulated under the barns produces enteric fermentation gas, if it is not discharged out of the barns in time, the pigs will be quickly killed by the accumulation of toxic fumes. So, this alternative is excluded.
8	Anaerobic digester (Anaerobic Digester-Aerobic Treatment system)	Applicable	A single Anaerobic digester is suitable for treating manure, but to implement such technology needs high investment compared to an Uncovered anaerobic lagoon, which is the most common and economic method. However, a single anaerobic process is not yet able to meet the requirements for the use of the waste and must be followed up with disposal, which requires the use of a combination of aerobic and anaerobic processes together. Thus, the project activity implemented a combine anaerobic digester-aerobic treatment system without being registered as a VCS project activity seems to be a plausible alternative without considering the investment analysis.
9	Burned for fuel	Not Applicable	The farm involved in this project is a large-scale swine farm, and the manure is flushed to the anaerobic digester. Therefore, the dung and urine of the project are not excreted on fields and the waste quantity is so large, it is

			unlikely to dry the dung before used as fuel. So, this alternative is excluded.
10	Cattle and Swine deep Bedding, <1month	Not Applicable	This method is only a storage method of manure, not a disposal method. The deep bedding is laborious, and this is counter to achieving economies of scale associated with large animal counts. The concentration of noxious gas in the bedding is high enough to poison swine if it is disposed inappropriately, and it is favorable for the survival and breeding of vermin and microorganisms due to its high temperature and humidity. So, this alternative is excluded.
	Cattle and Swine deep Bedding, >1month	Not Applicable	
11	Composting - In-vessel	Not Applicable	It is suitable to treat solid manure and is not applicable to manure with a large amount of water. Manure in this project is collected by using a scraping and flushing system. The manure in this project is in liquid form with a large volume of water. Therefore, this alternative is excluded.
12	Composting - Static pile	Not Applicable	Composting in piles with forced aeration but no mixing will consume a great deal of electricity for forced aeration because of the large quantity of swine manure. It is suitable to solid treat manure, not applicable for manure with a larger volume of water. Manure in this project is collected by using a scraping and flushing system. The manure in this project is liquid with a large volume of water. Therefore, this alternative is excluded.
13	Composting - Intensive windrow	Not Applicable	Composting in windrows with regular turning for mixing and aeration emits a large quantity of odor and GHGs during turning and consumes a lot of electricity for the aeration operation. It

			is suitable for solid treatment of manure. The manure in this project is collected by using a scraping and flushing system. The manure in this project is in liquid form with a large volume of water. Therefore, this alternative is excluded.
14	Composting – Passive windrow	Not Applicable	Composting in windrows with infrequent turning for mixing and aeration takes a long time and occupies a large area of land. This kind of solid manure management system emits strong odors and GHGs during turning. For this reason, it is excluded from the list of possible baseline scenarios.
15	Poultry manure with litter	Not Applicable	The farm involved in this project is a large-scale swine farm, not a poultry farm, so no poultry manure is produced. Therefore, this alternative is excluded.
16	Poultry manure without litter	Not Applicable	The farm involved in this project is a large-scale swine farm, not a poultry farm, so no poultry manure is produced. Therefore, this alternative is excluded.
17	Aerobic treatment (Anaerobic Digester Aerobic Treatment system)	Applicable	This kind of wastewater contains a large amount of highly concentrated organic matter, which is difficult to treat using the aerobic method and does not meet Chinese environmental quality standards or pollutant discharge standards for wastewater. Currently, a combined Anaerobic Digester-Aerobic Treatment System is considered one of the most advanced manure management systems. However, implementing such technology requires a high investment, and the proposed project will not be

			funded or constructed without being registered as a VCS project.

The outcome of Step 1a:

In summary, the alternatives to the baseline scenario are identified by tool 02: "Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)" as:

Scenario 6: "The manure is disposed of in an uncovered anaerobic lagoon";

Scenario 8 & 17: Anaerobic Digester & Aerobic Treatment, i.e., the proposed project activity not being registered as a VCS project activity.

Step 1b: Consistency with mandatory laws and regulations

There is no legal mandate or regulation requiring livestock farm owners in China to implement anaerobic digestion, aerobic, or other biological treatment techniques to treat animal manure. However, the discharge of manure directly into the environment without any treatment is prohibited according to the Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming[13] issued by the State Council in November 2013.

According to the "Technical specification for sanitation treatment of livestock and poultry manure"[14] in China, the uncovered anaerobic lagoon is a kind of manure treatment method recognized by the state, which requires minimal financial cost and is compliant with laws and regulations. Therefore, it is the most economical, viable, and reasonable option for livestock farm owners. As per the "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)"[15], anaerobic digesters, aerobic treatment, or other biological treatment methods to dispose of manure waste are encouraged by the state but not mandatory.

Therefore, Scenario 6: "The manure is disposed in an uncovered anaerobic lagoon," and Scenarios 8 and 17: Anaerobic Digester and Aerobic Treatment, are all consistent with mandatory laws and regulations. Therefore, the outcome of Step 1b is unchanged from Step 1a.

Based on the additionality analysis in the section below, Scenario 6 is the most plausible and attractive alternative, thus considered as the baseline scenario.

3.5 Additionality

3.5.1 Regulatory Surplus

[13] https://www.gov.cn/flfg/2013-11/26/content_2535095.htm

[14] https://oss.baigongbao.com/2020/12/14/MRyhTKQcWC.pdf

[15] http://www.moa.gov.cn/gk/tzgg_1/tfw/201801/t20180111_6134801.htm

Is the project located in an UNFCCC Annex 1 or Non-Annex 1 country?

☐ Annex 1 country ☒ Non-Annex 1 country

Are the project activities mandated by any law, statute, or other regulatory framework?

☐ Yes ☒ No

If the project is located inside a Non-Annex 1 country and the project activities are mandated by a law, statute, or other regulatory framework, are such laws, statutes, or regulatory frameworks systematically enforced?

☐ Yes ☒ No

There is no legal law or regulation to mandate livestock farm owners to implement anaerobic digestion, aerobic, or other biological treatment techniques to treat animal manure in China. Only the manure is prohibited from being discharged directly into the environment without any treatment, as per the Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming issued by the State Council in Nov. 2013. According to the "Technical specification for sanitation treatment of livestock and poultry manure," in China, the uncovered anaerobic lagoon is a kind of manure treatment method recognized by the state, which requires minimum financial cost and is compliant with laws and regulations. Therefore, it is the most economical, viable, and reasonable option for livestock farm owners. As stated in the "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)," anaerobic digesters, aerobic treatment, or other biological treatment methods to dispose of manure waste are encouraged by the state but not mandatory. Therefore, the project activity is not mandated by any law, statute, or other regulatory framework; it is regulatory surplus.

3.5.2 Additionality Methods

Additionality for the project activity is demonstrated using Tool 02 "Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)." Step 1 has been completed in Section 3.4 of the PD.

Step 2: Barrier analysis

There are no technology barriers, acceptability barriers and financial barriers that may prevent these two alternative scenarios to occur. As per Tool 02 Combined tool to identify the baseline. scenario and demonstrate additionality (Version 07.0), go to Step 3 (Investment Analysis).

Step 3: Investment analysis

The objective of Step 3 is to compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. If the investment analysis is conclusive, the economically or financially most attractive alternative scenario is considered as the baseline scenario. The comparison of economic attractiveness is carried out by applying

Step 3 Investment analysis of Tool 02 "Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)". The compared alternatives are Scenario 6: "The manure is disposed of in an uncovered anaerobic lagoon"; and Scenario 8&17: Anaerobic Digester Treatment i.e., the proposed project activity not being registered as a VCS project activity.

Sub-step 3a. Determine appropriate analysis method

Three analysis methods are suggested in the "Tools for the demonstration and assessment of additionality" (Version 07.0.0). They are simple cost analysis (the option I), investment comparison analysis (option II), and benchmark analysis (option III).

The proposed project will generate revenue from organic fertilizers sales, not only from VCUs, so the simple cost analysis method is not appropriate. The investment comparison analysis method (option II) applies to projects whose alternatives are also investment projects. Only on such a basis, comparison analysis can be conducted. Alternatives to this project are also investment projects, therefore the proposed project will use the investment comparison method (option II).

Sub-step 3b. investment comparison analysis method (option II)

As per paragraph 25 in section 4.4 of Tool 02 of Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0). Identify the financial indicator, such as IRR, NPV, cost benefit ratio, most suitable for the project type and decision-making context. There are no potential revenues involved in the baseline scenario. There are only negative flows in the scenario of uncovered anaerobic lagoon, so the Internal Rate of Return (IRR) cannot be calculated, and economic comparison should be based on the Net Present Value (NPV) indicator. According to Tool 27 (Version13.0), paragraph 8, discount rate shall be determined following the requirements as set out in this tool for the calculation of IRR benchmarks. For the proposed project, the applied benchmark in the investment analysis is animal husbandry Project IRR (after tax) of 9.5%, which is sourced from the "notice on adjusting financial benchmark rate of return of construction projects in some industries" 19 issued by NDRC and the ministry of housing and urban-rural development of PRC on 15/03/2013, the Notice was valid and the most recently official source at the time when completing PER (Mar-2020) and making investment decision (15-Mar-2020). Therefore 9.5% of NPV discount rate for this project is appropriate.

Sub-step 3c: Calculation and comparison of financial indicators

Undertake investment analysis of all the alternatives that don't face any barriers, as identified in Step 2. For each alternative, all costs and economic benefits attributable to the waste management scenario should be illustrated in a transparent and complete manner. The objective of Step 3 is to compare the economic or financial attractiveness of the alternative scenarios remaining after Step 2 by conducting an investment analysis. If the investment analysis is conclusive, the economically or financially most attractive alternative scenario is considered as the baseline scenario. The comparison of economic attractiveness is carried out by applying Step 3 Investment analysis of Tool 02 "Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)". The compared alternatives are Scenario 6: "The

manure is disposed of in an uncovered anaerobic lagoon"; and Scenario 8&17: Anaerobic Digester Treatment i.e., the proposed project activity not being registered as a VCS project activity.

The Project evaluation report (PER) was approved in March 2020, and the Project investment analysis was completed. The investment decision was approved by the board of directors during the investment decision meeting held on 15-Mar-2020. The time interval between the PER completion and the investment decision not exceed one month to ensure that the investment parameters will not change significantly, so the input values in the PER are valid and applicable in the investment decision.

(a) Basic parameters

Calculated according to Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011)[16] requirements, for this project, the baseline scenario is that manure from the farm is discharged directly into an uncovered anaerobic lagoon with a size of 90m × 85m × 6m in length, width and height. Its construction complies with the relevant provisions of GB/T 36195-2018 Technical specification for sanitation treatment of livestock and poultry manure, including not discharging into natural water bodies, Set the impermeable layer, the depth is not more than 6 meters, the storage time is not less than 30 days (actually may be longer).

The project is a Greenfield project. Baoshan East Hope swine farm leased approximately 280683.84 m^2 of land in total, including the swine farm area, manure treatment area, office and living area, as well as other supporting facilities. There is no specific value indicating the land cost for the new AWMS of the project activity, therefore the cash out of the project investment analysis does not include its land cost, it is conservative. The land cost for baseline lagoon can be estimated based on the design size and the unit price of the land in the land lease contract, which has been added in the updated NPV sheet. It is conservative for comparison of NPV between the baseline scenario and project scenario by only supplementing the land costs of baseline lagoon to the baseline investment analysis. Including the land cost in baseline scenario will result a lower NPV (-108.5) than the one without land cost (-104.77), similarly a higher NPV in project scenario is made if the cash out without considering the land cost.

According to the land lease agreement, the cost of land is 0.54/m^2/year. Further, area of uncovered lagoon in baseline scenario is 7,650(= 90m × 85m) m^2, which is compliance with "Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011)". Thus, the annual land cost for baseline lagoon is 0.42 $\times 10^4$ (=7650*0.54) CNY.

Further, the uncovered lagoon does not require the use of electricity or fossil energy, nor any other raw materials for daily operations. Therefore, the O&M cost only includes staff salary and welfare, without involving other costs.

In addition, Based on the expertise of local technical experts, the depreciation period of the uncovered lagoon is 20 years with a salvage value of 0. Before the end of the operational period,

[16] http://c.gb688.cn/bzgk/gb/showGb?type=online&hcno=677F1F753B88FE5000E7F52441CAFACB

the investment of the uncovered lagoon has been fully depreciated. Therefore, the residue value is 0 in the NVP calculation for the baseline lagoon.

Meanwhile, according to Article 31 of the Provisional Regulations of the People's Republic of China on Enterprise Income Tax and the Implementing Rules, "the salvage value ratio shall be within 5% of the original price and shall be determined by the enterprise itself". Thus, the residue value of the baseline lagoon is 0 in PER is reasonable.

Table 3-2 The basic parameters of the uncovered anaerobic lagoon

Main Parameters		Unit	Value	10,000 CNY	Source
	1 Basic paramete				
1.1	**uncovered anaerobic lagoon volume**	m^3	45,900		Calculated according to Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011) requirements
	2 Investment				
2.1	**Total investment**	10,000 CNY	55.08	55.08	
2.1.1	**Uncovered anaerobic lagoon volume**	m^3	45,900		Calculated according to Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011) requirements
2.1.2	**Earth moving prices**	CNY/ m^3	12		Unit price of construction project in 2023[17]
2.2	**Construction period**	Year	1		ata sources refer to the financial data in PER (Project Evaluation Report)
2.3	**Operation period**	Year	20		ata sources refer to the financial data in PER (Project Evaluation Report)
	3 Cost				
3.1	**Annual O & M cost**	10,000 CNY		7.20	PER
3.1.1	**Salary and welfare**	10,000 CNY		6.77	PER
	Employee number	Number	1		Analogy of the same industry situation
	Salary	10,000 CNY	4.8		Data sources refer to the financial data in PER (Project Evaluation Report)
	Welfare	%	41%		Data sources refer to the financial data in PER (Project Evaluation Report)

[17]https://wenku.baidu.com/view/a11683f2bad528ea81c758f5f61fb7360b4c2b82.html?_wkts_=1733816992586&needWelcomeRecommand=1

3.1.2	Annual Land cost	10,000 CNY		0.44	
3.1.2.1	Annual land price（Initial five years）	CNY/m^2	0.57		Land lease contract
3.1.2.2	Increase per five years	%	15%		Land lease contract
3.1.2.3	Uncovered anaerobic lagoon area	m^2	7650		7650(=90*85)m^2, calculated according to Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011) requirements

Table 3-3 The main parameters of the Anaerobic Digester-Aerobic Treatment

Main Parameters	Unit	Value	Source
Total statistic investment	10,000 CNY		PER
Annual O&M cost	10,000 CNY		PER
Annual sales of organic fertilizer	10,000 CNY		PER According to the EIA, the pig farm produces 26,718 tonnes of manure per year. According to PER, the annual sales volume of organic fertilizer for this project is 18,000 tons per year. According to PER, PP and local farmers have agreed that the organic fertilizer produced by this project will be sold to farmers around the project at a price lower than the market price[18], which is 120 yuan per ton. The Annual organic fertilizers sales revenue is calculated as 18,000×120= 216×10^4 CNY.
Construction period	Year	1	PER
Operation period	Year	20	PER
Rate of residual value	%	5%	PER
VAT rate (Equipment & Material)	%	13%	PER
VAT rate (Revenue)	%	13%	PER

[18] https://www.chinabgao.com/jiage/489584.html

Income tax rate	%	25%	PER
Urban maintenance and construction tax	%	5%	PER
Surtax for education	%	5%	PER
Rate of Profit appropriation - statutory surplus reserve	%	10%	PER
Rate of Profit appropriation - statutory welfare reserve	%	5%	PER
Emission reduction	tCO_2e		ER spreadsheet
VCU Price	CNY/ton		Expected

(b) Comparison of the project NPV for the project scenario and baseline scenario

The investment analysis results of the baseline scenario are as follows:

Costs and benefits	1	2	3-19	20	21
Cash inflow	0.00	0.00	0.00	0.00	0.00
Revenues from organic fertilizers sales	0.00	0.00	0.00	0.00	0.00
Subsidy income	0.00	0.00	0.00	0.00	0.00
Fixed assets residue value	0.00	0.00	0.00	0.00	0.00
Recovered current capital	0.00	0.00	0.00	0.00	0.00
Cash outflow	55.50	7.18	7.18	7.18	7.18
Construction investment	55.08	0.00	0.00	0.00	0.00
Current capital	0.00	0.00	0.00	0.00	0.00
O&M cost	0.42	7.18	7.18	7.18	7.18
- Salary and welfare	0.00	6.77	6.77	6.77	6.77
- Land cost	0.42	0.42	0.42	0.42	0.42
Sales tax and associate charge	0.00	0.00	0.00	0.00	0.00

Net cash flow	**-55.50**	**-7.18**	**-7.18**	**-7.18**	**-7.18**
NPV (discount rate=9.5%)	-108.50				

Table 3-4 Investment analysis of the uncovered anaerobic lagoon （10^4 RMB）

The financial analysis results of the project scenario are as follows:

Table 3-5 The results of financial analysis of Anaerobic Digester-Aerobic Treatment （10^4 RMB）

Year		**1**	**1**	**2**	**3-4**	**5-7**	**8-20**	**21**
1	Cash in	Income		216.00	216.00	216.00	216.00	216.00
		Recovery of residual value of fixed assets						42.45
		Recovery of current capital						188.60
2	Cash out	Equity Investment in fixed assets	849.00					
		Current capital		188.60				
		Operational and maintenance cost		162.28	162.28	162.28	162.28	162.28
		Tax		2.81	2.81	2.81	2.81	2.81
		Income tax		0.00	0.00	1.32	2.65	2.65
3	Cash flow after income tax		-849.00	-137.69	50.91	49.59	48.26	279.31
4	**NPV (discount rate=9.5%)**		-501.49					
5	Net cash flows with VCUs revenue		-62.21	126.39	125.07	123.74	48.26	279.31
6	**NPV with VCUs revenue (discount rate=9.5%)**		-68.69					

As shown in table 3-4 and 3-5, the NPV of both the project activity and the uncovered anaerobic lagoon are negative and the NPV of the project activity is far more negative than that of the uncovered anaerobic lagoon which means the cost of the project activity without VCU revenues is much higher than the uncovered anaerobic lagoon, so the uncovered anaerobic lagoon is the most attractive course of action and is considered to be the baseline scenario.

