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-August-2023 to 24-August-2033
Original date of issue	25-December-2024
Most recent date of issue	15-January-2026
Version	4.0
VCS Standard Version	VCS Standard v4.7
Prepared by	Xi'an Carbon Neutral Environmental Technology Co., Ltd.

CONTENTS

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) installs a total 1 set of new animal waste management system (AWMS) to treat the manure from a new-built swine farm in Wangzhai Village, Xiyi Township, Longyang District, Baoshan City, Yunnan Province, P. R. China, which is owned by Baoshan East Hope Animal Husbandry Co., Ltd (hereinafter called the project owner). The purpose of the project is to treat the waste produced in swine farm by adopting AWMS to avoid GHG 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 liquid will be treated through anaerobic digestion and the biogas generated during the treatment process will be captured and sent to generator for electricity generation and surplus biogas will be destroyed through the flaring system (if any). The sludge produced from anaerobic digestion will be treated through Composting- Passive windrow together with the solid. The effluent will be supplied to the farmers living around for free for agricultural irrigation.

The project is a greenfield project. In absence of the project, manure produced in livestock farm would have been treated in uncovered anaerobic lagoons on site. In the baseline, animal waste would have been poured into uncovered anaerobic lagoons. Uncovered anaerobic lagoon is a waste treatment approach in China[1]. Animal waste poured into the open lagoon would have been left to decay to generate methane emitting to the atmosphere directly without any recovery or destruction. There is no legal regulation to mandate animal waste treatment techniques and to capture and/or utilize methane generated at these lagoons, therefore uncovered anaerobic lagoons is the most economic and practical method for swine farms to handle the animal waste.

Benefiting from the “waste-biogas-fertilizer” pattern, harmlessness and ecological utilization of the swine manure can be realized. The project is expected to generate approximately $6.04*10^4$ m^3 of biogas per year, all of which 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. And the electricity generated will not be connected to the power grid.

In the baseline scenario, animal waste would be poured to uncovered anaerobic lagoons. The project reduces GHG emission into atmosphere through avoiding methane emission generated in baseline scenario by deploying anaerobic treatments in AWMS with biogas utilization and destruction systems. The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure and wastewater. The swine farm

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

and the AWMS began simultaneous construction on 01/10/2021, with the swine farm officially commencing operations on 25/06/2023. The AWMS started processing farm manure two months after the swine farm's operation, specifically on 25/08/2023. 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 49,328 tCO_2e and a total emission reduction of 493,280 tCO_2e during the fixed 10-year crediting period.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	(23-June-2025-25-June-2025)[2]	VCS	CTI Certification Co., Ltd.	10

1.3 Sectoral Scope and Project Type

Sectoral scope	Scope 13: waste handling and disposal, and Scope 15: Livestock and manure management.
Project activity type	The project is not AFOLU project and is not a grouped project.

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.

[2] The date of onsite audit

4) Project activities supported by a methodology approved under an approved GHG program: unless explicitly excluded (see the Verra website for exclusions): 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.

The project does not belong to projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal, or destruction.

Meanwhile, the project does not belong to the projects excluded in Table 1 of the VCS Standard (Version 4.7). Thus, the project is eligible under the scope of the VCS program.

The swine farm and AWMS commenced construction simultaneously on 01/10/2021. The swine farm officially began operations on 25/06/2023, while the AWMS was put into operation on 25/08/2023.

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.	Applicable. The project meets all applicable rules and requirements set out under the VCS Program, including VCS Standard 4.7. And the project is guided by the principles set out in Section 2.2.1.
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.	Applicable. The project applies the latest version of ACM0010 (version 08.0) from other approved GHG program, e.g. CDM Program, which complies with VCS program rules. The methodology ACM0010 (version 08.0) and the tools referred to by the methodology are applied in full, the applicability and the methodology and tools are specified in section 3 of this PD

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.	Applicable. The project applies the latest version of the applicable methodology ACM0010 (version 08.0), which is valid from 04-October-2013 onwards, and the project adopts fixed crediting periods of 10 years not revolve renewable of 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.	Applicable. The project and the implementation of the project comply with all the applicable laws specified section 1.15 below, not lead to the violation of any applicable law.
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).	Applicable. As per VCS Program Definitions version 4.5, model means "a formula or set of formulae that uses parameters and input values to establish the value of one or more output variables". The project activity has applied formulae in methodology ACM0010 (version 08.0), tools referenced, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and its 2019 Refinement to calculate emission reductions. Therefore, this criterion is applicable.
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.	Applicable. The third-party default factor applied by the project meet 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	Applicable. The project complies with the rules and requirements in the VCS Program under all conditions. The project is only seeking

requirements of the VCS Program shall take precedence.	registration under the VCS Program. It is not receiving or seeking credit for reductions and removals from a project activity under any other GHG program; it has not registered under any other GHG program, and it has not been rejected by any other GHG program.
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.	Applicable. 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, and are listed in a companion Summary of Effective Dates document which corresponds with each update.	Applicable. The latest VCS program rules is applied by the project.

Thus, the project is eligible under the scope of VCS program.

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
Telephone	+86 13365361369
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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Telephone	+86 188 9208 0395
Email	Liuxin@xiancarbon.com

1.8 Ownership

Baoshan East Hope Animal Husbandry Co., Ltd., as the owner unit legally entitled to project supervision and management rights, obtained the environmental impact assessment approval for the project from the Baoshan Municipal Ecology and Environment Bureau on 24/03/2021. The ownership of the project and the carbon credits has been established through a complete chain of legal evidence, including business licenses, investment project filing certificates,

equipment procurement contracts, and construction contracts, ensuring the lawful correspondence between certifications, construction content, and the attribution of emission reduction rights.

Thus, Baoshan East Hope Animal Husbandry Co., Ltd. shall have the sole right to distribute and utilize the VCUs generated from the project.

This ownership status aligns with the following criteria under the VCS (Version 4.7):

Evidence types of project ownership	Condition of the project and the project proponent
1) Project ownership arising or granted under statute, regulation or decree by a competent authority.	Baoshan Dongfang Hope Animal Husbandry Co., Ltd., as the project owner, derives its project ownership from administrative licenses and regulatory documents legally granted by government authorities. The business license, issued by the Longyang District Market Supervision Administration, confirms the company's legal entity status and legitimate scope of operations. The investment project filing certificate, issued by the Longyang District Development and Reform Bureau, indicates that the project complies with national and local industrial policies and falls under the category of legally filed management. The environmental impact assessment approval from the Baoshan Municipal Ecology and Environment Bureau specifies the project's environmental obligations and implementation conditions. Collectively, these documents constitute the government's administrative authorization for the enterprise to exercise project operation and control rights within compliant boundaries, reflecting the legal nature of project ownership being conferred by administrative authorities through statutory procedures.
2) Project ownership arising under law.	The legitimacy of project ownership is based on the procedures and standards established by laws and regulations such as the "Company Law of the People's Republic of China," the "Regulations on the Approval and Record-Filing Administration of Enterprise Investment Projects," and the "Environmental Impact Assessment Law." The business license, as the core credential for a company's lawful operation, grants the enterprise the legal capacity to engage in activities within the registered scope. The filing certificate

	ensures the compliance of project investments through administrative confirmation, reflecting legal recognition of the enterprise's autonomous investment rights. The environmental impact assessment approval, as a prerequisite for project construction, legally formalizes environmental protection obligations, ensuring the project is bound by law throughout its lifecycle. Together, these three documents prove that the enterprise has legally obtained the operational qualifications and management rights for project activities, laying the legal foundation for the establishment of project ownership.
3) Project ownership arising by virtue of a statutory, property or contractual right in the plant, equipment or process that generates GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership).	Project ownership further stems from the enterprise's legal rights and property rights over greenhouse gas emission reduction installations, equipment, and processes. The company obtains land use rights for the project through lease agreements with landowners, while construction contracts clearly define the responsibilities and ownership of engineering works. The purchase contracts for manure treatment equipment confirm ownership of the relevant assets. According to the Property Rights and Contract sections of the Civil Code, ownership of the equipment and usage rights of emission reduction technologies legally belong to the enterprise. Consequently, the emission reductions generated as direct project outcomes naturally extend their rights and interests to the enterprise through contractual agreements and asset ownership. Barring any legally prescribed circumstances that would revoke these rights, the enterprise's ownership of project assets and emission reductions is firmly grounded in both legal and factual bases.

1.9 Project Start Date

Project start date	**25-August-2023**
Justification	As per Section 3.8 of the VCS Standard v4.7, the project start date is defined as the date when the implementation of

	greenhouse gas emission reductions or removals begins. For this project, based on treatment plant operation records, the anaerobic manure treatment system began collecting swine manure on 25/08/2023. The operation of the black membrane anaerobic digester and the methane recovery for power generation on that day marked the commencement of swine manure treatment, which also represents the earliest date when the project could generate greenhouse gas emission reduction effects. Therefore, the project start date is determined to be 25/08/2023.

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-August-2023 to 24-August-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-August-2023 to 31-December-2023	17,434[3]
01-January-2024 to 31-December-2024	49,328
01-January-2025 to 31-December-2025	49,328
01-January-2026 to 31-December-2026	49,328
01-January-2027 to 31-December-2027	49,328
01-January-2028 to 31-December-2028	49,328

[3] From August 25, 2023, to December 31, 2023, a total of 129 days, the emission reduction is calculated as: 49328*（129/365）= 17434

01-January-2029 to 31-December-2029	49,328
01-January-2030 to 31-December-2030	49,328
01-January-2031 to 31-December-2031	49,328
01-January-2032 to 31-December-2032	49,328
01-January-2033 to 24-August-2033	31,894[4]
Total estimated ERRs during the first or fixed crediting period	493,280
Total number of years	10
Average annual ERRs	49,328

1.12 Description of the Project Activity

The project activity is designed to install a set of new Animal Waste Management Systems (AWMS) at Baoshan East Hope swine farm to treat the manure and wastewater from the swine farm and avoid methane generation in the baseline uncovered anaerobic lagoon. The swine farm involves 57,534 heads of market swine (annual average number of animals, N_{LT}).

The treatment process deployed by the newly built AWMSs consists of three steps: solid-liquid separation, anaerobic digestion, and passive windrow composting. All manure and urine collected from the swine farm are separated first. The solid components separated are then treated in a passive windrow composting system to produce organic fertilizer base materials. The liquids flow into the anaerobic digestion process to generate biogas for power generation. Excess biogas (if any) is destroyed through the flaring system. The sludge produced from anaerobic digestion is treated passively together with the separated solids in the first step, and the effluent is supplied to local farmers for agricultural irrigation free of charge. Market swine are kept for 168 days on the farms before shipment and are estimated to produce 26,718 tons of manure and 6.04×10^4 m^3 of biogas annually. Baoshan East Hope swine farm officially commenced operations on 25/06/2023, and the AWMS started processing farm manure two months after the swine farm's operation, specifically on 25/08/2023.

Baseline Scenario

Without this project, the manure and wastes from the swine farm would be left in uncovered anaerobic lagoon so that the methane would be sent to the atmosphere without any recovery thus leading a higher GHG emission. According to the "Technical Specifications for Sanitary

[4] From January 1, 2033, to August 24, 2033, a total of 236 days, the emission reduction is calculated as: 49328*（236/365）= 31894

Treatment of Livestock and Poultry Manure"[5], uncovered anaerobic lagoons are a common method of manure treatment recognized by the state in China. In addition, there are no legal provisions that mandate livestock farmers to implement anaerobic digestion, aerobic or other biological treatment technologies, and to collect and/or utilize the methane produced by these lagoons. Without this project activity, an uncovered anaerobic lagoon would be constructed here, and the parameters of the baseline lagoon are shown in Table 1-1.

Table 1-1 The parameters of baseline lagoons

Swine farm	Wangzhai Swine Farm
Livestock population	Market Swine:57,534
Size of baseline anaerobic lagoon (length × width × depth) (m^3)	90m × 85m × 6m[6]
Annual Manure Amount (ton)	26718

Project Technology Description

The project aims to build a centralized animal waste treatment system in a swine farm for collecting swine manure, urine, washing water, etc. The specific process is as follows:

All the manure and wastewater are collected into a waste collection tank and then separated into solid and liquid matter first. The solid is treated in a composting-passive windrow system, and organic fertilizer can be produced. Part of the fertilizer is distributed to local farmers for free, and the rest is sold on the domestic market. The liquid is treated in anaerobic digestion, and the biogas generated during the process is captured for electricity generation. The electricity generated in the anaerobic treatment is all used by the AWMS and is not connected to the regional power grid or other users. If there is surplus biogas, it is flared. The sludge produced from anaerobic digestion is treated through composting-passive windrow together with the solid, and the effluent is 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.