Anaerobic digester system is considered to be one of the most advanced manure management systems in the world. High costs involved in the investment compared to other available systems is required to implement such technology, so the NPV of the project activity is negative and it is difficult for the project proponents to get loans from the banks. Only the project proponents can prove that they can get revenues from VCS, it can attract the banks to provide loans for this project. For these reasons, without the revenues, PP is willing to adopt other manure management systems of lower costs which will lead to more GHG emissions.

Without income from selling VCUs, the NPV of the proposed project is -501.49, While considering such income, the NPV of the proposed project is -68.69. After taking into account the VCUs income, the NPV of the project is still negative. but the profitability of proposed Project with VCUs revenue is improved and the cash inflow of Project is close to cash outflow, i.e. the income of Project is close to the cost of investment and therefore more financially attractive to investors. In addition, the project owner attaches great importance to promoting the environmental protection technology, the VCUs revenue can improve the financial attractiveness to some extent and then can affect the project owner and investors affirmatively to promote this project as a global warming mitigation project.

Table 3-6 Project NPV with and without revenues from *VCUs*

	Without VCUs	With VCUs
NPV (discount rate=9.5%)	-501.49	-68.69

Sub-step 3d: Sensitivity analysis

The purpose of this step is to examine whether the conclusion regarding the financial attractiveness is robust to reasonable variations of the critical assumptions.

According to Guidance on the Assessment of Investment Analysis, the “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”. Therefore, the total static investment, and annual organic fertilizers sales revenue (Baseline scenario None) were taken as uncertain factors for sensitive analysis. Furthermore, the O&M cost which was widely included in the sensitivity analysis for projects in China was also examined in the analysis. As a result, the following parameters are selected for the analysis:

- Total static investment
- Annual O&M cost
- Annual organic fertilizers sales revenue

The variation range of -10%~10% which was employed in the Project technical evaluation report.

The results of sensitivity analysis of the above parameters are shown in the table:

Table 3-7 Sensitivity analysis of the baseline

	Variation				
Indicator	90%	95%	100%	105%	110%
NPV (discount rate=9.5%)					
Total static investment	-98.95	-103.60	-108.50	-113.66	-119.07
Annual O&M cost	-97.78	-103.01	-108.50	-114.27	-120.31

Table 3-8 Sensitivity analysis of the project

	Variation				
Indicator	90%	95%	100%	105%	110%
NPV (discount rate=9.5%)					
Total static investment	-352.48	-425.05	-501.49	-581.81	-666.00
Annual sales of organic fertilizer	-660.14	-574.36	-501.49	-428.72	-355.95
Annual O&M cost	-390.70	-446.10	-501.49	-556.88	-619.17

According to the above analysis, when the total static investment, annual organic fertilizer sales revenue and manure treatment and annual O&M cost are changing within the range of -10% to 10%, the project NPV (discount rate=9.5%) of the project is always be negative and lacking financial attractiveness comparing with the baseline scenario.

The sensitivity analysis was further conducted, and the project NPV (discount rate=9.5%) could reach the baseline NPV value if one of the following conditions can be achieved:

- Total static investment: decrease about 39.84%.
- Annual organic sales revenue: increase about 34.46%.
- O&M cost: decrease about 45.27%.

a) Total static investment

The NPV would exceed the baseline NPV value when the total static investment decreases by 39.84%. According to the publicly latest available sources, on the whole, the price indices for steel, fuel, power and construction materials and price indices for fixed asset investment in China have been increasing since 2021[19], and this trend seems unlikely to be changed before the

[19] https://www.stats.gov.cn/sj/ndsj/2022/indexch.htm

project construction is completed. As a result, the NPV cannot increase through the decrease of total static investment. In addition, the project has been put into operation. According to the overall design and construction contract, the actual total investment cost is 1,141.20*10^4 CNY, which is higher than the value estimated according to the project evaluation report (1,037.60*10^4 CNY). Therefore, the NPV cannot be increased by changes in total static investment.

b) Annual organic fertilizer sales revenue

The NPV would exceed the baseline NPV value when the annual organic fertilizer sales revenue increase by 34.46%. The organic fertilizers are produced through the aerobic composting system, which is determined by the manure of the swine farm. Since the scale of the swine farm will stay stable in the future. The purchase and sale intention agreement of organic fertilizer had been signed, however, due to the fact that the organic fertilizers produced by the project belong to semi-finished Products, which is harmless but not reaching the Chinese organic fertilizer standard, the organic fertilizer produced in the operation of the project could only be sold as semi-finished products of organic fertilizer, the price of the semi-finished products is lower than the commercial organic fertilizers. According to the actual signed organic fertilizer sales agreement, the unit price of organic fertilizer sales is only 120 CNY/ton, lower than the expected 300 CNY/ton, and actual sales were well below expectations.

Further, according to the Organic fertilizer distribution Agreement, PP and local farmers have agreed that the organic fertilizer produced by this project will be sold to farmers around the project at a price lower than the market price. The organic Fertilizer Distribution Agreement covers the entire Project credit period, and the size of local farmland is fixed, so the demand for organic fertilizer from local farmers will remain stable in the future. Therefore, the amount of fertilizers sales of Project is not likely to increase.

According to the actual Organic fertilizer sales records in 2023-2024, the actual sales volume of organic fertilizer of the project in 2023-2024 are shown in the following table.

Statistic	Estimated in PER	2023-2024
Produced organic fertilizer(tonnes)	18000	17578
Sales volume of organic fertilizer(tonnes)	18000	17578

By comparing the actual sales volume of organic fertilizers from the project in 2023-2024, the actual sales volume of organic fertilizers in 2023-2024 is below the PER estimate. Meanwhile, in the actual operation, some farmers are not willing to buy the semi-finished organic fertilizer of the project in order to protect their crop harvest. Therefore, it is impossible to increase the annual sales of organic fertilizers to the threshold.

c) Annual O&M cost

The NPV would exceed the baseline NPV value when the annual O&M cost decreases by 45.27%. Based on Chinese Statistic Yearbook[20] , the fluctuations of indices of purchasing price of raw material, power and fuel are increased significantly. The average wage of employed people in private units in rural, animal husbandry towns continued to increase during the last ten years in Yunnan Province[21]. Moreover, the equipment will be getting more and more with the abrasion, which means the maintenance cost will be increasing in the coming years. As a result, the drastic decreasing in Annual O&M cost is not realistic. The operation and maintenance costs of the project include material costs, electricity costs, maintenance costs, insurance premiums, labor wages, welfare costs and other costs. This project has been in operation for over one year. According to the actual operation and maintenance cost statistics, the actual operation and maintenance cost of the project in 2023 is $180*10^4$ CNY, which is higher than the value estimated according to the project evaluation report ($162.28*10^4$ CNY). Therefore, the NPV cannot be increased by changes in O&M cost.

As shown in the sensitivity analysis above, the NPV (discount rate=9.5%) will not reach the baseline NPV value within reasonable fluctuation range, and the fluctuation scenario of the uncertain factors which could make the proposed project financially feasible is unlikely to occur. Therefore, the conclusion regarding the infeasibility of the proposed project is robust to reasonable variations of the critical assumptions.

Ongoing Financial Need

According to the results of investment analysis described in section 3.5.2, NPV without carbon revenue of the project is -501.49. The project can apply for carbon credits under VCS project, the NPV can reach to -68.69 with carbon revenue, greatly improve the project's financial situation. Therefore, the revenue from VCS Standard certification is material to the ongoing sustainability of the project.

Conclusion of the assessment and demonstration of additionality

To summarize, “the Project is undertaken without being registered as a VCS project activity” is not financially attractive to investors, thus it is not feasible and is not a baseline scenario.

Only one alternative scenario (Scenario 6) is left.

Step 4. Common practice analysis.

The proposed project will achieve obvious greenhouse gas (GHG) emission reductions through capturing methane generated during the swine manure treatment process and the biogas can be used to generate electricity for self-consumption. Therefore, according to the “Tool 24 common practice (version 03.1)”, the measure of the proposed project belongs to “Methane formation avoidance”. Thus, sub-steps are adopted to take the common practice analysis.

[20] https://www.stats.gov.cn/sj/ndsj/

[21] https://stats.yn.gov.cn/List22.aspx

The project is not a first-of-its kind project. As per Tool 24 Common practice (Version 03.1), Step 4 common practice analysis will be conducted as follows:

Sub-step 4a. The proposed CDM project activity(ies) applies measure(s) that are listed in the definitions section above.

The proposed project is belonged to type (D) measure listed in the latest version of the "Guidelines on common practice, i.e., 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 per additionality tool, the "Guidelines on common practice" available on the UNFCCC website is applied as below:

Step 4a.1: Calculate applicable output range as +/-50% of the design output or capacity of the proposed project activity.

For this project, the swine farms involving 50,000 heads of marketing swine are included, and are estimated to produce 26718 tons of manure every year, therefore. The Swine Farm Animal Manure Management System GHG Mitigation projects that can handle manure from 13359 tons to 40077 tons every year are included.

Step 4a.2: Identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:

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

The common practice analysis is limited to the provincial level as the provincial government is at the highest level of local governments. Local regulatory frameworks are generally set by local governments (e.g., price regulation, investment policy). only the activities in the same province could be regarded as sharing the same "comparable environment". Therefore, Yunnan province is considered to be a geographical area with comparable investment climate and is selected for geographical boundaries of common practice analysis.

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

As described above, the measure of the proposed project belongs to "Methane formation avoidance".

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

The project is to treat the manure from the swine farm avoid methane emissions generated in the baseline uncovered anaerobic lagoons through new set of AWMS. The biogas captured for electricity generation, which is used for the AWMS.

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

26718 tons of animal manure waste can be treated annually and collect biogas to generate electricity for self-consumption. If the similar projects can produce electricity for self-consumption and treat the manure waste should be considered as the comparable service.

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

Based on the calculation in Sub-Step 4a.1, the output/capacity ranges of similar project are that can handle manure from 13359 tons to 40077 tons annually.

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

The day that the project design document is published for global stakeholder consultation is 05-Apr-2021, which is earlier than the project start date of construction (real action date defined under CDM) of the project activity, therefore only projects which started commercial operation before 05-Apr-2021 are considered. In summary, all biogas recovery and utilization projects produce biogas from anaerobic digestion of animal manure waste collect biogas to generate electricity for self-consumption, located in Yunnan province, the annual manure treatment capacity is 13359 tons to 40077 tons, and starting commercial operation before 05-Apr-2021 are identified as the similar projects.

Step 4a.3: Within the projects identified in Step 4.2, identify those that are neither registered CARBON project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number N_{all}.

Through searching UNFCCC website, CDM website, China CER exchange info- platform, GS website, VCS website, Development and Reform Commission of Yunnan Province [22] and Department of Agriculture and Rural Affairs of Yunnan Province[23], there are no similar projects, therefore N_{all} =0. Based on the analysis above, N_{all}=0.

Step 4a.4: Within similar projects identified in Step 4.3, identify those that apply technologies that are different to the technology applied in the proposed project activity. Note their number N_{diff}.

There is no similar project, so N_{diff}=0.

Step 4a.5: Calculate factor $F=1-N_{diff}/N_{all}$ 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.

[22] https://yndrc.yn.gov.cn/

[23] https://nync.yn.gov.cn/

According to the "Combined tool to identify the baseline scenario and demonstrate additionality", the proposed 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. As per the analysis above, the F of the project is zero, which is less than 0.2, and N_{all} - N_{diff} =0 is also less than 3. Therefore, the project is not a common practice.

Conclusion of the assessment and demonstration of additionality

To summarize, according to the above Investment Analysis and Common practice analysis, the project is not financially attractive without VCUs revenue and it is not a common practice, thus, the project is additional and the baseline scenario of the project is identified as scenario 6: "The manure is disposed in an uncovered anaerobic lagoon".

3.6 Methodology Deviations

No methodology deviations are applied for the project.

4 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

As per paragraph 26 of the applied methodology.

Baseline emissions are:

$$BE_y = BE_{CH4,y} + BE_{N20,y} + BE_{elec/heat,y} \quad \text{Equation (1)}$$

Where:

BE_y	Baseline emissions in year y (t CO_2/yr)
$BE_{CH4,y}$	Baseline CH_4 emissions in year y (t CO_2/yr)
$BE_{N20,y}$	Baseline N_2O emissions in year y (t CO_2/yr)
$BE_{elec/heat,y}$	Baseline CO_2 emissions from electricity and/or heat used in the baseline (t CO_2/yr)

(1) Baseline CH_4 emissions ($BE_{CH4,y}$)

$$BE_{CH4,y} = GWP_{CH4} \times D_{CH4} \times \sum_{j,LT}\left(MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{Bl,j}\right) \quad \text{Equation (2)}$$

Where:

$BE_{CH4,y}$	Baseline CH_4 emissions (t CO_2/yr)
GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (t CO_2e/t CH_4)
D_{CH4}	Density of CH_4 (t/m^3). 0.00067 t/m^3 at room temperature (20 °C) and 1 atm pressure
MCF_j	Annual methane conversion factor (MCF) for the baseline $AWMS_j$. IPCC 2019 refinement, table 10.17, chapter 10, volume 4.
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated by animal type LT (m^3CH_4/kg -dm)
$N_{LT,y}$	Annual average number of animals of type LT for the year y (number)
$VS_{LT,y}$	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis (kg -dm/animal/yr)
$MS\%_{Bl,j}$	Fraction of manure handled in system j in the baseline. In this project, the baseline manure management system is uncovered anaerobic lagoon only. The amount of manure handled by the anaerobic lagoon is 100%.
LT	Type of livestock
j	Type of treatment system

Estimation of various variables and parameters for above equations:

(A) $VS_{LT,y}$ shall be determined in one of the following ways, presented in the order of preference:

Option 1: Using published country specific data. If the data is expressed in kilogram volatile solid excretion per day on a dry-matter basis (kg -dm per day), multiply the value with nd_y (number of days treatment plant was operational in year y).

Option 2: Estimation of $VS_{LT,y}$ based on dietary intake of livestock:

$$VS_{LT,y} = \left[GE_{LT} \times \left(1 - \frac{DE_{LT}}{100}\right) + (UE \times GE_{LT})\right] \times \left[\left(\frac{1 - ASH}{ED_{LT}}\right)\right] \times nd_y \quad \text{Equation (3)}$$

Where:

$VS_{LT,y}$	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis (kg -dm/animal/yr)
GE_{LT}	Daily average gross energy intake (MJ/animal/day)
DE_{LT}	Digestible energy of the feed (per cent)
UE	Urinary energy (fraction of GE_{LT})
ASH	Ash content of manure (fraction of the dry matter feed intake)
ED_{LT}	Energy density of the feed fed to livestock type LT (MJ/kg -dm)
nd_y	Number of days treatment plant was operational in year y

Option 3: Scaling default IPCC values $VS_{default}$ to adjust for a site-specific average animal weight as shown in equation below:

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}}\right) \times VS_{default} \times nd_y \qquad \text{Equation (4)}$$

Where:

$VS_{LT,y}$	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis (kg -dm/animal/yr)
W_{site}	Average animal weight of a defined livestock population at the project site (kg)
$W_{default}$	Default average animal weight of a defined population (kg)
$VS_{default}$	Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock population (kg-dm/animal/day)
nd_y	Number of days treatment plant was operational in year y

Option 4: Utilizing published IPCC defaults for $VS_{LT,y}$ (IPCC 2006 guidelines, volume 4, chapter 10), multiply the value by nd_y (number of days in year y).

Developed countries $VS_{LT,y}$ values may be used provided the following conditions are satisfied:

(a) The genetic source of the production operations livestock originates from an Annex I Party;

(b) The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;

（c） The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.); and

（d） The project specific animal weights are more similar to developed country IPCC default values.

$VS_{LT,y}$ is determined in the way of Option 3 provided by ACM0010 due to the lack of data for Option 1 and Option 2, and not meeting the conditions for applying Option 4 of using developed countries $VS_{LT,y}$ values.

（B）Annual average number of animals of type LT (N_{LT}) shall be determined in one of the following ways, presented in order of preference:

Option 1:

$$N_{LT} = N_{da,LT} \times \left(\frac{N_{p,LT}}{365}\right) \quad \text{Equation（5a）}$$

Where:

N_{LT}	Annual average number of animals of type LT for the year y (number)
$N_{da,LT}$	Number of days animal of type LT is alive in the farm in the year y (number)
$N_{p,LT}$	Number of animals of type LT produced annually for the year y (number)

Option 2: If the project developer can monitor in a reliable and traceable way the daily stock of animals in the farm, discounting dead animals and animals discarded from the productive process from the daily stock, then the annual average number of animals (N_{LT}) may be calculated as follows:

$$N_{LT} = \frac{\sum_{1}^{365} N_{AA,LT}}{365} \quad \text{Equation（5b）}$$

Where:

N_{LT}	Annual average number of animals of type LT for the year y (number)
$N_{AA,LT}$	Daily stock of animals of type LT in the farm, discounting dead and discarded animals (number)

This project only has one type of market pig. PP can reliably monitor the daily inventory and remove market pigs that have died from the production process. Therefore, Option 2 is used to calculate the N_{LT} of market pigs.

（C）Maximum methane producing potential（$B_{0,LT}$）

According to the applied methodology ACM0010 (Version 08.0), this value varies by species and diet. Default values are used, and they are taken from tables 10.16 (IPCC 2019 Refinement Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10).

The proposed project is located in Longyang District, Baoshan City, Yunnan Province, China, Asia. According to Table 10.16 of the IPCC 2019 Refinement Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10, the maximum methane-producing potential ($B_{0,LT}$) for Market swine and Breeding swine in the Asia region is 0.45 m^3 CH_4/kg VS.

（D）Annual methane conversion factor (MCF_j) for the baseline AWMSj

（a） The MCF_j values are given in Table 10.17, Chapter 10, Volume 4, 2019 Refinement to the 2006 IPCC Guidelines should be used. MCF_j values depend on the climate zone where the anaerobic manure treatment facility in the baseline existed. For this project, the project site is located in the subtropical monsoon climate zone. The annual average temperature is 15.8°C, the average annual precipitation is 950.5 mm. Therefore, the climate zone of the project site can be determined as "Warm temperature moist", and the value of 73% is applied.

（b） A conservatism factor should be applied by multiplying MCF_j values (estimated as per the above bullet) with a value of 0.94, to account for the 20% uncertainty in the MCF_j values as reported by the IPCC.

（2）Baseline N_2O emissions($BE_{N20,y}$)

$$BE_{N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(E_{N20,D,y} + E_{N20,ID,y}\right) \quad \text{Equation（6）}$$

Where:

$BE_{N20,y}$	Annual baseline N_2O emissions in (t CO_2e/yr)
GWP_{N20}	Global Warming Potential (GWP) for N_2O (t CO_2e/tN_2O)
$CF_{N20-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$E_{N20,D,y}$	Direct N_2O emission in year y (kg N_2O-N/year)
$E_{N20,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)

$$E_{N20,D,y} = \sum_{j,LT} EF_{N20,D,j} \times NEX_{LT,y} \times N_{LT} \times MS\%_{Bl,j} \quad \text{Equation（7）}$$

Where:

$E_{N20,D,y}$	Direct N_2O emission in year y (kg N_2O-N/yr)
$EF_{N20,D,j}$	Direct N_2O emission factor for the treatment system j of the manure management system (kg N_2O-N/kg N). (Estimated with site specific, regional or national data if such data is available, otherwise use default EF3 from table 10.21, chapter 10, volume 4, in the 2019 Refinement to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories). The site specific, regional or national data are not available, so this project activity adopts default EF3.
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr) estimated as described in appendix 2
N_{LT}	Fraction of manure handled in system j (fraction)
$MS\%_{Bl,j}$	Annual Average number of animals of type LT for the year y estimated as per equation (5a) or (5b) (number)

$$E_{N20,ID,y} = \sum_{j,LT} EF_{N20,ID} \times F_{gasMS,j,LT} \times NEX_{LT,y} \times N_{LT} \times MS\%_{Bl,j} \quad \text{Equation (8)}$$

Where:

$E_{N20,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)
$EF_{N20,ID}$	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces (kgN_2O-N/kg NH_3-N and NO_X-N) (Estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF4 from table 11.3, chapter 11, volume 4 of 2019 Refinement to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories can be used). The site-specific, regional or national data are not available, so this project activity adopts default EF4.
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/year) estimated as described in appendix 2
$MS\%_{Bl,j}$	Fraction of manure handled in system j (fraction)
$F_{gasMS,j,LT}$	Default values for nitrogen loss due to volatilisation of NH_3 and NO_X from manure management (fraction)
N_{LT}	Annual Average number of animals of type LT for the year y estimated as per equation (5(a)) or (5(b)) (number)

Estimation of various variables and parameters for above equations:

(A) Procedure for estimating （NEX_{LT}）

Option 1:

$$NEX_{LT} = N_{intake} \times (1 - N_{retention}) \times nd_y \quad \text{Equation（9）}$$

Where:

N_{intake}	Daily N intake per animal (kg N/animal/yr)
$N_{retention}$	Portion of that N intake that is retained in the animal (kg N retained/animal/yr)
nd_y	Number of days treatment plant was operational in year y

N_{intake} may be calculated using：

$$N_{intake} = \left(\frac{GE}{18.45}\right) \times \left(\frac{CP/100}{6.25}\right) \quad \text{Equation（10）}$$

Where:

CP	Crude per cent of protein (per cent)
GE	Gross energy intake of the animal (MJ/animal/day-)
18.45	Conversion factor for dietary GE per kg of dry matter (MJ/kg). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock
6.25	Conversion from kg of dietary protein to kg of dietary N, kg feed protein (kg N)$^{-1}$

Option 2: In the absence of availability of project specific information on protein intake, which should be justified in the JPM, national or regional data should be used for the nitrogen excretion NEX_{LT}, if available. In the absence of such data, default values from table 10.19 of the 2019 Refinement to the 2006 IPCC Guidelines, Volume 4, Chapter 10) may be used and should be corrected for the animal weight at the project site in the following way:

$$NEX_{LT,y} = \frac{W_{site}}{W_{default}} \times NEX_{IPCC\ default} \quad \text{Equation（11）}$$

Where:

$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr)
W_{site}	Average animal weight of a defined livestock population at the project site (kg)
$W_{default}$	Default average animal weight of a defined population (kg)
$NEX_{IPCC\ default}$	Default value for the nitrogen excretion per head of a defined livestock population (kg N/animal/year)

$$NEX_{IPCC\ default} = N_{rate}(T) \times \frac{TAM}{1000} \times 365 \quad \text{Equation (12)}$$

Where:

$N_{rate}(T)$	The default N excretion rate, kg N/ (1000 kg animal mass)/ day, table 10.19, chapter 10, volume 4 of 2019 Refinement to the IPCC 2006 Guidelines.
TAM	Typical animal mass for livestock in kg/animal.

The protein content of the purchased feed is not completely fixed. The feeders will adjust the type and amount of feed according to the growth of the pigs, and the feed intake of the pigs cannot be determined. Therefore, the protein intake information of the pigs cannot be obtained. No national or Yunnan data were available to calculate nitrogen excretion NEX. For this project, neither specific information on the portion of that N intake nor site-specific national or regional data is available. Therefore, Option 2 is adopted to calculate $NEX_{LT,y}$.

(3) Baseline CO_2 emission from electricity and/or heat used in the baseline

$$BE_{elec/heat,y} = BE_{EC,y} + BE_{HG,y} \quad \text{Equation (13)}$$

Where:

$BE_{elec/heat,y}$	Baseline CO_2 emissions from electricity and/or heat used in the baseline (t CO_2/yr)
$BE_{EC,y}$	Baseline emissions associated with electricity generation in year y (t CO_2/yr)
$BE_{HG,y}$	Baseline emissions associated with heat generation in year y (t CO_2/yr)

As the biogas captured for heat generation which will be only used for the daily operation of the AWMSs and will not be produced to other users, it does not involve replacement of heat that

would be generated from fossil fuels in baseline scenario. Besides, the biogas recovered is not used to generate electricity. Therefore, $BE_{elec/heat,y}$ =0

4.2 Project Emissions

Two stages are involved in the manure treatment for the project activity: (1) anaerobic digester; (2) aerobic composting.

Project emissions are estimated as follows:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N20,y} + PE_{EC/FC,y} \quad \text{Equation (14)}$$

Where:

PE_y	Project emissions in year y (t CO_2e)
$PE_{AD,y}$	Project emissions associated with the anaerobic digester in year y (t CO_2e/yr)
$PE_{Aer,y}$	Project CH_4 emissions from aerobic AWMS treatment (t CO_2e/yr)
$PE_{N20,y}$	Project N_2O emissions in year y (t CO_2/yr)
$PE_{EC/FC,y}$	Project emissions from electricity consumption and fossil fuel combustion (t CO_2e/yr)

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

Based on the methodology ACM0010 "GHG emission reductions from manure management systems (Version 08.0)". $PE_{AD,y}$ is determined using the methodological tool "Project and leakage emissions from anaerobic digesters".

According to the TOOL14 "Project and leakage emissions from anaerobic digesters (Version 02.0)", the project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined as follows:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y} \quad \text{Equation (15)}$$

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)

The anaerobic digestion process of this project does not involve the use of fossil fuels, so the project emissions from fossil fuel consumption associated with the anaerobic digester are 0, i.e., $PE_{FC,y}$ = 0. This project involves the use of electricity, but the electricity consumption of the anaerobic process, aerobic process, and other auxiliary projects cannot be separated. The project emissions of power consumption are uniformly calculated in the calculation of $PE_{AD,y}$, at one time and are not repeated in other parts.

The biogas generated in this project will be captured for electricity generation, and all the electricity generated from this project will be used only by the AWMS. The flare is only used in emergency situations when the biogas boiler and generator set are shut down for maintenance (if any).

In summary, the project emissions associated with the anaerobic digester in year y (t CO_2e) are as follows, i.e., $PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$.

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

Since the electricity consumption of the anaerobic digestion system cannot be measured separately from the entire AWMS, the project emissions from electricity consumption associated with the anaerobic digester, as well as those not related to the anaerobic digester, are calculated together.

The project emissions from electricity consumption are calculated according to the tool 05 "Baseline, project, and/or leakage emissions from electricity consumption and monitoring of electricity generation" (Version 03.0):

$$PE_{EC,y} = \sum_{j,LT} EC_{PJ,j,y} \times EF_{EF,j,y} \times \left(1 + TDL_{j,y}\right) \quad \text{Equation (16)}$$

Where:

$PE_{EC,y}$	Project emissions from electricity consumption in year y (t CO_2e)
$PE_{PJ,j,y}$	Quantity of electricity consumed by the project electricity consumption source j in year y (MWh/yr)
$PE_{EF,j,y}$	Emission factor for electricity generation for source j in year y (t CO_2/MWh)

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

According to the tool "Baseline, project, and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0), the average technical transmission and distribution losses for providing electricity to the source ($TDL_{j,y}$ =20%).

The emission coefficient of power generation was calculated by CDM tool 07. The project consumes electricity from China Southern Power Grid (CSPG);therefore, $EF_{EF,j,y}$ shall be determined as the combined margin emission factor ($EF_{grid,CM,y}$) of the CSPG, calculated in accordance with the "Tool to calculate the emission factor of an electricity system" ($EF_{EF,j,y}$ = $EF_{grid,CM,y}$).

According to the tool, the calculation of the combined margin (CM) emission factor ($EF_{grid,CM,y}$) is based on one of the following methods:

(a) Weighted average CM; or

(b) Simplified CM.

The weighted average CM method (Option a) should be used as the preferred option.

The simplified CM method (option b) can only be used if:

The project activity is located in: (i) a Least Developed Country (LDC); or (ii) a country with less than 10 registered CDM projects at the starting date of validation; or (iii) a Small Island Developing State (SIDS); and the data requirements for the application cannot be met.

The PD choose option A.

The calculation of the combined marginal emission factor according to tool 07 V7.0 is as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad \text{Equation（17）}$$

Where:

$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year y (t CO_2/MWh)
$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (t CO_2/MWh)
w_{OM}	Weighting of operating margin emission factor (per cent)
w_{BM}	Weighting of build margin emission factor (per cent)

The project is powered by the China Southern Power Grid (CSPG), and the emission factor $EF_{grid,OM,y}$ = 0.7738, $EF_{grid,BM,y}$ = 0.1981 of the China Southern Power Grid (CSPG) comes from the Ministry of Ecology and Environment, PRC.

According to "Tool to calculate the emission factor for an electricity system", the following default values should be used for w_{OM} and w_{BM}:

（a） Wind and solar power generation project activities: w_{OM} = 0.75 and w_{BM} = 0.25 (owing to their intermittent and non-dispatchable nature) for the first crediting period and for subsequent crediting periods;

（b） All other projects: w_{OM} = 0.5 and w_{BM} = 0.5 for the first crediting periods, and w_{OM} = 0.25 and w_{BM} = 0.75 for the second and third crediting period, unless otherwise specified in the approved methodology that refers to this tool.

For the project, not wind or solar power generation project activities, w_{OM} and w_{BM} are both 0.5 by default for the first crediting period. w_{OM}= 0.5 and w_{BM} = 0.5.

Therefore, the combined baseline emission factor:

$EF_{EF,j,y}$ = $EF_{grid,CM,y}$=0.7738×0.5+0.1981×0.5=0.48595 tCO_2/MWh

Through the meter measurement, cross-check with the grid report to determine the electricity consumption purchased from the grid company.

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

In case, there is gas stream which is flared by flaring and the project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the tool 06 "Project emissions from flaring" (version 04.0).

The calculation procedure in this tool determines the project emissions from flaring the residual gas ($PE_{flare,y}$) based on the flare efficiency ($\eta_{flare,m}$) and the mass flow of methane to the flare ($F_{CH4,RG,m}$). The flare efficiency is determined for each minute m of year y based on monitored data or default values.

The calculation procedure for project emissions from flaring is given in the following steps:

STEP 1: Determination of the methane mass flow of the residual gas;

STEP 2: Determination of the flare efficiency;

STEP 3: Calculation of project emissions from flaring.

Step 1: Determination of the methane mass flow in the residual gas

The tool 08 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" shall be used to determine the following parameter $F_{CH4,m}$:

The following requirements apply:

（a） The gaseous stream to which the tool is applied is the residual biogas for flaring;

（b） The flow of the gaseous stream shall be measured continuously;

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

（d） The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and

（e） The time interval t for which mass flow should be calculated is every minute m.

$F_{CH4,m}$, which is measured as the mass flow during minute m, shall then be used to determine the mass of methane in kilograms fed to the flare in minute m ($F_{CH4,RG,m}$). $F_{CH4,m}$ shall be determined on a dry basis.

Therefore, option A is adopted to calculate the mass flow of the residual biogas for flaring as per Tool 08, "Tool to determine the mass flow of a greenhouse gas in a gaseous stream".

As per paragraph 23 of Tool 8: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0) ", the way to prove that the gaseous stream is dry needs to demonstrate that the temperature of the gaseous stream (Tt) is less than 60℃ (333.15 K) at the flow measurement point. For this project, the flowmeters installed in the outlet of the anaerobic tanks and the temperature of the anaerobic treatment unit of this project are designed as medium temperature, and the optimal temperature range is 35 ~ 38 ℃. Therefore, if the gas temperature measured by the flowmeter does not exceed 60 ℃, it can be demonstrated that the gaseous stream is dry.