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

[6] It is compliance with “Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011)”

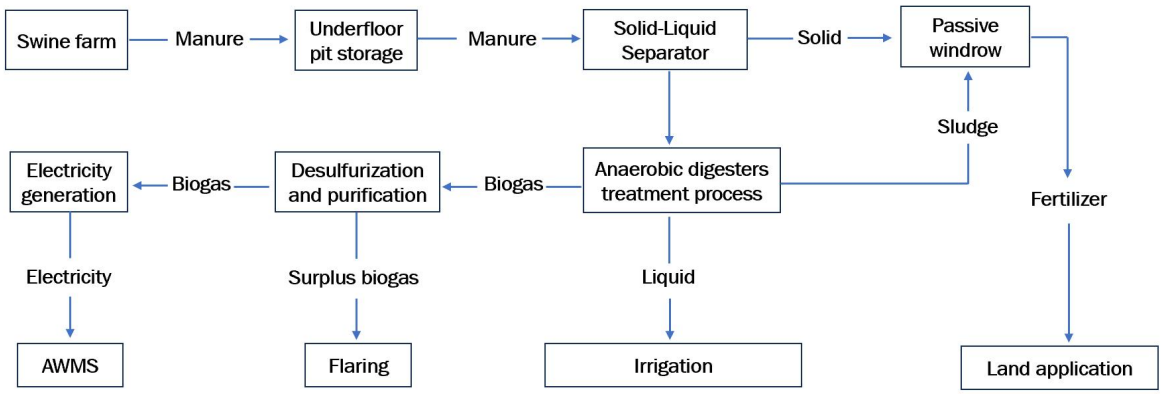

Figure 1-1 Process flow diagram of the project activity

- Manure temporary storage

The project consists of one swine farm. There are 57,534 head of market swine in the swine farm. The breeding cycle of market swine is 168 days. The project activity applies a flushing system to collect the manure within the barns automatically. All the manure and wastewater are collected and then stored in the pit under the barns temporarily. The manure in the pit is cleaned once every day and sent to a solid-liquid separation system.

- Solid-liquid separation

This project adopts a dry manure cleaning process to achieve comprehensive collection of manure waste, utilizing a high-efficiency wedge-shaped solid-liquid separation device (water-cutting type) to achieve primary solid-liquid separation with a solid-phase retention rate of ⩾50%. Post-separation, the solid fraction undergoes composting via a passive windrow process for maturation and fermentation, converting it into organic fertilizer products. The liquid fraction is treated through a black-film anaerobic digester, coupled with a biogas power generation unit for energy recovery, with all generated electricity dedicated to sustaining the system's autonomous operation. The system design incorporates an emergency buffer storage unit, featuring pre-digestion liquid storage capacity sufficient for 72 hours of continuous manure processing, ensuring no wastewater overflow under extreme conditions. All digestate and biogas slurry produced throughout the treatment process are integrated into the composting system for material reuse, while the final effluent, after stabilization treatment, meets the water quality standards for agricultural irrigation.

- Anaerobic digesters treatment process

The fully lined geomembrane anaerobic lagoon system integrates fermentation and biogas storage functions through a high-strength, impermeable high-density polyethylene (HDPE) geomembrane monolithic sealing structure. Its core design features seamless connection between bottom and top membranes via anchor trenches, creating an airtight enclosed space that effectively collects biogas while maintaining strict anaerobic conditions. The system operates on fundamental principles of anaerobic digestion, utilizing synergistic metabolic

activities of hydrolytic acidogens and methanogens to decompose organic matter in manure and convert it into biogas energy. To ensure safe operation and system stability, the anaerobic lagoon adopts a parallel dual-tank configuration. The interconnected tanks maintain hydraulic balance through liquid transfer pipes while sharing a unified biogas collection system that forms a common gas space, achieving treatment efficiency while controlling individual tank capacity.

The anaerobic treatment unit adopts a semi-buried structural design with mesophilic (30-35°C) fermentation process. A natural insulation system formed by the geomembrane covering the top and the biogas layer creates a temperature buffer, maintaining an optimal temperature range of 17-19°C in winter without requiring external heating sources, enabling year-round stable operation. With a configured wastewater retention time of 40 days, the system ensures efficient organic degradation. At 50% loading rate and continuous 24-hour operation, the annual biogas production reaches $6.04*10^4$ m^3. The semi-underground structure effectively isolates external weather fluctuations through soil enclosure, significantly reducing the impact of ambient temperature on the thermodynamic environment of the tank. Its unique thermal insulation properties maintain stable biochemical reaction conditions throughout seasonal changes, demonstrating excellent climate adaptability and ensuring consistent effluent quality and treatment efficiency regardless of seasonal variations.

Table 1-2 The construction and start operation date of AWMS in Baoshan East Hope swine farm involved in this project.

Table 1-2 The construction date and start of operation date of AWMS

Location of the AWMS	Construction start date	Operation start date
99° 16′ 32″ E 24° 56′ 15″ N	01/10/2021	25/08/2023

- Passive windrow composting

Solids from solid-liquid separation and sludge from anaerobic digestion are transported to the Composting- Passive windrow plant. The Composting- Passive windrow process in this project uses strip stack composting and it is unregularly turned over. The composting cycle is 12-15 days.

- Biogas pre-treatment system

After being produced from the anaerobic reactor, the biogas first undergoes gravity dewatering in a condensate removal tank, removing approximately 40% of the moisture. The minimal amount of condensate generated is directed into the wastewater treatment system. The biogas then enters a dry desulfurization unit, where at low flow rates, it passes through an iron oxide filler layer. Hydrogen sulfide (H_2S) is catalytically oxidized into elemental sulfur crystals, achieving a desulfurization efficiency of over 95% and reducing the sulfur content in the biogas to 0.0017% (by volume). The desulfurizing agent is replaced every six months (or when the outlet H_2S

concentration exceeds 20mg/m^3), with the spent agent being recycled and regenerated by the manufacturer. The purified biogas is further processed by a pretreatment system (including filtration, dehumidification, cooling, etc.) to remove impurities and stabilize its quality. Finally, the biogas is delivered to the generator set for combustion and power generation. All the electricity produced is reused within the AWMS of the farm, achieving a self-sustaining energy cycle.

- Biogas utilization and flaring system

The purified biogas can be fed into the generator system for power generation. The installed capacity of the project is 235kW (235kW×1). The type of generator is YC6K350N-D30, and the estimated annual electricity production is 90.6 MWh[7]. The generated electricity is used to operate the AWMS system. Any excess biogas (when the generator cannot utilize it) is subjected to combustion treatment. The designed utilization and combustion quantities of biogas in the project are shown in Table 1-3 below:

Table 1-3 Biogas utilized and flared designed in the project (10^4 m^3/a)

Swine farm	Biogas utilized	Biogas flared
Baoshan East Hope swine farm	6.04	0

Table1-4 The parameters of equipment

Swine Farm Name	Wangzhai Swine Farm
Livestock population	Market Swine:57,534
Treatment of capacity of AWMS(m^3/a)	30000
Baseline anaerobic lagoon	
Size of baseline anaerobic lagoon (m^3)	90m × 85m × 6m
Technical life	Not less than 20 years
Underfloor pit storage	
Size of underfloor pit storage(m^3)	100m×60m×5m

[7] In the EIA, the generator has a capacity of 1.5 kwh/m^3. Since the projected annual biogas production amounts to 6.04*10^4 m^3, the projected annual electricity production is 90.6 MWh (=6.04*10^4 m^3×1.5 kwh/m^3).