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \qquad \text{Equation（18）}$$

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \qquad \text{Equation（19）}$$

Where:

$F_{i,t}$	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)

$\rho_{i,t}$	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ gas i)
P_t	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	Molecular mass of greenhouse gas i (kg/kmol)
R_u	Universal ideal gases constant (Pa.m³/kmol.K)
T_t	Temperature of the gaseous stream in time interval t (K)

Step 2: Determination of the flare efficiency;

The flare efficiency depends on the efficiency of combustion in the flare and the time that the flare is operating. For determining the efficiency of combustion of enclosed flares, there is the option to apply a default value or determine the efficiency based on monitored data. For open flares, a default value must be applied. The time the flare is operating is determined by monitoring the flame using a flame detector and, for enclosed flares, the monitoring requirements provided by the manufacturer's specifications for operating conditions shall be met.

The flare in this project belongs to enclosed flares. According to tool 06 paragraph 19-23: In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute m ($\eta_{flare,m}$) and shall document in the PD which option is selected:

(a) Option A: Apply a default value for flare efficiency;

(b) Option B: Measure the flare efficiency.

In case of missing data for parameters relevant to the measurement of the flare efficiency as per Option B above, the project participants may also choose to follow the provisions of Option A above as a backup approach. The project participant shall document this choice in the PD.

Option A: Default value

The flare efficiency for the minute m ($\eta_{flare,m}$) is 90% when the following two conditions are met to demonstrate that the flare is operating:

(a) The temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's operating specification for the flare (SPECflare) in the minute m; and

(b) The flame is detected in the minute m ($Flame_m$).

Otherwise $\eta_{flare,m}$ is 0%.

For enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points.

Due to the lack of parameter data related to the measurement of torch efficiency according to the above scheme B, the project chooses to determine the combustion efficiency of the torch according to the above scheme A.

Since the temperature of the flare ($T_{EG.m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) are within the manufacturer's operating specifications for the flare (SPECflare) in the minute m, and the flame is detected in minute m ($Flame_m$), and the flare of this project is a low-height torch, therefore, the combustion efficiency of the torch in this project is 80% when the flame is detected in minute m ($Flame_m$); otherwise, $\eta_{flare,m}$ is 0%.

Since the flame is not detected within the minute, a fixed value of 0% for the flare efficiency will be applied for this project, which is a conservative measure.

Step 3: Calculation of project emissions from flaring

Project emissions from flaring are calculated as the sum of emissions for each minute m in year y, based on the methane mass flow in the residual gas ($F_{CH4,RG,m}$) and the flare efficiency ($\eta_{flare,m}$), as follows:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad \text{Equation (20)}$$

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas in year y (t CO_2e)
GWP_{CH4}	Global warming potential of methane valid for the commitment period (t CO_2e/t CH_4)
$F_{CH4,RG,m}$	Mass flow of methane in the residual gas in the minute m (kg)
$\eta_{flare,m}$	Flare efficiency in the minute m

As described above, $F_{CH4,RG,m}$ will be determined according to equations 18 and 19, so the project emissions from flaring can be calculated by:

$$PE_{flare,y} = GWP_{CH4} \times V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad \text{Equation (21)}$$

Where:

$V_{t,db}$	Volumetric flow of the residual gas for flaring in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	Volumetric fraction of greenhouse gas i in the gaseous stream for flaring in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)

$\rho_{i,t}$	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m³ gas i)

Since the gaseous stream will be distributed through the same pipeline, and the temperature and pressure of the gaseous stream can be stable, the $v_{i,t,db}$ and $\rho_{i,t}$ of the residual gas will be the same as the biogas produced in the anaerobic digester.

As all the biogas generated in the AWMS is collected for heat generation, no biogas is flared in pre-calculation. During the monitoring period, the project emissions from flaring of biogas are calculated according to the actual situation.

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

$PE_{CH4,y}$ was determined following step 4 of the applied tool 14 "Project and leakage emissions from anaerobic digesters (Version 02.0) ". Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and sidewalls, 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:

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \quad \text{Equation (22)}$$

Where:

$PE_{CH4,y}$	Project emissions from flaring of the residual gas in year y (t CO_2e)
$Q_{CH4,y}$	Global warming potential of methane valid for the commitment period (t CO_2e/t CH_4)
$EF_{CH4,default}$	Mass flow of methane in the residual gas in the minute m (kg)
GWP_{CH4}	Flare efficiency in the minute m

Estimation of various variables and parameters for above equations:

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

According to the tool 14 "Project and leakage emissions from anaerobic digesters (Version 02.0) ". There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). For large-scale projects defined by CDM, only Option 1 shall be used. For small-scale projects defined by CDM, project participants may choose between Option 1 or Option 2. The proposed project belongs to small-scale projects defined by CDM, and $Q_{CH4,y}$ was determined following Step 1 and Option 1 of the applied tool. Below is the formula used for the calculation of $Q_{CH4,y}$.

Option1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the "Tool to determine the mass flow of a 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.

The biogas is produced and collected from the anaerobic digestion process. The flow meters are installed at the outlet of the biogas digesters and measure on an hourly basis time interval. Therefore, the quantity of methane produced in the digester in year y ($Q_{CH4,y}$) is the accumulation of the mass flow of methane in the gaseous stream on an hourly basis. i.e.,$Q_{CH4,y} = \sum_{i=1}^{8760} F_{i,t}$

The mass flow of greenhouse gas i ($F_{i,t}$) is determined as follows:

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \qquad \text{Equation (23)}$$

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \qquad \text{Equation (24)}$$

Where:

$F_{i,t}$	Mass flow of greenhouse gas i in the gaseous stream in time interval t (kg gas/h)
$V_{t,db}$	Volumetric flow of the gaseous stream in time interval t on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	Volumetric fraction of greenhouse gas i in the gaseous stream in a time interval t on a dry basis (m^3 gas i/m^3 dry gas)
$\rho_{i,t}$	Density of greenhouse gas i in the gaseous stream in time interval t (kg gas i/m^3 gas i)
P_t	Absolute pressure of the gaseous stream in time interval t (Pa)
MM_i	Molecular mass of greenhouse gas i (kg/kmol)
R_u	Universal ideal gases constant (Pa.m^3/kmol.K)
T_t	Temperature of the gaseous stream in time interval t (K)

In summary, the Project emissions associated with the anaerobic digester in year y (t CO_2e) are the sum of the Project emissions of methane from the anaerobic digester in year y (t CO_2e), the

project emissions from electricity consumption and the project emission from flaring of biogas (if any). i.e.,$PE_{AD,y} = PE_{CH4,y} + PE_{EC,y} + PE_{flare,y}$.

(2) Project CH_4 emissions from aerobic AWMS treatment ($PE_{Aer,y}$)

IPCC guidelines specify emissions from aerobic lagoons as 0.1 percent of the total methane-generating potential of the waste processed, which can be used as a default for all types of aerobic AWMS treatment.

$$PE_{Sl,y} = GWP_{CH4} \times D_{CH4} \times MCF_{sl} \times F_{Aer} \times \left[\prod_{n=1}^{N}(1 - R_{VS,n})\right] \times \sum_{j,LT}(B_{0.LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j) + PE_{sl,y} \quad \text{Equation (25)}$$

Where:

GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (t CO_2e/t CH_4)
$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated (fraction)
D_{CH4}	Density of CH_4 (t/m^3)
F_{Aer}	Fraction of volatile solid directed to aerobic system (fraction)
LT	Type of livestock
$B_{0.LT}$	Maximum methane producing potential of the volatile solid generated by animal type LT (m^3CH_4/kg dm)
$VS_{LT,y}$	Annual volatile solid excretion livestock type LT entering all AWMS on a dry matter weight basis in (kg -dm/animal/yr)
N_{LT}	Annual average number of animals of type LT for the year y (number) as estimated in equation (5(a)) or (5(b))
$PE_{sl,y}$	Project CH_4 emissions from sludge disposed of in storage pit prior to disposal during the year y (t CO_2e/yr)
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)

All sludge produced from the aerobic composting will be sold as organic fertilizer, which will be calculated as leakage emission, so $PE_{Sl,y}$=0. So,

$$PE_{Sl,y} = GWP_{CH4} \times D_{CH4} \times MCF_{sl} \times F_{Aer} \times \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] \times \sum_{j,LT}\left(B_{0.LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j\right)$$ Equation（26）

(3) Project N_2O emissions in year y ($PE_{N2O,y}$)

$$PE_{N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(E_{N20,D,y} + E_{N20,ID,y}\right)$$ Equation（27）

Where:

$PE_{N20,y}$	Project N_2O emissions in year y (t CO_2/yr)
GWP_{N20}	Global Warming Potential (GWP) for N_2O (t CO_2e/t N_2O)
$CF_{N20-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$E_{N2O,D,y}$	Direct N_2O emission in year y (kg N_2O-N/year)
$E_{N2O,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)

Option1:

$$E_{N20,D,y} = \sum_{j,LT} EF_{N2O,D,j} \times NEX_{LT,y} \times N_{LT} \times MS\%_j$$ Equation（28）

Where:

$E_{N20,D,y}$	Direct N_2O emission in year y (kg N_2O-N/yr)
$EF_{N2O,D,j}$	Direct N_2O emission factor for the treatment system j of the manure management system (kg N_2O-N/kg N)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr) estimated as described in appendix 2
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)
N_{LT}	Annual average number of animals of type LT for the year y estimated as per equation (5(a)) or (5(b)) (number)

$$E_{N20,ID,y} = \sum_{j,LT} EF_{N2O,ID,j} \times F_{gasMS,j,LT} \times NEX_{LT,y} \times N_{LT} \times MS\%_j$$ Equation（29）

Where:

$E_{N20,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)
$EF_{N20,ID,j}$	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces (kg N_2O N/kg NH_3-N and NO_X-N)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr) estimated as described in appendix 2
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)
$F_{gasMS,j,LT}$	Default values for nitrogen loss due to volatilisation of NH_3 and NO_X from manure management (fraction)
N_{LT}	Annual average number of animals of type LT for the year y estimated as per equation (5(a)) or (5(b)) (number)

Option2:

$$E_{N20,D,y} = \sum_{j} EF_{N20,D,j} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right) \quad \text{Equation (30)}$$

$$E_{N20,ID,y} = EF_{N20,ID} \times \sum_{j,LT} F_{gasMS,j,LT} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right) \quad \text{Equation (31)}$$

Where:

$E_{N20,D,y}$	Direct N_2O emission in year y (kg N_2O-N/year)
$E_{N20,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)
$EF_{N20,D,j}$	Direct N_2O emission factor for the treatment system j of the manure management system (kg N_2O-N/kg N)
$Q_{EM,m}$	Monthly volume of the effluent mix entering the manure management system (m^3/month)
$[N]_{EM,m}$	Monthly total nitrogen concentration in the effluent mix entering the manure management system (kg N/m^3)

$EF_{N20,ID}$	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces (kg N_2O N/kg NH_3-N and NO_X-N)
$F_{gasMS,j,LT}$	Default values for nitrogen loss due to volatilisation of NH_3 and NO_X from manure management (fraction)

The same method used to estimate the emissions in the baseline should be used to estimate the project emissions of nitrous oxide, so Option 1 is used to calculate the Project N_2O emissions $PE_{N2O,y}$.

(4) Project emissions from the use of heat and/or electricity ($PE_{elec/heat}$)

$$PE_{EC/FC,y} = PE_{EC,y} + \sum_{j} PE_{FC,j,y} \qquad \text{Equation (32)}$$

Where:

$PE_{EC,y}$	Project emissions from electricity consumption in year y. The project emissions from electricity consumption will be calculated following the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". In case, the electricity consumption is not measured then the electricity consumption shall be estimated as follows $EC_{PJ,y} = \sum_i CP_{i,y}\, x\, 8760$, where $CP_{i,y}$ is the rated capacity (in MW) of electrical equipment i used for the project activity.
$PE_{FC,j,y}$	Project emissions from fossil fuel combustion in process j during the year y. The project emissions from fossil fuel combustion will be calculated following the latest version of the "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion". For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the AWMS (not including fossil fuels consumed for transportation of feed material and sludge or any other on-site transportation).

These emissions should only be considered for the consumption of electricity or heat that is not related to the anaerobic digester. As described above, since the electricity consumption that is not related to the anaerobic digester cannot be separated from the total electricity consumption, therefore the emission for consumption of electricity is calculated in $PE_{EC,y}$, please refer to $PE_{AD,y}$ calculation.

4.3 Leakage Emissions

Leakage covers the emissions from the land application of treated manure as well as the emissions related to anaerobic digestion in a digester, occurring outside the project boundary. These emissions are estimated as a net of those released under the project activity and those released in the baseline scenario. Net leakage is only considered if it is positive.

$$LE_y = \left(LE_{PJ,N20,y} - LE_{BL,N20,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right) + LE_{AD,y} \quad \text{Equation (33)}$$

Where:

$LE_{PJ,N20,y}$	Leakage N_2O emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)
$LE_{BL,N20,y}$	Leakage N_2O emissions released during baseline scenario from land application of the treated manure in year y (t CO_2e/yr)
$LE_{PJ,CH4,y}$	Leakage CH_4 emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)
$LE_{BL,CH4,y}$	Leakage CH_4 emissions released during baseline scenario from land application of the treated manure in year y (t CO_2e/yr)
$LE_{AD,y}$	Leakage emissions associated with the anaerobic digester in year y (t CO_2e)

(1) Estimation of leakage N_2O emissions released during baseline scenario from land application of the treated manure in year y, $LE_{BL,N20,y}$

$$LE_{BL,N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y}\right) \quad \text{Equation (34)}$$

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (35)}$$

$$LE_{N20,runoff,y} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (36)}$$

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (37)}$$

Where:

GWP_{N20}	Global Warming Potential (GWP) for N_2O (t CO_2e/t N_2O)

$CF_{N20-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$LE_{N20,land,y}$	Leakage N_2O emissions from application of manure waste in year y (kg N_2O N/year)
$LE_{N20,runoff,y}$	Leakage N_2O emissions due to leaching and run-off in year y (kg N_2O-N/year)
$LE_{N20,vol,y}$	Leakage N_2O emissions due to volatilisation in year y (kg N_2O N/year)
F_{gasm}	Fraction of N lost due to volatilization (fraction)
N_{LT}	Annual average number of animals of type LT estimated as per equation (5(a)) or (5(b)) (number)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/year) estimated as described in appendix 2
EF_1	Emission factor for N_2O emissions from N inputs (kg N_2O N/kg N input)
EF_5	Emission factor for N_2O emissions from N leaching and runoff in(kg N_2O-N/kg N leached and runoff)
EF_4	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O/ (kg NH_3-N + NO_X-N volatilized)]
F_{leach}	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (fraction)
$R_{N,n}$	Nitrogen reduction factor (fraction)

(2) Estimation of leakage N_2O emissions released during project activity from land application of the treated manure in year y, $LE_{PJ,N2O}$

$$LE_{PJ,N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y}\right) \quad \text{Equation (38)}$$

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (39)}$$

$$LE_{N20,runoff,y} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (40)}$$

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (41)}$$

Where:

GWP_{N20}	Global Warming Potential (GWP) for N_2O (t CO_2e/t N_2O)
$CF_{N20-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$LE_{N20,land,y}$	Leakage N_2O emissions from application of manure waste in year y (kg N_2O N/year)
$LE_{N20,runoff,y}$	Leakage N_2O emissions due to leaching and run-off in year y (kg N_2O-N/year)
$LE_{N20,vol,y}$	Leakage N_2O emissions due to volatilisation in year y (kg N_2O N/year)
F_{gasm}	Fraction of N lost due to volatilization (fraction)
N_{LT}	Annual average number of animals of type LT estimated as per equation (5(a)) or (5(b)) (number)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/year) estimated as described in appendix 2
EF_1	Emission factor for N_2O emissions from N inputs (kg N_2O N/kg N input)
EF_5	Emission factor for N_2O emissions from N leaching and runoff in (kg N_2O-N/kg N leached and runoff)
EF_4	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O/ (kg NH_3-N + NO_X-N volatilized)]
F_{leach}	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (fraction)
$R_{N,n}$	Nitrogen reduction factor (fraction)

It is not possible to measure the quantity of manure applied to land in kg manure/yr (Q_{DM}) and the nitrogen concentration in kg N/kg manure (N_{DM}) in the manure to estimate the total quantity

of nitrogen applied to land. In this case, $\prod_{n=1}^{N}(1-R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT}$ does not need to be replaced by $Q_{DM} \times N_{DM}$.

(3) Estimation of leakage CH_4 emissions from land application of the treated manure

The calculation of methane emissions from land application of manure in the baseline and project cases are estimated as below:

$$LE_{BL,CH4,y} = GWP_{CH4} \times D_{CH4} \times MCF_d \times \left[\prod_{n=1}^{N}(1-R_{VS,n})\right] \times \sum_{j,LT} B_{0,LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j \quad \text{Equation (42)}$$

$$LE_{PJ,CH4,y} = GWP_{CH4} \times D_{CH4} \times MCF_d \times \left[\prod_{n=1}^{N}(1-R_{VS,n})\right] \times \sum_{j,LT} B_{0,LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j \quad \text{Equation (43)}$$

Where:

$LE_{BL,CH4,y}$	Leakage CH_4 emissions released during baseline scenario from land application of the treated manure in year y (t CO_2e/yr)
$LE_{PJ,CH4,y}$	Leakage CH_4 emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)
$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to sludge being treated
GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (t CO_2e/t CH_4)
D_{CH4}	Density of CH_4 (t/m^3)
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated by animal type LT (m^3 CH_4/kg dm)
N_{LT}	Annual average number of animals of type LT estimated as per equation (5(a)) or (5(b)), expressed (number)
$VS_{LT,y}$	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis (kg -dm/animal/yr)

$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)
MCF_d	Methane conversion factor (MCF) assumed to be equal to 1

(4) Estimation of leakage emissions associated with the anaerobic digester

$LE_{AD,y}$ is determined using the methodological tool 14 "Project and leakage emissions from anaerobic digesters (Version 02.0) ".

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:

$$LE_{AD} = LE_{stroage,y} + LE_{comp,y} \quad \text{Equation (44)}$$

Where:

$LE_{AD,y}$	Leakage N_2O emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)
$LE_{stroage,y}$	Leakage N_2O emissions released during baseline scenario from land application of the treated manure in year y (t CO_2e/yr)
$LE_{comp,y}$	Leakage CH_4 emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)

For subsequent treatment stages, the reduction of nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by $(1 - R_N)$, where R_N is the relative reduction of nitrogen from the previous stage. The relative reduction (R_N) of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in Appendix 1 (values for T_N).

The anaerobic digestion process of this project is carried out in a fully enclosed system. The biogas generated during the treatment process will be captured for heat generation. After anaerobic digestion, the fermented sludge will be treated in an aerobic composting system, which will be used as fertilizer. Wastewater from the animal waste management systems will be treated aerobically and then used for agricultural irrigation. Therefore, the estimation of leakage emissions associated with the anaerobic digester is 0, i.e., $LE_{AD,y}$ =0.

4.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals

The emission reduction ER_y by the project activity during a given year y is the difference between the baseline emissions (BE_y) and the sum of project emissions (PE_y) and leakage, as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (45)}$$

Further, when estimating emissions reductions to claim certified emissions reductions, if the calculated CH_4 baseline emissions from anaerobic lagoons are higher than the measured CH_4 generated in the anaerobic digester in the project situation ($Q_{CH4,y}$ in the tool "Project and leakage emissions from anaerobic digesters"), then the latter shall be used to calculate the emissions reduction for claiming certified emissions reductions. Therefore, the actual methane captured from an anaerobic digester should be compared to the ($BE_{CH4,y} - PE_{AD,y}$ in the tool "Project and leakage emissions from anaerobic digesters"). if it is found to be lower, then ($BE_{CH4,y} - PE_{AD,y}$) (which is a component of $BE_y - PE_y$) in Equation (45) is replaced by $Q_{CH4,y}$.

As described above, emission reductions of the project are as below:

Calculation of the baseline emission:

$$BE_y = BE_{CH4,y} + BE_{N2O,y}$$

Parameter	Value	Unit
GWP_{CH4}	28	t CO_2/t CH_4
D_{CH4}	0.00067	t /m^3
MCF_j	73%	%
Conservative Factor	0.94	/
MCF with cons. Factor	68.62%	/
$B_{0,LT}$	0.45	m^3 CH_4 /kg-dm
N_{LT}	50,000	No of heads
W_{site}	115	kg
$W_{default}$	49	kg
$VS_{default}$	0.3332	kg-dm/animal/day
$VS_{LT,y}$	285.43	kg-dm/animal/yr
$MS\%_{BI,j}$	100%	%
nd_y	365	days
$BE_{CH4,y}$	**82,673**	**t CO_2e**

Parameter	Value	Unit
$EF_{N2O,D,j}$	0	kg N_2O-N/kg N
$N_{rate(T)}$	0.7	kg N/1000kg animal mass/day
$NEX_{IPCCdefault}$	12.52	%
W_{site}	115	/
$W_{default}$	49	/
$NEX_{LT,y}$	29.38	m^3 CH_4 /kg-dm
N_{LT}	50,000	No of heads
$MS\%_{BI,j}$	100%	%
$E_{N2O,D,j}$	**0**	**kg N_2O-N/year**

Parameter	Value	Unit
$EF_{N2O,ID,y}$	0.01	kg N_2O/kg N
$F_{gasMS,j,LT}$	40%	kg N/1000kg animal mass/day
$NEX_{LT,y}$	29.38	m^3 CH_4 /kg-dm
N_{LT}	50,000	No of heads
$MS\%_{BI,j}$	100%	%
$E_{N2O,ID,j}$	**5,877**	**kg N_2O-N/year**

Parameter	Value	Unit
$E_{N2O,D,j}$	0	kg N_2O-N/year
$E_{N2O,ID,j}$	5,877	kg N_2O-N/year
GWP_{N2O}	265	t CO_2/t N_2O
$CF_{N2O,N-N}$	1.57	Conversion Factor N_2O-N to N_2O
$BE_{N2O,y}$	**2,447**	**t CO_2e**

Baseline Emissions: $BE_{CH4,y} + BE_{N2O,y}$=82,673 tCO_2e + 2,447 tCO_2e = 85120 tCO_2e

Calculation of the project emission:

Parameter	Value	Unit
$EC_{PJ,j,y}$	500	MWh/year
$EF_{EF,j,y}$	0.4860	tCO_2/MWh
$TDL_{j,y}$	20%	/
$PE_{EC,y}$	**292**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$EF_{CH4,default}$	0.10	tCH_4 leaked / tCH_4 produced
$Q_{CH4,y}$	24.29	tCH_4
$PE_{CH4,y}$	**69**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$F_{CH4,RG,m}$	0	tCH_4
$\eta_{flare,m}$	0	%
$PE_{flare,y}$	**0***	**t CO_2e**

*As all the biogas generated in the AWMS is collected for heat generation, no biogas is flared in pre-calculation. In the monitoring period, the project emissions from flaring of biogas are calculated according to the actual situation.

$PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$ = 292 tCO_2e + 35 tCO_2e + 0 tCO_2e = 327 tCO_2e

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
	0.001	/
F_{Aer}	100%	/
$1-R_{VS,1}$	20%	/

$B_{0,LT}$	0.45	m^3 CH_4 /kg VS
N_{LT}	50,000	No of heads
$VS_{LT,y}$	285.43	kg-dm/animal/yr
$MS\%_j$	100%	/
$PE_{Aer,y}$	**25**	**t CO_2e**

Parameter	Value	Unit
$EF_{N2O,D,j}$	0.01	kg N_2O-N/kg NH_3 and NO_X-N
$NEX_{LT,y}$	29.38	kg N/animal/yr
N_{LT}	50,000	No of heads
MS%j	100%	/
$E_{N2O,D,y}$	882	kg N_2O-N/yr

Parameter	Value	Unit
$EF_{N2O,ID,j}$	0.01	kg N_2O-N/kg NH_3 and NO_X-N
F_{gas}	50%	/
N_{LT}	50,000	No of heads
MS%j	100%	/
$EF_{N2O,ID,y}$	7,346	kg N_2O-N/yr

Parameter	Value	Unit
GWP_{N2O}	265	tCO_2/tN_2O
$CF_{N2O-N,N}$	1.57	Conversion Factor N_2O-N to N_2O
$PE_{N2O,y}$	**3,427**	**t CO_2e**

Project Emissions: $PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y}$ = 361 tCO_2 + 25 tCO_2 + 3,427 tCO_2 = 3813 tCO_2

Calculation of leakage:

$$LE_y = \left(LE_{PJ,N2O,y} - LE_{BL,N2O,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right)$$

Parameter	Value	Unit
N_{LT}	50,000	No of heads
$NEX_{LT,y}$	29.38	Kg N/animal/yr
$R_{N,n}$	80%	/
EF_1	0.01	kg N_2O-N/kg N
EF_5	0.011	kg N_2O-N/kg N
EF_4	0.01	kg N_2O-N/kg NH_3 and NO_X-N
F_{leach}	0.24	/
F_{gasm}	0.21	/
GWP_{N2O}	265	tCO_2/tN_2O
$LE_{N2O,land,y}$	2,938	kg N_2O-N/yr
$LE_{N2O,runoff,y}$	776	kg N_2O-N/yr
$LE_{N2O,vol,y}$	617	kg N_2O-N/yr
$LE_{BL,N2O,y}$	**1,803**	**t CO_2e**

Parameter	Value	Unit
N_{LT}	50,000	No of heads
$NEX_{LT,y}$	29.38	Kg N/animal/yr
$R_{N,n1}$	5%	/
$R_{N,n2}$	25%	/
EF_1	0.01	kg N_2O-N/kg N
EF_5	0.011	kg N_2O-N/kg N
EF_4	0.01	kg N_2O-N/kg NH_3 and NO_X-N
F_{leach}	0.24	/
F_{gasm}	0.21	/
GWP_{N2O}	265	tCO_2/tN_2O
$LE_{N2O,land,y}$	10,468	kg N_2O-N/yr

$LE_{N2O,runoff,y}$	2,763	kg N_2O-N/yr
$LE_{N2O,vol,y}$	2,199	kg N_2O-N/yr
$LE_{PJ,N2O,y}$	**6,426**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
MCF_d	1	/
$VS_{LT,y}$	285.43	kg-dm/animal/yr
N_{LT}	50,000	No of heads
B_0	0.45	m^3 CH_4 /kg VS
R_{vs}	85%	/
$MS\%_j$	100%	/
$LE_{BL,CH4,y}$	**18,072**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
MCF_d	1	/
$VS_{LT,y}$	285.43	kg-dm/animal/yr
N_{LT}	50,000	No of heads
B_0	0.45	m^3 CH_4 /kg VS
R_{vs}	85%	/
$MS\%_j$	100%	/
$LE_{BL,CH4,y}$	**18,072**	**t CO_2e**

Parameter	Value	Unit

GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
MCF_d	1	/
$VS_{LT,y}$	285.43	kg-dm/animal/yr
N_{LT}	50,000	No of heads
B_0	0.45	m^3 CH_4 /kg VS
$R_{vs,1}$	20%	/
$R_{vs,2}$	80%	/
$MS\%_j$	100%	/
$LE_{PJ,CH4,y}$	**19,227**	**t CO_2e**

$LE_y=(LE_{PJ,N2O,y} - LE_{BL,N2O,y})+(LE_{PJ,CH4,y} - LE_{BL,CH4,y})=(6,426 - 1,803)\ tCO_2 + (19277 - 18072)\ tCO_2 = 5,828\ tCO_2$

$ER_y = BE_y – PE_y – LE_y = 85,120\ tCO_2 – 3,813\ tCO_2 – 5,828\ tCO_2 = 75,4790\ tCO_2$

Vintage period	Estimated baseline emissions (tCO_2e)	Estimated project emissions (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated reduction VCUs (tCO_2e)	Estimated removal VCUs (tCO_2e)	Estimated total VCUs (tCO_2e)
25-Jun-2023 to 31-Dec-2023	65,584	1,985	3,034	60,565	0	58,182
01-Jan-2024 to 31-Dec-2024	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2025 to 31-Dec-2025	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2026 to 31-Dec-2026	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2027 to 31-Dec-2027	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2028 to 31-Dec-2028	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2029 to 31-Dec-2029	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2030 to 31-Dec-2030	85,120	3,813	5,828	75,479	0	75,479

01-Jan-2031 to 31-Dec-2031	85,120	3,813	5,828	75,479	0	75,479
01-Jan-2032 to 24-Jun-2032	19,536	1828	2,794	14,914	0	14,914
Total	**851200**	**38,130**	**58,280**	**754,790**	**0**	**754,790**

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC Fifth Assessment Report (AR5)
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	As per the requirements described in Section 3.15.4 of the VCS Standard (V4.7), all reductions shall be converted to CO_2e using 100-year global warming potential (GWP) values. For reductions occurring on or after January 1, 2021, all ex-ante estimates and ex-post calculations shall be converted to CO_2e using GWP values from the IPCC Fifth Assessment Report (AR5).
Purpose of data	Calculation of baseline emissions and project emissions
Comments	N/A

Data / Parameter	GWP_{N2O}
Data unit	t CO_2e/tN_2O
Description	Global Warming Potential of N_2O
Source of data	IPCC Fifth Assessment Report (AR5)
Value applied	265
Justification of choice of data or description of	As per the requirements described in Section 3.15.4 of the VCS Standard (V4.7), all reductions shall be converted to CO_2e using 100-year global warming potential (GWP) values. For reductions

measurement methods and procedures applied	occurring on or after January 1, 2021, all ex-ante estimates and ex-post calculations shall be converted to CO_2e using GWP values from the IPCC Fifth Assessment Report (AR5).
Purpose of data	Calculation of baseline emissions and project emissions
Comments	N/A

Data / Parameter	D_{CH4}
Data unit	t/m^3
Description	Density of CH_4
Source of data	ACM0010 Version 08.0
Value applied	0.00067
Justification of choice of data or description of measurement methods and procedures applied	0.00067 t/m^3 at room temperature 20˚C and 1 atm pressure.
Purpose of data	Used in project emission/baseline calculations
Comments	N/A

Data / Parameter	MCF_j
Data unit	/
Description	Methane conversion factor for the baseline $AWMS_j$
Source of data	IPCC 2019 Refinement, volume 4, chapter 10, table 10.17
Value applied	73%
Justification of choice of data or description of measurement methods and procedures applied	MCF_j value for uncovered anaerobic lagoon (baseline AWMS) is chosen. A conservativeness factor has been applied by multiplying MCF_j value (i.e., 73%) with a value of 0.94, to account for the 20 per cent uncertainty in the MCF_j values as reported by IPCC. (a) The MCF_j values are given in table 10.17, chapter 10, volume 4, 2019 Refinement to the 2006 IPCC Guidelines should be used. MCF_j values depend on the climate zone where the anaerobic manure treatment facility in the baseline existed. For this project, the annual average temperature is 15.5°C, the average annual

	precipitation is 966.5 mm[24]. Therefore, the climate zone of the project site can be determined to "Warm temperature moist", and the value of 73% is applied. Therefore, MCF_j value of 68.62% will be applied.
Purpose of data	Used in project emission/baseline calculations
Comments	N/A

Data / Parameter	$MS\%_{BI,j}$
Data unit	Fraction
Description	Fraction of manure handled in system j in the baseline
Source of data	Project proponent
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	In this project, the baseline manure management system is an uncovered anaerobic lagoon only. The amount of manure handled by the anaerobic lagoon is 100%.
Purpose of data	Used in baseline emission calculations
Comments	N/A

Data / Parameter	$W_{default}$
Data unit	kg
Description	Default average animal weight of a defined population
Source of data	2019 Refinement to the 2006 IPCC Guidelines table 10A.5, chapter 10, volume 4
Value applied	49
Justification of choice of data or description of measurement methods and procedures applied	The project is located in China, Asia. Thus, the default values for market swine in the Asia area given by IPCC are applied.
Purpose of data	Used in baseline emission calculations