Design height (m)	5
Technical life (year)	Not less than 20 years
Solid-liquid separators	
Type	QX-120TS
Power(KW)	3
Lifetime	Not less than 20 years
Anaerobic digester	
Design capacity (m^3)	20000
Anaerobic technology	Black membrane biogas digester
Stay time (day)	40
Fermentation temperature (℃)	30~35
Equipment Quantity	2
Equipment technical life	Not less than 20 years
Flared system	
Type	YHHJ-250
Treatment capacities (m^3/h)	250
Power (KW)	6
Height (m)	3.6
Equipment Quantity	1
Equipment technical life	Not less than 20 years
Generator sets	
Type	YC6K350N-D30
Rated power(kw)	235

Rated speed (r/min)	1500
Equipment Quantity	1
Equipment Technical life	Not less than 20 years
Desulfurization tower	
Type	YTQ-7018
Design working pressure (KPa)	2
Desulfurization efficiency	99%
Treatment capacities (m^3/h)	50
Quantity	1
lifetime	Not less than 20 years
Dehydration tower	
Type	ZFQ-6014
Design working pressure (KPa)	2
Dehydration efficiency	90%
Treatment capacities (m^3/h)	40
Quantity	1
lifetime	Not less than 20 years

1.13 Project Location

The project is located at Wangzhai Village, Xiyi Township, Longyang 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 1-2 shows the location of the Project.


中华人民共和国地图
Yunnan province
图 例
北京 首都
天津 省级行政中心
国界
省、自治区、直辖市界
特别行政区界
1：32 000 000
审图号：GS(2019)1829号
自然资源部 监制
昆明
云南省

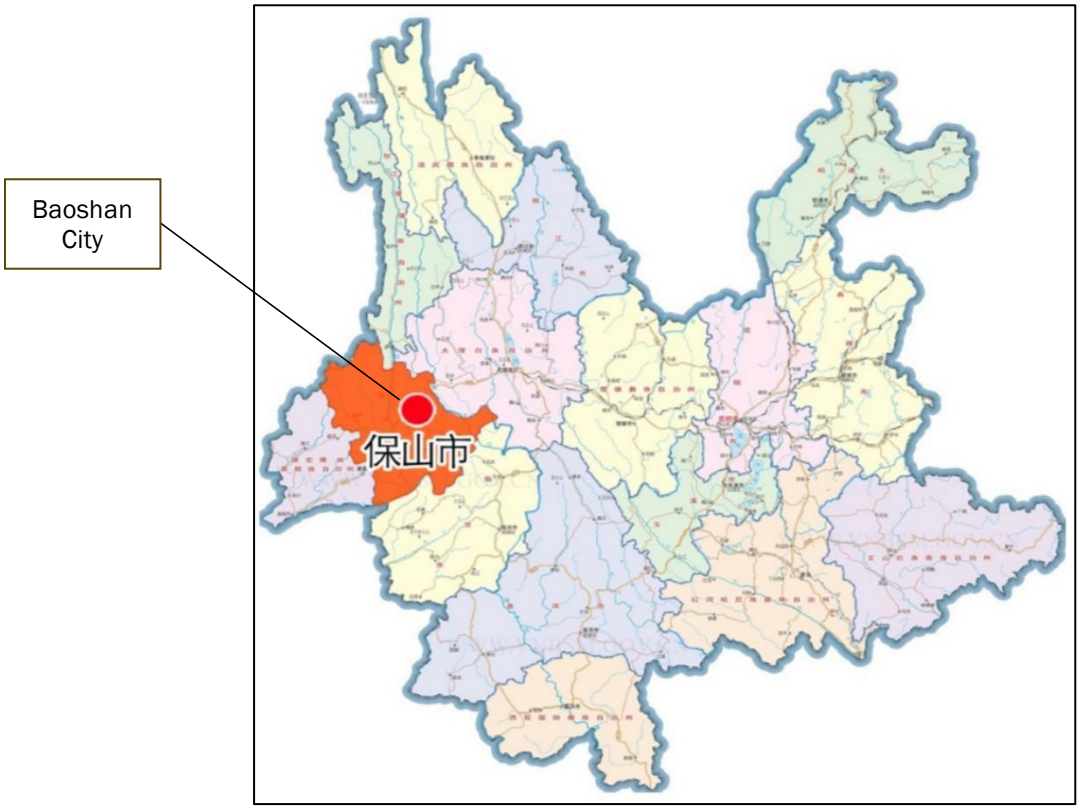
Baoshan City
保山市

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	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

	Control of Solid Waste Pollution[8].	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[9].	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 (2019 revision)[10].	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 People's Republic of China[11].	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 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.

[8] https://www.mee.gov.cn/ywgz/fgbz/fl/202004/t20200430_777580.shtml

[9] https://www.moj.gov.cn/pub/sfbgw/zcjd/201311/t20131127_390029.html

[10] https://www.gov.cn/xinwen/2019-11/06/5449193/files/26c9d25f713f4ed5b8dc51ae40ef37af.pdf

[11] https://www.mee.gov.cn/ywgz/fgbz/fl/201404/t20140425_271040.shtml

5	Law of the People's Republic of China on Environmental Impact Assessment[12].	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

1.16.3 Projects Rejected by Other GHG Programs

[12] https://www.mee.gov.cn/ywgz/fgbz/fl/201901/t20190111_689247.shtml

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

The project owner is not part of any emission trading program. The net GHG emission reductions from the project will not be used for compliance with emission trading programs or to meet binding limits on GHG emissions. The project activity has not participated under any other GHG programs.

China has a national emissions trading scheme only cover the high-emission industries that emit at least 26,000 tons of (eg. petrochemical, chemical, building materials, iron and steel, non-ferrous, paper, aviation) CO_2e/year, not including renewable project[13]. And the project activity is not included the mandatory emission control scheme and there is no emission cap enforced for the project owner according to the enforced company list in public information[14]. The project did not register or applied for registration under the Chinese Pilot Market for Carbon Trading. The Chinese Pilot Market for Carbon Emission Trading built 7 pilot markets for carbon trading in 2011 in Beijing City, Shanghai City, Tianjin City, Chongqing City, Guangdong Province, Liaoning Province, and Shenzhen City[15]. The project locates in Liaoning Province, which was not part of the pilot markets. Furthermore, the project does not register or applies for registration under the Chinese Carbon Trading Market, which replaces the pilot market since 2021.

Hence, it is confirmed that the emission reductions will not be double counted.

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.

[13] https://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html

[14] http://sthjt.zj.gov.cn/art/2021/12/16/art_1229263559_4843729.html

[15] https://www.gov.cn/xinwen/2021-08/03/content_5629115.htm

☐ 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

The purpose of the project activity is to avoid methane emissions through controlled anaerobic digestion, aerobic treatment and capturing and/or utilizing methane generated. In absence of the project, all manure waste produced from the existing swine farm was left to decay in an uncovered anaerobic lagoon at the livestock farm and methane is emitted to the atmosphere directly without any methane recovery and destruction facility.