[24] https://www.longyang.gov.cn/info/6305/9999849.htm

Comments	N/A

Data / Parameter	$VS_{default}$
Data unit	kg-dm/animal/day
Description	Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock population
Source of data	Calculated according to the default value in table 10.13A and 10A.5, chapter 10, volume 4, 2019 Refinement to the 2006 IPCC Guidelines
Value applied	Calculated by the equation: $VS_{default} = VS_{rate(T)} * TAM/1000$ $VS_{default} = 0.3332$
Justification of choice of data or description of measurement methods and procedures applied	VS default value is calculated with the default values for volatile solid excretion rate and $W_{default}$. The project is located in China, Asia; thus, the default values for market swine in the Asia area, as given by the IPCC, are applied. The involved swine farm is situated somewhere between high productivity systems and low productivity systems. According to table 10.13A and 10A.5, chapter 10, volume 4, 2019 Refinement to the 2006 IPCC Guidelines, a volatile solid excretion rate value of 6.8 kg VS (1000 kg animal mass)$^{-1}$ day^{-1} is applied for market swine.
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$NEX_{IPCC\ default}$
Data unit	kg N/animal/year
Description	Default value for the nitrogen excretion per head of a defined livestock population
Source of data	Calculated by the equation: $NEX_{IPCC\ default} = N_{rate(T)} * TAM/1000*365$
Value applied	$NEX_{IPCC\ default} = 12.52$
Justification of choice of data or description of	The $NEX_{IPCC\ default}$ is calculated as equation 10.30 in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse

measurement methods and procedures applied	Gas Inventories. $N_{rate(T)}$ and TAM are default values from the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Purpose of data	Baseline, project and leakage emissions calculations
Comments	N/A

Data / Parameter	$N_{rate(T)}$
Data unit	kg N (1000 kg animal mass) $^{-1}$ day $^{-1}$
Description	default N excretion rate
Source of data	$N_{rate(T)}$ is default values from table 10.19, chapter 10, volume 4 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied	$N_{rate(T)}$=0.7
Justification of choice of data or description of measurement methods and procedures applied	Default value from 2019 Refinement to the 2006 IPCC Guidelines is applied.
Purpose of data	$NEX_{IPCC\ default}$ calculations
Comments	N/A

Data / Parameter	TAM
Data unit	kg animal^{-1}
Description	typical animal mass for livestock category
Source of data	2019 Refinement to the 2006 IPCC Guidelines table 10A.5, chapter 10, volume 4
Value applied	49
Justification of choice of data or description of measurement methods and procedures applied	Default value from 2019 Refinement of 2006 IPCC Guidelines is applied.
Purpose of data	$NEX_{IPCC\ default}$ calculations
Comments	N/A

Data / Parameter	$F_{gas\ MS,j,LT}$
Data unit	Fraction
Description	Default values for nitrogen loss due to volatilization of NH_3 and NO_X from manure management
Source of data	2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10, Table 10.22
Value applied	40% (Baseline, anaerobic lagoon) 50% (Project, anaerobic digester)
Justification of choice of data or description of measurement methods and procedures applied	Default value for anaerobic lagoon (Baseline) Max default value given for Anaerobic digester (Project) adopted for conservativeness
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$EF_{N2O,D,j}$
Data unit	kg N_2O-N/kg N
Description	Direct N_2O emission factor for the treatment system j of the manure management system
Source of data	2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10, Table 10.21
Value applied	$EF_{N2O,D}$=0 for Uncovered anaerobic lagoon, $EF_{N2O,D}$=0.0006 for Anaerobic Digester
Justification of choice of data or description of measurement methods and procedures applied	Site-specific data is unavailable; therefore, default values are opted for.
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$EF_{N2O,ID,j}$

Data unit	kg N_2O-N/kg NH_3-N and NO_X-N
Description	Indirect N_2O emission factor for the treatment system j of the manure management system
Source of data	2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
Value applied	0.01
Justification of choice of data or description of measurement methods and procedures applied	Site-specific data is unavailable; therefore, default values are opted for.
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

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 by those leaks from the anaerobic digester (fraction)
Source of data	Tool 14: "Project and leakage emissions from anaerobic digesters (version 02.0)"
Value applied	0.10[25]
Justification of choice of data or description of measurement methods and procedures applied	Black membrane biogas digester, floating gas holders with no external water seal.
Purpose of data	Calculation of project emissions
Comments	$PE_{CH4,y}$ for ex-ante estimation, adopted equation (4) of the methodological tool "Project and leakage emissions from anaerobic digesters." The amount of biogas collected at the digester will be monitored.

[25] As per tool 14: "project and leakage emission from anaerobic digesters (version 02.0)", the value this parameter should be determined according to the type of digester used in the project activity and the digester type shall be identified by manufacturer information. For this project, as per the purchasing contract of Anaerobic digester, the type of digester used in the project activity belongs to black membrane biogas digester, so the Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester (fraction) is 0.10 t CH_4 leaked / t CH_4 produced.

Data / Parameter	$R_{VS,n}$
Data unit	Fraction
Description	Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated
Source of data	Refer to Appendix 1 of methodology ACM0010 (version 08.0)
Value applied	$R_{VS,n}$, aerobic treatment and anaerobic digester[26] :20%, 80% leakage CH_4 emission released during project activity. $R_{VS,n}$ uncovered anaerobic lagoon[27] : 85% for leakage CH_4 emission released during baseline scenario.
Justification of choice of data or description of measurement methods and procedures applied	Estimated from Table provided in Appendix 1 of ACM0010. The most conservative value for the given technology must be used.
Purpose of data	Used in project emission/ leakage calculations
Comments	The most conservative value for the given technology must be used.

Data / Parameter	$R_{N,n}$
Data unit	Fraction
Description	Nitrogen reduction factor
Source of data	Refer to Appendix 1 of methodology ACM0010 (version 08.0)
Value applied	$R_{N,n}$, anaerobic digester: 5%, 25%[28] for leakage N_2O emission released during project activity.

[26] For the project, prior to the sludge being treated, it undergoes two stages of homogenization pretreatment, and anaerobic fermentation, which similar to the anaerobic treatment of underfloor pit storage and covered first cell of two cell lagoon. Therefore, the corresponding R_{VS} of each stage is 20% and 80% respectively as Appendix 1 of the methodology.

[27] For project, the baseline is uncovered anaerobic lagoon which belongs to the anaerobic treatment of "One-cell lagoon" in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{VS,n}$ is 85% which is the most conservative value.

[28] Since RVS of each stage is 20% and 80%. Therefore $R_{N,n}$ is 5% and 25% corresponding as Appendix 1 of applied methodology ACM0010 (version 08.0).

	$R_{N,n}$, uncovered anaerobic lagoon: 80% [29] for leakage N_2O emission released during baseline scenario.
Justification of choice of data or description of measurement methods and procedures applied	Estimated from Table provided in Appendix 1 of ACM0010. The most conservative value for the given technology must be used.
Purpose of data	Calculation of leakage emission
Comments	N/A

Data / Parameter	EF_1, EF_4, EF_5
Data unit	kg N_2O-N/kg N for EF_1, EF_5 and [kg N_2O-N/ (kg NH_3-N and NO_X-N) for EF_4
Description	Emission factor for N_2O emissions from N inputs; from N leaching and runoff; from atmospheric deposition of N on soils and water surfaces
Source of data	EF_1 from 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.1. EF_4 and EF_5 from 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
Value applied	EF_1 = 0.010 EF_4 =0.010 EF_5 = 0.011
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of data	Calculation of leakage emission
Comments	N/A

Data / Parameter	F_{gasm}
Data unit	Fraction

[29] For the project, the baseline is uncovered anaerobic lagoon which similar to the anaerobic treatment of One-cell lagoon in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{N,n}$ is 80% which is the most conservative value.

Description	Fraction of N lost due to volatilization
Source of data	Default values from 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
Value applied	0.21
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	F_{leach}
Data unit	Fraction
Description	Fraction of all N added to/mineralized in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff
Source of data	Default values from 2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, Table 11.3
Value applied	0.24
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of data	Used in leakage emission calculation.
Comments	N/A

Data / Parameter	MCF_d
Data unit	/
Description	Methane conversion factor for leakage calculation
Source of data	Methodology ACM0010(version 08.0)

Value applied	1
Justification of choice of data or description of measurement methods and procedures applied	According to paragraph 51 of the methodology ACM0010 "GHG emission reductions from manure management systems (version 08.0)", the Methane conversion factor for leakage calculation is assumed to be equal to 1.
Purpose of data	Used in leakage emission calculation.
Comments	N/A

Data / Parameter	$EF_{EF,j,y}$
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation
Source of data	Published by Ministry of Ecology and Environment of China, which is the DNA of China[30]
Value applied	0.4860
Justification of choice of data or description of measurement methods and procedures applied	According to tool "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Purpose of data	Used in project emission calculation.
Comments	N/A

Data / Parameter	R_u
Data unit	$Pa.m^3/kmol.K$
Description	Universal ideal gases constant
Source of data	Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)"
Value applied	8314
Justification of choice of data or description of	Value is fixed as Tool 08

[30] http://www.ncsc.org.cn/SY/zywj/202407/t20240709_1081217.shtml

measurement methods and procedures applied	
Purpose of data	Used in project emission calculation.
Comments	N/A

Data / Parameter	MM_i
Data unit	kg/kmol
Description	Molecular mass of greenhouse gas i
Source of data	Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)"
Value applied	16.04 kg/mol for methane
Justification of choice of data or description of measurement methods and procedures applied	Value is fixed as Tool 08
Purpose of data	Used in project emission calculation.
Comments	N/A

Data / Parameter	$\eta_{flare,m}$
Data unit	%
Description	Flare efficiency in minute m
Source of data	Tool 06"Project emissions from flaring (Version 04.0)"
Value applied	0%
Justification of choice of data or description of measurement methods and procedures applied	Since the temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's operating specification for the flare ($SPEC_{flare}$) in the minute m; and the flame is detected in the minute m ($Flame_m$), and the flare of this project is a low height torch, therefore, the combustion efficiency of the torch in this project is 80% when the flame is detected in the minute m ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%. Since the flame is not detected in the minute, therefore, fixed value of 0% for the flare efficiency will be applied for this project, and this is for conservative.

Purpose of data	Used in project emission calculation.
Comments	N/A

5.2 Data and Parameters Monitored

Data / Parameter	$N_{AA,LT}$
Data unit	Number
Description	Daily stock of animals on the farm, discounting dead and discarded animals.
Source of data	Project proponent
Description of measurement methods and procedures to be applied	Each pig involved in this project has a unique electronic ear tag that it was born with, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag is connected to the Data Collection System (DCS), which can store and read information. The technicians on farms monitor and record the number of swine through the auto-tracking devices of electronic ear tags daily, including new imported animals and excluding dead and discharged animals. The annual average number of animals ($N_{AA,LT}$) is calculated as an average of the daily stock of swine on the farms without considering dead animals and discarded animals.
Frequency of monitoring/recording	Daily
Value applied	50,000 heads of market swine were used to estimate, and this value is sourced from the project evaluation report.
Monitoring equipment	N/A
QA/QC procedures to be applied	Archive electronically during the project plus 5 years.
Purpose of data	Used for the calculation of N_{LT}, which is used in the calculation of the baseline emission, project emission, and leakages emission.
Calculation method	N/A
Comments	The project proponent monitors the population of breeding pigs through the auto-tracking device, which is connected to the Data

	Collection System (DCS). Therefore, the data of $N_{AA,LT}$ can be obtained through DCS.

Data / Parameter	W_{site}
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Source of data	Project evaluation report from project proponent
Description of measurement methods and procedures to be applied	Measured by the weight measurer
Frequency of monitoring/recording	Monthly
Value applied	135
Monitoring equipment	weight measurer
QA/QC procedures to be applied	Sampling procedures will be used to estimate this variable, taking into account the following guidance: (a) To ensure representativeness, each defined livestock population should be classified into a minimum of three age categories. (b) For each defined livestock population, a minimum of one monthly sample per age category should be taken. (c) When estimating baseline emissions and emissions released during the baseline scenario from land application of the treated manure in the leakage section, the lower bound of the 95% confidence interval obtained from the sampling measurements should be used. (d) When estimating project emissions and emissions released during project activity from land application of the treated manure in the leakage section, the upper bound of the 95% confidence interval obtained from the sampling measurements should be used. The weight measurer will be calibrated annually to ensure the reliability of the parameter.
Purpose of data	Used for estimating $VS_{LT,y}$ and $NEX_{LT,y}$

Calculation method	N/A
Comments	N/A

Data / Parameter	F_{Aer}
Data unit	Fraction
Description	Fraction of volatile solids directed to aerobic treatment
Source of data	Project Evaluation Report
Description of measurement methods and procedures to be applied	As this parameter is not monitored in the actual operation, it is important to be conservative during the monitoring period. Therefore, the value of this parameter in the emission reduction calculation is set at 100%.
Frequency of monitoring/recording	Annually
Value applied	100%
Monitoring equipment	N/A
QA/QC procedures to be applied	The value of this parameter in the emission reduction calculation is 100%, which is conservative.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	nd_y
Data unit	Number
Description	Number of days treatment plant was operational in year y
Source of data	Project proponent
Description of measurement methods	The number of days the treatment plant was operational will be recorded manually by the responsible staff.

and procedures to be applied	
Frequency of monitoring/recording	Daily recorded, monthly aggregated
Value applied	365 days for ex-ante estimation. The actual number of days the treatment plant was operational during the monitoring periods will be monitored by the project proponent.
Monitoring equipment	N/A
QA/QC procedures to be applied	The daily readout of the flowmeter installed at the outlet of the anaerobic digestion on the farm can be cross-checked to ensure that the treatment plant on each farm is operational.
Purpose of data	Calculation of Baseline emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	V_f
Data unit	m^3
Description	Biogas flow
Source of data	Project proponent
Description of measurement methods and procedures to be applied	Measured by the flow meters.
Frequency of monitoring/recording	Continuously by flow meter and reported cumulatively on weekly basis.
Value applied	$6.04*10^4$ m^3 of biogas are expected to be generated by the project annually, which is sourced from the Project Evaluation Report.
Monitoring equipment	Flow meters
QA/QC procedures to be applied	The calibration of flow meters, including the frequency of calibration, should be done in accordance with national standards or requirements. According to the flow meter calibration standard JJG1029-2007 "Vortex flow meter Verification Regulations", the verification cycle of the flow meter is generally not more than 2 years.

Purpose of data	Calculation of project emissions and leakage
Calculation method	N/A
Comments	The biogas flow will be measured at three points. However, if the project participants can demonstrate that there is zero leakage in the distribution pipeline, it does not need to be measured at any three points. The biogas flow used to heat equipment at a given moment can be considered destroyed by monitoring whether the equipment was working during that time. For the proposed project, the biogas generated during the treatment process will be captured for heat generation. Therefore, the biogas produced from anaerobic digestion, the amount of biogas used for heat generation, and the amount of biogas flared (if any) will be monitored through the flow meter.

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the proposed project in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Description of measurement methods and procedures to be applied	Measured by electricity meters installed at the electricity consumption sources.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	500 MWh for ex-ante estimation. During the monitoring period, if the electricity consumption is sourced from the grid company, then the value will be determined according to the electricity meters monitoring and cross-checked with the grid statement.
Monitoring equipment	Electricity meters
QA/QC procedures to be applied	The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$TDL_{j,y}$
Data unit	/
Description	Average technical transmission and distribution losses for providing electricity to source j in year y
Source of data	Tool 05"Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
Description of measurement methods and procedures to be applied	Default value of 20% will be applied, which is conservative. According to tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (version 03.0)
Frequency of monitoring/recording	This value will change once the tool is updated
Value applied	20%
Monitoring equipment	N/A
QA/QC procedures to be applied	Default value of 20% is applied, which is the maximum value as per Methodology tool 05 Version 03.0 and conservative
Purpose of data	Calculation of project emissions
Calculation method	/
Comments	N/A

Data / Parameter	$V_{t,db}$
Data unit	m^3 dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Measured by Electronic flowmeter
Description of measurement methods and procedures to be applied	Volumetric flow measurement should always refer to the actual pressure and temperature.
Frequency of monitoring/recording	Continuous measurement, hourly recorded

Value applied	Biogas was estimated based on the amount of manure for ex ante estimation and will be monitored during the monitoring period.
Monitoring equipment	Electronic flowmeter
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration and frequency of calibration should be in accordance with the manufacturer's specifications, which are required to comply with the flowmeter calibration standard JJG1029-2007 "Vortex Flowmeter Verification Regulations." The verification cycle for the flowmeter is generally not more than 2 years.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$V_{i,t,db}$
Data unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Measured by gas analyzer
Description of measurement methods and procedures to be applied	Continuous gas analyzers operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature
Frequency of monitoring/recording	Continuous measurement, hourly recorded
Value applied	CH_4 fraction of biogas is 60% in pre-estimated which sourced from Project evaluation report. In monitoring period, this value will be monitored by the gas analyzers.
Monitoring equipment	Gas analyzer
QA/QC procedures to be applied	Calibration should include zero verification with an inert gas (e.g., N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be within their validity period. According to JJG693-2011 "Verification Regulation of Alarm Detectors of Combustible Gas," the verification cycle of the gas analyzers is generally not more than 1 year.

Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	T_t
Data unit	K
Description	Temperature of the gaseous stream in time interval t
Source of data	Measured by Electronic flowmeter
Description of measurement methods and procedures to be applied	Measured continuously by the biogas flow meters, since the flowmeters can monitor other parameter such as $V_{t,db}$, T_t and P_t simultaneously. And record hourly and saved automatically in the DCS system.
Frequency of monitoring/recording	Continuous measurement and the data can be obtained from this system and the monthly data was exported by the staff at the beginning of next month and then recorded in monthly operation report. Daily and monthly temperature was calculated based on the 24-hour average and daily average temperature.
Value applied	293.15 K was used in the pre-calculation for the density of CH_4 as the applied methodology ACM0010(Version08.0), in actual monitoring period, the temperature of the gaseous stream is monitored by the recordable electronic signal. The temperature Tt(K) is calculated as the equation T(K)=t(°C) +273.15.
Monitoring equipment	Electronic flowmeter
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration and frequency of calibration should be in accordance with the manufacturer's specifications, which are required to comply with the flowmeter calibration standard JJG1029-2007 "Vortex Flowmeter Verification Regulations". The verification cycle for the flowmeter is generally not more than 2 years.
Purpose of data	Calculation of project emissions
Calculation method	N/A

Comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination, and therefore it should be measured only when performing such measurements (with the same frequency).

Data / Parameter	P_t
Data unit	Pa
Description	Pressure of the gaseous stream in time interval t
Source of data	Measured by Electronic flowmeter
Description of measurement methods and procedures to be applied	Measured continuously by the biogas flow meters since the flowmeters can monitor other parameter such as $V_{t,db}$, T_t and P_t simultaneously. And record hourly and saved automatically in the DCS system.
Frequency of monitoring/recording	Continuous measurement and data can be obtained from this system. The monthly data is exported by the staff at the beginning of the next month and then recorded in the monthly operation report.
Value applied	101.325 kPa for the pre-calculation for the density of CH_4 as the applied methodology ACM0010 (Version08.0), in actual monitoring period, the pressure of the gaseous stream is monitored by the recordable electronic signal.
Monitoring equipment	Electronic flowmeter
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. The calibration and frequency of calibration should be in accordance with the manufacturer's specifications, which are required to comply with the flowmeter calibration standard JJG1029-2007 "Vortex Flowmeter Verification Regulations." The verification cycle for the flowmeter is generally not more than 2 years.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	Provided all parameters are converted to normal conditions during the monitoring process, this parameter may not be needed except for moisture content determination and therefore it should be metered only when performing such measurements (with same frequency)

Data / Parameter	$\rho_{i,t}$
Data unit	kg gas i/m³ gas i
Description	Density of greenhouse gas i in the gaseous stream in time interval t
Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculated based on temperature and pressure of the gaseous stream in time interval t
Frequency of monitoring/recording	Pressure and temperature are measured continuously by the electronic flow meter
Value applied	0.00067 t/m³ for ex-estimated. In monitoring period, this parameter is calculated based on temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emissions
Calculation method	Calculation as Equation 19 and Equation 24
Comments	N/A

Data / Parameter	$MS\%_j$
Data unit	Fraction
Description	Fraction of manure handled in system j in project activity
Source of data	Project proponent
Description of measurement methods and procedures to be applied	All the manure flew into AWMSs to be treated, no manure will be discharged outside. Therefore, the value of this parameter is 100% or total $MS\%_j$ in different treatment system is 100%.
Frequency of monitoring/recording	Annually

Value applied	100% for ex-estimated. As this parameter is not monitored in the actual operation. so, in the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is 100%.
Monitoring equipment	N/A
QA/QC procedures to be applied	100% is the maximum value and conservative
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$B_{0,LT}$
Data unit	m^3CH_4/kg -dm
Description	Maximum methane producing potential of the volatile solid generated by animal type LT
Source of data	2019 Refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 10, Table 10.16
Description of measurement methods and procedures to be applied	According to Table 10.16 of IPCC 2019 Refinement Guidelines for National Greenhouse Gas Inventories Volume 4, Chapter 10, the maximum methane-producing potential ($B_{0,LT}$) for Market swine and Breeding swine in the Asia region is 0.45 m^3 CH_4/kg VS. Since this parameter is not monitored in the actual operation, 0.45 m^3 CH_4/kg-dm is still applied during the monitoring period. The actual methane-producing potential of the volatile solid generated by swine manure is 479.4 ml/g VS according to the public literature, which is higher. Therefore, the application of 0.45 m^3 CH_4/kg-dm during the monitoring period is conservative.
Frequency of monitoring/recording	Annually
Value applied	101.325 kPa is used for the pre-calculation of the density of CH4 according to the applied methodology ACM0010 (Version 08.0). During the actual monitoring period, the pressure of the gaseous stream is recorded by an electronic signal.
Monitoring equipment	N/A
QA/QC procedures to be applied	The value is taken from 2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4. The parameter value should be updated on latest available IPCC

Purpose of data	Used in baseline and project emission calculations
Calculation method	N/A
Comments	N/A

Data / Parameter	$NEX_{LT,y}$
Data unit	kg N/animal/year
Description	Annual average nitrogen excretion per head of a defined livestock population, estimated as described in Appendix 2.
Source of data	Calculated as the equation below: $NEX_{LT,y} = \frac{W_{site}}{W_{default}} \times NEX_{IPCC\ default}$ While, NEXIPCC default calculated as equation 30 of the 2019 Refinement to the 2006 IPCC Guidelines, volume 4, chapter 10 $NEX_{IPCC\ default} = N_{rate(T)} * TAM/1000*365$
Description of measurement methods and procedures to be applied	$W_{default}$, $N_{rate(T)}$ and TAM are default value from 2019 Refinement to the 2006 IPCC Guidelines. The measurement methods and procedures for W_{site}, please refer to the monitoring parameter W_{site}.
Frequency of monitoring/recording	Annually
Value applied	$NEX_{LT,y}$=29.38
Monitoring equipment	N/A
QA/QC procedures to be applied	The parameter is calculated as the equation in "Source of Data" from methodology ACM0010 Version 08 and the value of other parameter applied in the equation is taken from published sources (2019 Refinement to the 2006 IPCC Guidelines). The value should be updated on latest available IPCC. QA/QC procedure for W_{site}, please refer to the monitoring parameter W_{site}.
Purpose of data	Used in project emission/baseline calculations
Calculation method	Calculated as the equation of option 2 in Appendix 2.
Comments	N/A

Data / Parameter	Type
Data unit	/
Description	Type of barn and AWMS i.e. Enclosed Anaerobic Digester, the same below
Source of data	Project proponent
Description of measurement methods and procedures to be applied	The swine barn and AWMS layout and configuration are collected. Archive electronically during project plus 5 years
Frequency of monitoring/recording	Once for each monitoring period
Value applied	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	After the first verification, only changes in the type of barn and AWMS will be reported.
Purpose of data	Confirm whether the implementation of project as design
Calculation method	N/A
Comments	N/A

Data / Parameter	T
Data unit	°C
Description	Annual average ambient temperature at project site
Source of data	Official public information
Description of measurement methods and procedures to be applied	The data published by Official public information can prove that the annual average ambient temperature at project site.
Frequency of monitoring/recording	monthly
Value applied	15.5°C for ex-ante estimated
Monitoring equipment	N/A

QA/QC procedures to be applied	The actual Annual average ambient temperature at project site from Official public information during this monitoring period will be compared with the value of ex-ante estimated, i.e., 15.5°C. In the monitoring period, to be conservative, corresponding MCF_j with lower annual average ambient temperature as per Appendix 3 of ACM0010(Version08.0) will be used for calculation after comparing the actual value and the value of ex-ante estimated.
Purpose of data	Used to determine the climate zones of the project site and then select the annual MCF_j from 2019 Refinement to the 2006 IPCC Guidelines.
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

The monitoring plan presented ensures that real, measurable, long-term GHG emission reductions can be monitored, recorded, and reported. It is a crucial procedure to identify the final VCUs of the project. This monitoring plan will be implemented by the project owner during the project operation. The details of the monitoring plan are specified as follows:

(1) Monitoring framework and data aggregation, collation and reporting

The project owner will be responsible for the whole monitoring work.

The Project owner organizes a specific VCS team in the project development department to be responsible for data collection. The general manager of the project owner will appoint a VCS manager or a chief officer. The operational and monitoring manager of the plant, the financial chief, and the technical chief are responsible for the collection of the data and information required in the monitoring plan, and the technical chief is responsible for the collation and calculation of the data. In addition, the Project developers set up internal audit procedures. The collected information will be documented and sent to the VCS manager monthly. The VCS manager will be in charge of the implementation of the monitoring plan and will report to the general manager of the project owner. The general manager of the project owner will confirm the monitoring, calculation data, and reports. A monitoring and management manual for the project that identifies detailed duties and responsibilities of the relevant parties is developed and serves as the basis for project monitoring. All the data will be reviewed by the project developer and VVB. The overall monitoring system structure of the project is shown below:

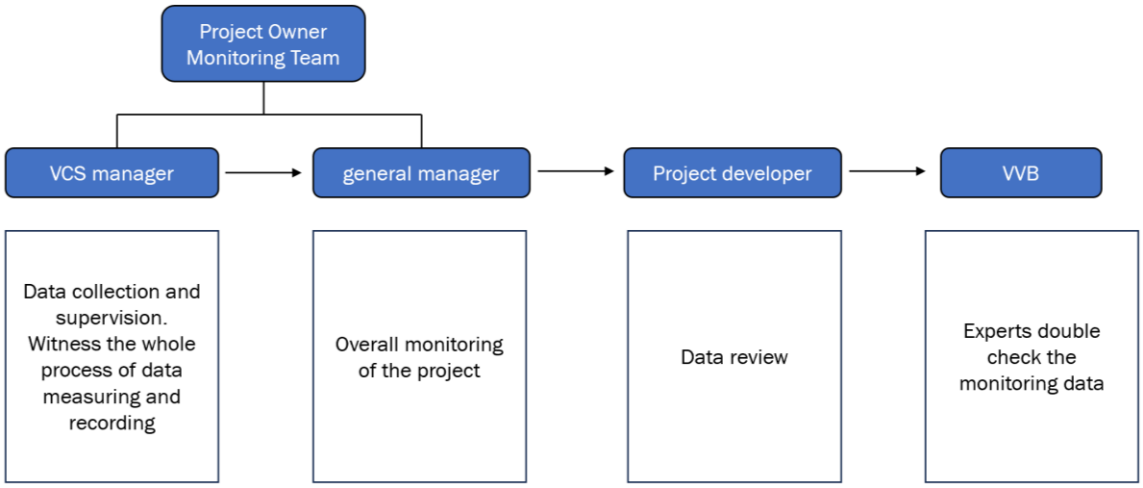

Figure 5-1 Operation and management structure of the Project

(2) Parameters to be monitored and the method of measurement/recording

The monitoring requirements for this methodology include the monitoring of parameters for both baseline emissions, project emissions, and leakage calculations. All provisions in the methodology and relevant tools shall apply, as described for each parameter in Section 5.2 of the PD.

For this project, the parameters that need to be monitored are as described in section 5.2 of the PD.

Item	Parameter to be monitored	Method to monitor/record
a	Daily stock of swine in the farm, discounting dead and discarded animals, $N_{AA,LT}$	Each pig involved in this project has a unique electronic ear tag, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag is connected to the Data Collection System (DCS), which can store and read information. The technicians on the farms monitor and record the number of swine through the auto-tracking devices of electronic ear tags daily, including newly imported animals while excluding dead and discharged animals. The annual average number of animals (NAA, LT) is calculated as an average of the daily stock of swine on the farms without considering dead and discarded animals.

b	Average animal weight of a defined livestock population at the project site, W_{site}	Sampling procedures will be used to estimate this variable, taking into account the following guidance: (a) To ensure representativeness, each defined livestock population should be classified into a minimum of three age categories; (b) For each defined livestock population, a minimum of one monthly sample per age category should be taken; (c) When estimating baseline emissions and emissions released during the baseline scenario from land application of the treated manure in the leakage section, the lower bound of the 95% confidence interval obtained from the sampling measurements should be used; (d) When estimating project emissions and emissions released during the project activity from land application of the treated manure in the leakage section, the upper bound of the 95% confidence interval obtained from the sampling measurements should be used. The weight measurer will be calibrated annually to ensure the reliability of the parameter.
c	Number of days treatment plant was operational in year y, nd_y	The number of days the treatment plant was operational will be recorded manually by the responsible staff. The daily readout of the flowmeter installed at the outlet of the anaerobic digestion in each farm can be crosschecked to ensure that the treatment plant in each farm is operational.
d	Quantity of electricity consumed by the proposed project in year y, $EC_{PJ,j,y}$	The quantity of electricity consumed from the grid company by the project is sourced from the summary table of monthly power consumption and cross-checked with the grid statement issued by the power company.

e	Average technical transmission and distribution losses for providing electricity to source j in year y, $TDL_{j,y}$	Sourced from tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)". This value will be renewed once the tool is updated.
f	Biogas flow, V_f	Continuously measurement by the electronic biogas flowmeters (biogas flowmeter 1 installed at the outlet of the anaerobic digestion, biogas flowmeter 2 installed at the inlet of boiler and biogas flowmeter 3 installed in the inlet of flare and record hourly and saved automatically in DCS system.
g	Volumetric flow of the gaseous stream in time interval t on a dry basis, $V_{t,db}$	Measured by the same electronic biogas flowmeters that monitor parameter V_f, which can record hourly and is saved automatically in the DCS system, the flowmeters can also monitor other parameters such as $V_{t,db}$, T_t, and P_t simultaneously.
h	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis, m^3 gas i/m^3 dry gas, $V_{i,t,db}$	Continuously measure and record hourly data using an online gas analyzer installed at the outlet of the anaerobic digester, which is automatically saved in the DCS system.
i	Temperature of the gaseous stream in time interval t, T_t.	Measured by the same electronic biogas flowmeters that monitor parameter V_f, which can be recorded hourly and saved automatically in the DCS system. This is because the flowmeters can also monitor other parameters such as $V_{t,db}$, T_t, and P_t simultaneously.
j	Pressure of the gaseous stream in time interval t, P_t.	Measured by the same electronic biogas flowmeters that monitor parameter V_f, which can record hourly and saved automatically in the DCS system since the flowmeters can monitor other parameter such as $V_{t,db}$, T_t and P_t simultaneously.

k	Density of greenhouse gas i in the gaseous stream in time interval t, $\rho_{i,t}$	Calculated based on the temperature and pressure of the gaseous stream in time interval t, the monitor of the temperature and pressure of the gaseous stream; please refer to the description of the above two parameters.
l	Fraction of volatile solids directed to aerobic treatment, F_{Aer}	According to the methodology, F_{Aer} should be monitored annually. Since this parameter is not currently monitored in the actual operation, during the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is considered to be 100%.
m	Fraction of manure handled in system j in the project activity, $MS\%_j$.	According to the methodology, $MS\%_j$ should be monitored annually. However, there is no equipment installed in the project activity to monitor it. Therefore, to be conservative, the value of this parameter in the emission reduction calculation is set at 100%.
n	Maximum methane-producing potential of the volatile solids generated by animal types LT, $B_{0,LT}$.	The value is taken from the 2019 Refinement to the 2006 IPCC Guidelines, which is a published source. The parameter value will be updated based on the latest available public data source.
o	Type of barn and AWMS, Type	The swine barn and AWMS layout and configuration are collected, which can prove the type of barn and AWMS, and only changes in the type of barn and AWMS will be reported after the first verification.
p	Annual average ambient temperature at the project site, T.	"The corresponding MCF_j with a lower annual average ambient temperature, as per Appendix 3 of ACM0010 (Version 08.0), will be used for calculation after comparing the actual value with the ex-ante estimated value."
q	Annual average nitrogen excretion per head of a defined livestock population, estimated	The parameter is calculated as the equation of option 2 in Appendix 2 of methodology ACM0010 Version 08.0, and the value of the

	as described in Appendix 2, $NEX_{LT,y}$.	other parameter applied in the equation is taken from the 2019 Refinement to the 2006 IPCC Guidelines, which is a published source. The parameter value will be updated based on the latest available public data source. As for the parameter W_{site}, it is monitored during the monitoring period; please refer to the monitoring parameter W_{site}.

(3) Monitoring equipment and calibration procedures

The installation of relevant monitoring instruments shall be carried out in accordance with industry requirements and manufacturer specifications.

Installation and configuration of meters are shown as Figure 5-2. In order to ensure measurements with a low degree of uncertainty, all the monitoring devices used (including weight measurers, electric meter, flow meter, gas analyzer) will be calibrated periodically according to relevant national standards and regulations as specified in Section 5.2 above. The calibration of the project monitoring equipment is the responsibility of the project owner's Operations and Monitoring Manager. The person in charge of calibration will regularly check the operation of the monitoring equipment to ensure the normal operation of the monitoring equipment, and in accordance with the corresponding calibration standards of each monitoring equipment, entrust a third-party calibration unit that meets the qualification requirements to carry out calibration on schedule. The calibration records will be appropriately maintained and made available for review by VVB.

If the monitoring instruments are changed or added during the crediting period, this should be documented transparently in the monitoring reports, and the procedure for post-registration changes should be followed.

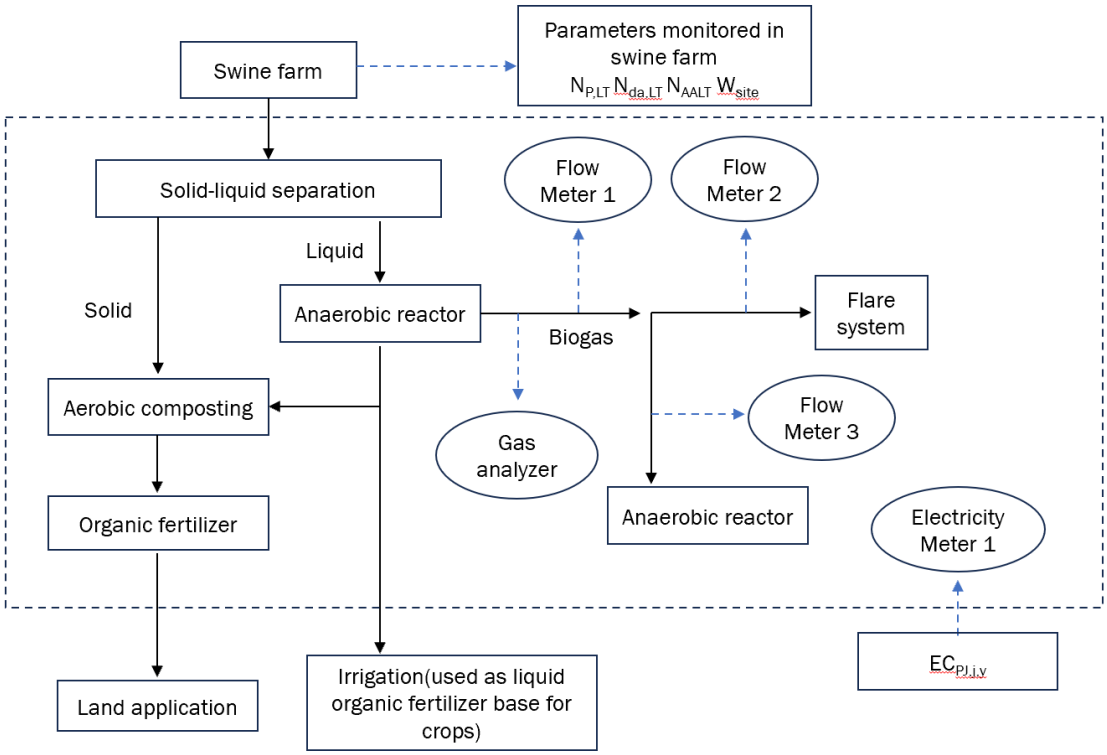

Figure 5-2 Installation and Configuration of meters

(4) The procedures for internal auditing

All monitoring data will be collected monthly and submitted for review to the VCS manager, who will be staffed by experienced experts. Data review should be combined with the actual operating conditions. If it is found that the monitoring data is inconsistent with the operating conditions or there are obvious anomalies, it should be immediately analyzed to determine the reasons and appropriate corrective actions should be taken. The monitoring data confirmed by the VCS manager will be submitted to the general manager of the project owner for regular reconfirmation to ensure the accuracy and reliability of all monitoring data.

(5) Data management and storage

The PP will designate VCS managers to be fully responsible for GHG emission reduction monitoring work, and the operational and monitoring manager of the plant, the financial chief, and the technical chief will be responsible for the collection, calculation, and archiving of specific project monitoring data. All monitoring data is collected monthly. All monitoring data and related data, including electronic and paper data, documents for cross-checking, calibration reports of monitoring equipment, etc., will be collected and archived. All data collected as part of the monitoring plan should be saved with at least 1 backup copy until the end of the crediting period. After the crediting period ends, the electronic data should be archived electronically on hard disks

and paper data should be summarized and filed in the archives. All the monitoring data should be kept for at least 2 years after the end of the last crediting period.

(6) QA/QC.

A quality management system will be established, which ensures the quality and accuracy of the measured data.

Training

For all members involved in the project, necessary trainings will be provided by the project owner. Each member of the VCS monitoring team will be trained by the VCS managers at least once a year. The project owner should ensure that only skilled employees are allowed to undertake the monitoring work. The training contents should regard the general and technical aspects of the project to the extent appropriate, as well as basic understandings of VCS Standard and climate change.

Emergency procedure

Employees need to be familiar with the process flow and emergency situations that may occur during project operation and operate in strict accordance with the technical specifications of each process treatment equipment and monitoring equipment. During the operation of the project, all equipment and related instruments shall be checked regularly according to the manufacturer's recommendations. In the event of a failure of the instrument, calibration and/or proper repair have to be carried out immediately by a professional engineer.

In case of malfunction and/or damage of any system or piece of the process, it may cause damage to the operation of the system, especially serious damage to the biogas generation and combustion system it must be dealt with as soon as possible and reported to the Operations and Monitoring Manager.

The data monitored during the error measurement and replacement of the faulty instrument should be used as a zero value, and the time period should be clearly recorded, as well as the reason.

(7) The procedures for handling non-conformances with the validated monitoring plan

The whole VCS monitoring team will follow recognized standard data evaluation methods to identify non-conformance and ensure the reliability and accuracy of the data. The quality control and quality assurance procedures include the handling and correction of nonconformities in the implementation of the project or the monitoring plan. In case such nonconformities are observed:

- An analysis of the nonconformity and its causes will be carried out immediately by the project owner, with the help of external experts if necessary.

- A corrective action plan should then be developed to eliminate the nonconformity and its causes, in order to prevent its recurrence.

- Corrective actions are implemented and reported back to the VCS monitoring team.

- Relevant information will be included in the monitoring report and reported to VVB during the verification.

If the data record is missing or damaged during the monitoring period, the following makeup process will be conducted:

-The general principle is that conservative values will be used for the missing or damaged data. This is the most conservative approach. The monitoring personnel will be trained before the start of the project operation to ensure that each team member is fully aware of and able to strictly follow this conservative principle. During the monitoring process, the monitoring personnel will be required to strictly abide by the above conservative principle in data recording, i.e., use conservative values for all the missing or damaged data.

- If this is due to the error of the monitoring personnel, provide further training until he or she can perform the job properly. In the meantime, use conservative values for the missing or damaged data.

"If this is due to the inability or attitude of a particular worker in the monitoring team, dismiss that worker and rehire those with the proper ability and attitude. In the meantime, use conservative values for the missing or damaged data."

- If some data recorded is significantly higher than the normal range, the monitoring personnel should ask for the reason. If the measurement is high due to the damage of measurement equipment, a conservative value will be used for that day's data. There is a need to calibrate and maintain the measuring equipment immediately and avoid this situation in the future.

If the monitoring results are satisfactory in terms of correct reporting, data completeness, and correct analysis, the data will be accepted for the monitoring report.

(8) The sampling sizes

The sampling objective

To determine the average animal weight of a defined livestock population at the project site during the crediting period with a 95% confidence level and 10% precision.

According to “Sampling and surveys for CDM project activities and programmes of activities (Version 09.0)”, the sampling plan is as follows:

Parameter	W_{site}
Objectives and reliability requirements	Determining the average animal weight of a defined livestock population at the project site during the crediting period.

	According to the standard of the "Sampling and Surveys for CDM Project Activities and Programmes of Activities (Version 09.0)," PP shall use a 95/10 confidence/precision as the criteria for the reliability of sampling efforts for large-scale projects. According to the methodology "ACM0010: GHG Emission Reductions from Manure Management Systems (Version 08.0)," each defined livestock population should be classified into a minimum of three age categories. Market pigs are divided into the lactation period of 30 to 60 days, growth period of 60 to 130 days, and maturity period of 130 to 180 days. Breeding pigs are divided into three age classes according to day age, namely lactation period of 30-70 days, growth period of 70-220 days, and maturity period of 220-310 days. The average animal weight of the designated herds at the project site will be monitored in each farm by three age groups: breeding and lactation, growth and maturity. For each defined livestock population, a minimum of one monthly sample per age category should be taken. In this project, the monitoring activities of the average animal weight of a defined livestock population at the project site will be conducted in the three age groups of Market swine and Breeding swine at least once monthly.
Target population and sampling frame	For the ex-calculation, a total of 144,000 market swine and 13,500 breeding swine are included in this project, and the data on the average animal weight of a defined livestock population at the project site is from the project evaluation report. As the applied values of 144,000 market swine and 13,500 breeding swine represent the design scale, during the monitoring periods, the actual breeding scale of the farm does not exceed the design value. Therefore, the sample size calculated from the design values can be used during the monitoring period, and it is conservative.

Sampling method	For this project, the swine farm has breeding swine and market swine in stock. Since this project involves one swine farm and two types of swine, namely Market swine and Breeding swine, and as per the applied methodology, each defined livestock population should be classified into a minimum of three age categories. Therefore, the sampling method is stratified random sampling. The specific sampling methods are as follows: For the sampling, PP should calculate the overall sample size based on the population of swine in stock firstly. As the project involved one swine farm, so the sample size in this swine farm should be determined based on the proportion of the total number of this farm. Similarly, the sample size of each age group of Market swine and Breeding swine in a farm was also calculated based on the proportion of the number of each age group of Market swine and Breeding swine to the total number of swine in the farm. After the sample size in each age group of Market swine and Breeding swine of this swine farm is determined, the sample can be conducted in the swine farm. Since swine of different ages are kept in different barns, samples can be randomly selected from barns of this age group. After the samples are selected, the weight is measured by weight measurers and recorded in the weight record table.

The sampling sizes

According to the standard of the "Sampling and Surveys for CDM Project Activities and Programmes of Activities (Version 09.0)", PP shall use 95/10 confidence/precision as the criteria for the reliability of sampling efforts for large-scale projects. The sampling size will be calculated as outlined in Appendix 6 of the guidelines of the "Sampling and Surveys for CDM Project Activities and Programmes of Activities (Version 04.0)".

PP first calculates the total sample size based on the pig herd. The total number of pigs in this project is 50,000. Since the application of 50,000 market swine is calculated according to the design scale, the actual breeding scale of the pig farm will not exceed the design scale during the monitoring period. Therefore, the sample size calculated according to the design value during the monitoring period is the largest and most conservative.

According to the statistical principle and sampling survey method, the sample size is determined as follows:

$$n_1 = \frac{Z^2\sigma^2}{d^2} = \frac{Z^2(\sigma^2/X^2)}{d^2/X^2} = \frac{Z^2V^2}{e^2}$$

$$n_2 = \frac{n_1 \times N}{N + n_1}$$

$$n_3 = B \times n_2$$

$$n_4 = n_3/r$$

$$n = n_4 \times 100\%$$

Where:

Z	the Z-statistic and the value taken is 1.96 (corresponding to 95% confidence level);
σ	the standard deviation;
d	the maximum error of estimate;
X	the mean value of samples;
V	the coefficient of variation, V= σ/X≤1 and its maximum value 1 is taken;
e	the allowed relative sampling error (“precision”) and the value taken is 10%;
N	the total number of involved swine 157,500;
B	the survey design effect and the value taken is 1 because for stratification sampling the B value is less than or equal to 1;
r	the survey replies rate and the value taken is 100%;
110%	10% contingency was added to produce the final sample size;
n_1 n_2 n_3 n_4 n	The adjusted values after each step, with n being the final number of samples to be taken. Actually, n4 is the required number of samples based on calculation. A 10% contingency was added to n4 to produce n in this sampling.

For pre-calculation, since the total number of involved swine is 50,000, N in the calculation of sample size is 50,000, and the calculation result is as follows:

Z	V	e	N	B	r
1.96	1	10%	50000	1	100%
n_1	Z^2V^2/e^2	385			
n_2	$n_1N/(N+n_1)$	384			
n_3	Bn_2	384			
n_4	n_3/r	384			
n	n_4 (110%)	422			

The calculation result of n is 422. Therefore, 422 samples should be sufficient to meet the desired confidence and accuracy. According to the method of stratified sampling, 422 samples were taken from the sampling box every month.

The sample size of market pigs and breeding pigs of all ages on pig farms was calculated according to the proportion of market pigs and breeding pigs of all ages in the total number of pigs on pig farms. Each identified stock of livestock should be divided into at least three age categories. Market pigs are divided into the lactation period of 30 to 60 days, the growth period of 60 to 130 days, and the maturity period of 130 to 180 days. Breeding pigs are divided into three age classes according to day age, namely the lactation period of 30-70 days, the growth period of 70-220 days, and the maturity period of 220-310 days. The average animal weight of the designated herds at the project site will be monitored in each farm by three age groups. The sample size of each age group of market swine on a farm was also calculated based on the proportion of the number of each age group of market swine and breeding swine to the total number of swine on the farm. To be conservative, the sample number of the farm is adjusted to an integer value.

According to the conditions of the pig farm for the month, after determining the sample size of each farm's market pigs and breeding pigs of all ages, sampling was conducted at each farm. Since pigs of different ages are raised in different pig houses, a random sample was drawn from pig houses of that age. After the sample is selected, the weight is measured with a weighing instrument and recorded in the weight record sheet.

Because the sampling activity occurs once a month, all the samples will be replaced next month. Monitoring data will be collected and recorded throughout the credited period.

Implementation and Monitoring frequency

The sampling process will start as soon as the target population is determined. The sampling process will be determined by the VCS monitoring team. The monthly monitoring activity of the samples will be completed during each monitoring period.

The monitoring data will be collected and recorded throughout the entire crediting period. All archived data and documentation will be kept for at least 2 years after the end of the last crediting period.

Procedures for Administering Data Collection and Minimizing Non-sampling Errors

During the monthly monitoring activities, the weight of the month's sample was recorded in the weight record table by the monitoring team member in the swine farm. Then the average weight of a defined livestock population at the project site was calculated based on this data by the monitoring team member. The data is reviewed by the project developer and VVB. If the recorded raw data on the monitoring form are reasonable and basically consistent with the actual growth state, the raw data is archived. If the data record is missing, damaged, or if the target animal was dead during the monitoring periods, the following makeup process should be conducted:

1) The general principle is that a zero value is used for missing or damaged data. This is the most conservative approach. The monitoring personnel are trained before the start of the project operation to ensure that each team member is fully aware and able to strictly follow this conservative principle. During the monitoring process, the monitoring personnel are required to strictly abide by the above conservative principle in data recording, i.e., using zero values for all missing or damaged data.

2) If this is due to the errors of the monitoring personnel, further train the person until he or she can perform the job properly. In the meantime, use a zero value for the missing or damaged data.

3) If this is due to the inability or attitude of a particular worker in the monitoring team, dismiss such a worker and rehire those with the proper ability and attitude. In the meantime, use a zero value for the missing or damaged data.

4) If some recorded data are significantly higher than the normal range and inconsistent with normal growth, the monitoring personnel should ask for the reason. If the measurement is high due to the damage of weighing scales or other measurement equipment, a zero value is used for that day's data. It is necessary to calibrate and maintain the weighing scale or replace the measuring equipment immediately to avoid this situation in the future. If the monitoring results are satisfactory in terms of correct reporting, data completeness, and correct analysis, the data is accepted for the monitoring report.

QA/QC Procedures

Before implementing the project, the VCS manager will train the personnel of monitoring teams on how to properly conduct the monitoring process.

If the data reported by the team member significantly deviates from the normal range, the monitoring personnel should write down the reasons and report to the team leader. No action is allowed before permission. The monitoring team will arrange research according to the attached form. At the same time, if the verification group has any doubts about the correct result, they can arrange related research.

The project owner's technical chief should enter all the measured data into the datasheet each month, using Excel to calculate the weighted mean value of the average animal weight of a defined livestock population at the project site from all the samples, compared with the everyday normal growth state.

APPENDIX 1: COMMERCIALLY SENSITIVE INFORMATION