For the project activity, the emissions reductions are due to the changes of the way that the manure disposed. Therefore, the project activities will not impact the emissions of goods and services in a supply chain, i.e., Scope 3 emissions.

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 8: Decent Work and Economic Growth

The project activity will provide job opportunities for locals during the implementation and monitoring activities, irrespective of gender or any other status. The impact parameter of the proposed project on SDG 8 is the number of full-time jobs created. 5 local residents (2 females and 3 males) are employed in the operation of the project. This meets one of China's action plans: "Increase the labor force participation rate through implementation of the classification policy. Vigorously enforce the Law on Promotion of Employment."[16] During the crediting period, this parameter is monitored by PP to monitor the number of male and female employees involved in the project and their average earnings.

SDG Goal 12: Ensure sustainable consumption and production patterns

The project activity aims to significantly reduce waste generation through prevention, reduction, recycling, and reuse. Specifically, it will annually treat 26,718 tons of manure from market swine farming via anaerobic digestion to produce biogas for electricity generation. The digested residue will then be composted and converted into organic fertilizer, with an expected annual output of 18,000 tons. This approach fully aligns with China's goal of "achieving substantial waste reduction by 2030 through prevention, reduction, recycling, and reuse." During implementation, project participants will track waste treatment effectiveness by monitoring the volume of livestock manure entering all animal waste management systems and the final output of organic fertilizer.

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. The project reduces CO_2 emissions by displacing equivalent electricity generated from fossil fuel-based generators. It is estimated that 49,328 tCO_2e emission reductions can be achieved annually. The project also helps to achieve China's national goal of carbon peaking in 2030 and carbon neutrality in 2060.

The annual emission reduction is estimated to be 49,328 tCO_2e, and 6.04×10^4 m^3 of biogas (please refer to the monitored parameter "V_f" in Section 5.2 of the PD for details) is generated by the project annually. A total of five jobs for local people were created (including two females and three males). Please see the table below for details.

[16] https://www.gov.cn/guoqing/2021-10/29/content_5647636.htm

SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
8.5	Number of jobs created	Implemented activities to increase	Total, 5 jobs for local people were created (including 2 females and 3 males) by the project.	The project activity generates permanent job opportunities for 5 persons including 2 females and 3 males during the operation period. From the operation start date of the project activity to the end of this monitoring period, 5 jobs for local people were created (including 2 females and 3 males) by the project.
12.5	Production of organic fertilizer per year	Implemented activities to increase	Annually, 26,718 tons of manure are processed, producing approximately 18,000 tons of organic fertilizer.	During the operational period, the project will process 26,718 tons of fresh swine manure annually and produce 18,000 tons of organic fertilizer.
13.2	Total greenhouse gas emissions per year	Implemented activities to increase	Annually, the project has achieved GHG emission reductions of 49,328tCO_2e.	The project will achieve GHG emission reductions of 493,280 tCO_2e per year during the whole operating lifetime.

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 stakeholder identification process for the project involved a step-by-step approach. Initially, the project owner performed a project scope analysis. This included evaluating the geographic boundary, potential environmental impacts, and the communities served by the project. Following this, the project owner engaged in a stakeholder mapping exercise, identifying individuals and organizations with a vested interest or potential influence over the project. Interviews and surveys were conducted with residents, businesses, and subject matter experts to gather various perspectives. In addition, the project owner reviewed regulatory standards and consulted with government entities to ensure compliance and to identify any legal stakeholders.

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 farm 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	Direct	It can provide them with new jobs and organic

	site		fertilizer.
	Local government: Baoshan Municipal Ecology and Environment Bureau	Direct	Approval for construction and operation of the AWMSs. Daily supervision of the normal operation of the swine farm.
	Xi'an Carbon Neutral Environmental Technology Co., Ltd.	Indirect	Consultant of the carbon reduction project.
Legal or customary tenure/access rights	The project is located in a rural area, and the land transfer was completed through legal procedures: According to Articles 2 and 9 of the Land Administration Law of the People's Republic of China, land in rural and suburban areas, except for that owned by the state as stipulated by law, is collectively owned by farmers, with the villagers' committee acting as the legal representative of the collective landowner to exercise rights. The villagers' committee, as the legal representative, signed a 20-year land lease agreement. (01/08/2020-31/07/2040) with the project party, covering a total area of 421.07 mu, which can cover the crediting period of the proposed project. The land is explicitly designated as non-basic farmland, non-industrial or mining areas, and non-ecological public welfare forest, and it does not fall within urban planning boundaries, meeting the site selection requirements for pig farming projects. All villagers were fully informed and consented to the land lease, with the lease contract including documents signed by villager representatives and consent forms from contracted farmers. The land ownership is clear and undisputed, with no legal or customary conflicts regarding resource usage rights or community property rights. The project activities strictly adhere to land and resource usage regulations: The land transfer process fully complies with the voluntary principle under the Rural Land Contracting Law, without altering the original land use or the legal or customary rights of stakeholders. As the farm project party and the implementing entity are the same, the utilization of manure resources is managed under		

	a unified framework, neither infringing on the existing usage rights of indigenous people or local communities nor causing conflicts over resource allocation. Through standardized land lease agreements and resource management mechanisms, the project effectively safeguards community rights and ecological security, ensuring compliant integration of agricultural production and resource recycling.
Stakeholder diversity and changes over time	Diversity of Stakeholders: Swine farm employees, neighboring farmers, and government regulators are all directly impacted by project activities. Swine farm workers are primarily from the local area, predominantly Han Chinese (including one Yi ethnic employee). While there are differences in education levels and skills, there is no pay disparity for the same job positions. Neighboring farmers are scattered across different villages, with their income heavily influenced by crop types and harvest fluctuations. Their social networks and interaction patterns vary due to regional differences. Government regulators span multiple departments, including environmental protection and agriculture, with cross-departmental differences in professional backgrounds and policy enforcement standards. They collaborate in approving farm construction and waste management system operations. Although individual members of these groups may change due to personnel turnover, their structural characteristics—such as social class, economic models, and cultural attributes—remain generally stable.
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. Climate change Impact: The project changes the ecosystem in three main ways: 1)The project installed AWMS facilities to treat manure and wastewater generated by a swine farm. The treated wastewater and organic fertilizer will be used in the surrounding farmland and will not be emitted into natural water bodies, reducing the risk of pollution to them. 2) Atmospheric environment. The project recovered methane and use to generate power through generator, avoiding emission of methane produced by traditional manure treatment methods in swine farm to the atmosphere and reducing the impact of greenhouse gases on climate. 3) Cropland ecosystem. The organic fertilizer produced by the Project is distributed to surrounding farmers free of charge, which reduces the use of chemical fertilizer, reduces the pollution of land and surrounding water, and improves the cropland ecosystem. Collectively, these changes will have a positive impact on villagers' livelihoods and living environment, while helping to improve ecosystem services and enhance the sustainability of local communities.
Location of stakeholders	Stakeholders in this project located at the project site and within a few kilometers of it.
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, Longyang 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	Prior to the project construction, the project owner conducted local stakeholder consultation by meeting and distributing survey questionnaires on 10-February-2021, to get informed of the stakeholders' opinion about the Project in various aspects. The project owner started notifying stakeholders on 03- February-2021 by means of distributing brochures and putting up leaflets on bulletin boards at various locations of the swine farm and the village. The brochures and leaflets included general information of the project (purpose, planned location, planned dates of construction and commissioning), the date and the purpose of the upcoming stakeholder consultation as well as the project owner's phone number and email address. On 10-February-2021, a stakeholder consultation meeting (LSC) was held, inviting 30 participants (15 male and 15 female), covering diverse genders, ages, occupations, and educational backgrounds, with a 100% questionnaire return rate. The meeting process included an introduction to the farm planning and manure treatment solutions, group discussions on key issues, and on-site Q&A. The project team committed to categorizing and addressing feedback—providing additional explanations for common concerns and incorporating feasible suggestions into design or operational optimizations. The entire mechanism balances information transparency and demand responsiveness, ensuring dynamic equilibrium among multiple interests throughout project implementation.

Distribution Item		Number	Percentage
Gender	Male	15	50%
	Female	15	50%
Age	<25	6	20%
	25~45	12	40%

	45~60	9	30%
	>60	3	10%
Education	Junior high school or below	7	23.3%
	Senior high school	10	33.3%
	College or above	13	43.3%
Occupation	Worker	8	26.6%
	Farmer/peasant	8	26.6%
	Management personnel	7	23.3%
	Civil servant	5	16.7%
	Other	2	6.7%

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 know the purpose of the project?	Yes, very much	25
		Yes, a little	5
		No, not at all	0

	2	What impact do you think the implementation of this project will have on local environment?	Positive	30
			Negative	0
			Don't know	0
	3	What impact do you think the implementation of this project will have on your life?	Positive	30
			Negative	0
			Don't know	0
	4	What impact do you think the implementation of this project will have on the social economy?	Positive	30
			Negative	0
			Don't know	0
	5	Are you satisfied with the environmental protection measures that the proposed project has made?	Yes	30
			No	0
			No idea	0
	6	Does the project create employment opportunities?	Yes	29
			No	0
			No idea	1
	7	Do you think other regions should also vigorously promote this type of technology?	Yes	28
			No	0
			No idea	2
	8	Do you support the construction and	Yes	30
			No	0

		implementation of this project?	No idea	0

The survey shows that stakeholders believe that the project will have a positive impact on local ecology and employment. All stakeholders expressed support for the project and no negative comments were received.

Ongoing communication	During the project implementation phase, the project owner established a systematic communication and grievance mechanism to ensure stakeholder engagement through multiple channels: Key project information (including schedules, carbon development, risk-benefit analyses, etc.) was displayed in real-time on bulletin boards at the project site and surrounding areas, along with the contact number of a dedicated liaison officer. Biannual stakeholder consultation meetings were held regularly to discuss core issues such as operations management, benefit distribution, and monitoring and evaluation, while also explaining the grievance process and feedback channels to participants. For day-to-day communication, the project office maintained a suggestion log where stakeholders could submit comments or grievances at any time. The project team committed to reviewing and providing written responses to all submissions every two weeks. For negative feedback, a public meeting would be convened within one month to negotiate solutions, with the final resolution publicly announced under the witness of the local environmental protection bureau. If a proposed solution was not accepted, stakeholders could legally escalate their grievances to the government or courts.
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	The project belongs to the emission reduction project and is supported and encouraged by the government. The project has obtained project approval and EIA approval from local government. Therefore, the project has been approved by the local government. Meanwhile, the project owner of Baoshan East Hope Swine Farm is

	the same with the project, therefore there is no conflict over biogas resources. The project has maintained ongoing communication with the local residents and has secured permission and support for its construction and operation, as detailed in section 2.1.2. There are no ongoing or unresolved conflicts.
Outcome of FPIC	Local stakeholders are supportive of the construction of the project. The project was constructed with the consent of government departments at all levels. The project has not encroached on land, relocated people without consent, and forced physical or economic displacement. Most surveyed stakeholders think the project improves regional economic development without adverse environmental impact. The survey shows that the stakeholders are supportive of 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: Specific staff will propose a solution and mediation plan within 7 days based on all information gathered

	through the hearing or meeting, and the conflict should be dealt with within an overall time period of 30 days upon receiving the complaints. If the dispute cannot be settled by the project proponent, then it can be submitted to the county's first-level arbitration department or court.
Grievance redress procedure	Firstly, once getting the complaints or grievances, project owner shall contact and discuss with relevant community or other stakeholders within 3 days. Then the specific staff of project owner should propose a solution and mediation which is performed by relevant government agency within a week based on all collected information. Thirdly, the project owner will address their complaints or grievances by relevant legal method such as arbitration and courts if necessary. Finally, the entire complaints or grievances redress process shall be dealt within 30 days.

2.1.5 Public Comments

This project will open for public comment during the public comment period. If comments are received in the future, we will respond within 1 to 2 weeks, and the response to the comments will be implemented until the next verification, and the relevant evidence will be provided to VVB for review and confirmation.

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 farming enterprise with an annual supply of over one million commercial swine, operating multiple large-scale swine farms across the country. To promote ecological farming, some farm areas have innovatively applied black membrane anaerobic biogas technology to treat swine manure, effectively achieving resource utilization of waste[17]. With an experienced management team, the company has established a mature farming management system. Its wholly-owned subsidiary, Baoshan East Hope Animal Husbandry Co., Ltd., as the project initiator, leverages the parent company's technical expertise in the Anaerobic Wastewater Management System (AWMS) field and has developed a professional operation and maintenance system for similar projects, demonstrating profound industry technical capabilities.

[17] https://www.broas.com.cn/static/upload/file/20240620/1718875874825648.pdf

Xi'an Carbon Neutral Environmental Technology Co., Ltd., as the consulting party for this project, possesses extensive professional expertise in the field of carbon asset development. With years of deep industry engagement, the company has successfully developed numerous domestic and international carbon asset projects, covering sectors such as renewable energy power generation, forestry carbon sequestration, and manure treatment. Notably, the company has successfully registered and operated two manure composting projects (Project IDs 4612 and 4675) under the Verified Carbon Standard (VCS) mechanism, demonstrating its outstanding capabilities in carbon emission reduction technology application and project execution. Leveraging its mature development experience and technical expertise, Xi'an Carbon Neutral Environmental Technology Co., Ltd. is fully qualified to implement this project with professional competence and technical assurance.

Thus, the management team has expertise and experience in implementing similar project activities and engaging communities.

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 this project not only prevents methane emissions into the atmosphere, provides villagers with free liquid digestate fertilizer, converts the generated biogas into clean electricity, and establishes a sustainable energy supply model, but also creates employment opportunities and promotes local economic development. Therefore, it does not pose a risk to the well-being of stakeholders.
Risks to stakeholder participation	No risk identified	The mechanism for on-going communication with local stakeholders has been set up. Stakeholders are free to reach the reflection portals anytime anywhere and face no barrier or pressure to report the problems without leaving their name or showing face.

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. Moreover, the project uses anaerobic digesters to treat swine manure. Its main purpose is to collect and eliminate the biogas produced by anaerobic fermentation for power generation, avoiding direct methane emissions into the atmosphere, reducing the emission of odorous gases, and improving the working environment.
Safety of women and girls	No risk identified	Article 12 of the Labor Law of the People's Republic of China states: Laborers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. The project owner obeys the anti-discrimination rules set out in the law.
Safety of minority and marginalized groups, including children	No risk identified	Article 12 of Labor Law of the People's Republic of China enforces: Laborers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. And article 15 enforces: The employing units are prohibited from recruiting minors under the age of 16. The project owner strictly obeys the law.
Pollutants (air, noise, discharges to water, generation of waste, and release of hazardous materials and chemical pesticides and fertilizers)	No risk identified	The EIA obtained approval for the project from the Baoshan Municipal Ecology and Environment Bureau on March 24, 2021. The impacts of project activities are summarized as follows: 1.Construction Phase:

		Noise Noise during civil construction primarily stems from equipment operation and transport vehicles. Multiple measures have been implemented to mitigate noise impacts, including: speed limits and horn bans for daytime transportation, with enhanced controls through villages; nighttime transport prohibition; and strict adherence to the Construction Site Boundary Noise Standards for time-slot construction. Consequently, construction noise will not affect the surrounding environment. Air Quality During construction, air pollution includes exhaust emissions from equipment and vehicles, as well as dust from earthworks. Due to intermittent generation, small and dispersed quantities, and favorable surrounding diffusion conditions, natural dilution minimizes air quality impacts. To reduce dust and exhaust pollution, the following measures are adopted: Regular water spraying for dust suppression, with increased frequency on windy days; Standardized material storage — sand and gravel covered, cement stored indoors, and careful handling to prevent breakage; Prompt backfilling of earthworks and vegetation stabilization to prevent erosion; Covered transport to prevent dust dispersion; Enhanced vehicle maintenance to reduce emissions. Through comprehensive management, the environmental impact of construction dust and exhaust is minimal. Water Quality Construction-phase wastewater includes construction wastewater, domestic sewage, and surface runoff. Construction wastewater is treated in two 10m³ sedimentation tanks for reuse in dust suppression; personnel cleaning wastewater is treated in a 2.5m³ temporary sedimentation tank

		for reuse; rainy-season runoff is directed via drainage ditches to a 40m³ grit chamber for sedimentation before discharge. Temporary dry toilets collect feces for periodic agricultural use, with backfilling post-construction. All wastewater is recycled, with no external discharge. Solid Waste Construction-phase solid waste mainly comprises earthworks, construction debris, and domestic waste. Treatment measures for different categories of solid waste are as follows: Earthworks transport must use enclosed vehicles, with thorough cleaning before departure to prevent mud on roads, alongside speed limits and spill prevention to control dust pollution; construction debris is sorted for prioritized recycling, with non-recyclable portions transported to designated disposal sites at 100% compliance; domestic waste is uniformly deposited in project bins and regularly transported to nearby village collection points for centralized treatment, strictly following sorting requirements. All processes adhere to pollution prevention and resource recovery principles, with full-process oversight. 2.Operation period: Noise During the project's operational phase, the primary sources of noise are generated by the operation of various equipment, with noise levels ranging from 70 to 90 dB(A). The nearest residential area to the project site is approximately 470 meters away, which is relatively distant. After accounting for distance attenuation, the impact on sensitive points is minimal. With the implementation of noise control measures, the noise levels at the factory boundary during both day and night will comply with the Class 2 standards specified in the

"Emission Standard for Industrial Enterprises Noise at Boundary" (GB12348-2008).

Air Quality

During the operational phase, the air pollution during the operation mainly includes the exhaust gas of the anaerobic fermentation system, biogas generator and the flare. The exhaust gas is to be treated through 2 stage purification equipment before being discharged through exhaust cylinders with a height of not less than 15m.

The H_2S, NH_3 and odorous substance in all the exhaust gas by the project can meet the requirements of Table 2 standard limit of the "Odorous Pollutant Emission Standard" (GB14554-1993). The SO_2, NO_x, and particulate matter in all the exhaust gas by the project meets Grade 2 emission standard of "Integrated Emission Standard of Air Pollutants" (GB16297-1996).

Water Environment

During the operational phase, all types of waste water (such as swine urine, cleaning wastewater, disinfection wastewater, odor treatment wastewater, and oily wastewater) are treated in the on-site wastewater treatment plant. Domestic sewage is pre-treated in two 5 m^3 septic tanks and one 2 m^3 grease trap before entering the treatment system. Leachate from the composting site is directed to a 1 m^3 leachate collection tank via a collection ditch and fully reused for composting fermentation, achieving zero discharge. This approach will not cause significant adverse effects on the surrounding environment.

Solid Waste

General solid waste generated during the operational phase is collected in workshops and sold for comprehensive utilization. The storage of general industrial solid wastes can meet the requirements of “Standard for

		pollution on the storage and disposal site for general industrial solid wastes" (GB18599-2001). Hazardous waste is stored and transported using dedicated vehicles and containers, strictly prohibiting mixing with household waste. Hazardous waste storage areas must display unified identification signs to ensure full compliance. The project site sets up a hazardous waste collection site, and hazardous waste collected is disposed by the qualified company. The storage and disposal meet the requirements of "Standard for pollution control on hazardous waste storage " (GB18597-2001&2013). All solid waste from this project is effectively disposed of with clear destinations, posing no significant adverse impact on the surrounding environment. In conclusion, the environmental impact during the project operation will be minor. The project can reduce greenhouse gas emissions and environmental pollution caused by methane release. The project owner takes appropriate measures to minimize adverse environmental impacts.

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.	Article 12 of Labor Law of the People's Republic of China enforces: Laborers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. The project owner strictly obeys the anti-discrimination rules set out in the law. No discrimination has occurred or will occur.

Sexual harassment	No risk identified.	Article 40 of Law of People's Republic of China for the Protection of Women's Rights and Interests enforces: Sexual harassment of women is prohibited. Women victims have the right to complain to their units and relevant authorities. The project owner strictly obeys the anti-discrimination rules set out in the law. No discrimination or sexual harassment has occurred or will occur.
Equal pay for equal work	No risk identified.	Article 46 of the Labor Law of the People's Republic of China stipulates that the distribution of wages shall be based on the principle of distribution according to work, with equal pay for equal work.
Gender equity in labor and work	No risk identified.	Chapter IV Labor and Social Security Rights and Interests of Law of People's Republic of China for the Protection of Women's Rights and Interests provide the legal enforcement for gender equity in labor and work. The project owner strictly obeys the law.
Forced labor	No risk identified.	Article 244 of the Criminal Law of the People's Republic of China [Crime of Forced Labor] Anyone who forces another person to work by means of violence, threat or restriction of personal freedom shall be sentenced to fixed-term imprisonment of not more than three years or detention, and shall be fined; if the circumstances are serious, he shall be sentenced to fixed-term imprisonment of not less than three years but not more than 10 years, and shall be fined. The project owner strictly obeys the law.
Child labor	No risk identified.	Article 15 of the Labor Law of the People's Republic of China states: "Employers are prohibited from employing minors under the age of sixteen. The project owner strictly obeys the law.
Human trafficking	No risk identified.	All the labor is hired from normal paths. Laborers have the right to resign anytime. Article

		15 of Labor Law of People's Republic of China enforces: The employing units are prohibited from recruiting minors under the age of 16. The project owner strictly obeys the law.

2.3.2 Human Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified.	The project does not involve any IPs, LCs, and customary rights holders, as demonstrated above, the project does not impact legal or customary tenure/access rights to territories and resources, including collective and conflicting rights, held by stakeholders, Indigenous People (IPs), local communities (LCs), and customary rights holders. Therefore, the project's human rights focus is primarily on its employees and the local residents. The project's construction and operation strictly implement various pollution prevention and risk prevention measures proposed in the environmental impact assessment report. The main pollutants from each pollution source can meet the discharge standards, resulting in a relatively small impact on the environment. The project strictly abides by the relevant laws and regulations mentioned in section 2.3.1 above, including the Labor Law, the Law on the Protection of Women's Rights and Interests, etc. In addition, the project owner has formulated a number of corporate systems to safeguard human rights (such as safety and environmental department management policy, finance department management policy, warehouse department management policy, dismantling workshop management policy, reduction workshop management policy, human resources department management policy, marketing department management policy, and administrative department management policy, etc.) to ensure equal working opportunities for men and women, equal pay, no forced labor, no employment of child labor, a safe working environment, and regular organization of employee training, ensuring compliance with national laws/regulations and international human rights standards. Therefore, no related risks were identified during this monitoring period.

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.	The project prioritizes protecting stakeholders' property rights by engaging in regular consultations, complying with legal standards, documenting rights, offering accessible conflict resolution, and ensuring fair benefit sharing and transparent monitoring.

2.3.5 Benefit Sharing

Process used to design the benefit sharing plan	There is no considerable negative effect of project activities to any stakeholder groups. The project has been approved by the local government. And by implementing the project, the local environment has been improved. The project does not result in any risks related to protecting and preserving the property rights of IPs, LCs, and customary rights holders, and to protecting legal or customary tenure/access rights to territories, property, and resources. Therefore, no benefit sharing plan is required.
Summary of the benefit sharing plan	As clarified above, no benefit sharing plan is required for the project.
Approval and dissemination of benefit sharing plan	As clarified above, no benefit sharing plan is required for the project.

2.4 Ecosystem Health

	Risks identified	Mitigation or preventative measure(s) taken
Impacts on biodiversity and ecosystems	No risk identified.	The project activity is renewable electricity generation that avoids direct emissions of methane (CH_4) emissions

		from the anaerobic animal manure management system (lagoon) into the atmosphere, which has no negative impact to biodiversity and ecosystems. The project is also not located in the protected area.
Soil degradation and soil erosion	No risk identified.	According to the EIA of the project, the facilities for storing, transporting, and treating wastewater in this project are equipped with anti-leakage measures, and the maintenance and upkeep of the anaerobic fermentation system are strengthened to ensure the normal operation of the equipment. At the same time, taking into account the fertilizer requirements, soil conditions, climate environment, and other factors in the project area, the combination and application amount of biogas slurry are determined, and scientific and reasonable fertilization is carried out. After the project is put into operation, it will provide high-quality fertilizers, which can reduce the use of chemical fertilizers and pesticides and improve the physical and chemical properties of the soil.
Water consumption and stress	No risk identified.	Cooling water of biogas power generation system is recycled for reuse, as a way to optimize and minimize the water consumption by the project. The water consumption by the project does not affect local water use and does not lead to increased 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

Not applicable as the project does not plant or introduce any species.

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[18]	8.0
Tool	Tool 02	Tool 02: Combined tool to identify the baseline scenario and demonstrate additionality[19]	7.0
Tool	Tool 05	Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation[20]	3.0
Tool	Tool 06	Tool 06: Project emissions from flaring[21]	4.0

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

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

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

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

Tool	Tool 07	Tool 07: Tool to calculate the emission factor for an electricity system[22]	7.0
Tool	Tool 08	Tool 08: Tool to determine the mass flow of a greenhouse gas in a gaseous stream[23]	3.0
Tool	Tool 14	Tool 14: Project and leakage emissions from anaerobic digesters[24]	3.0
Tool	Tool 24	Tool 24: Common practice[25]	03.1
Tool	Tool 27	Tool 27: Investment analysis[26]	14.0

3.2 Applicability of Methodology

Methodology ID	Applicability condition	Justification of compliance
ACM0010	This methodology applies to project activities that include destruction of 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.	Applicable. For this project, the AWMS was installed in a new-built swine farm to treat the manure and wastewater from the swine farm, avoiding CH_4 and N_2O 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.

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

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

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

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

[26] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-27-v14.0.pdf

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.	Applicable. It is a Greenfield project; one set of AWMS was installed on a new-built swine farm in order to treat the manure and wastewater, which treated in the baseline uncovered anaerobic lagoons prior to the implementation of the project. The project activity will reduce of GHG in the atmosphere through avoiding CH_4 and N_2O emissions from anaerobic treatment of swine manure and wastewater.
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 in the baseline existed is higher than 5 ˚C ; (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-	(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) As the EIA report, manure or the streams obtained after treatment are not discharged into natural water resources (e.g. river or estuaries) (c) The open anaerobic lagoons considered in the baseline scenario are designed for deep storage and used for manure management and as per Technical Specification for Wastewater Treatment Engineering (CJJT54-2017), the design depth of anaerobic lagoons should be 3m – 6m, which is greater than 1m.

	permeable layer at the lagoon bottom.	(d) The annual average ambient temperature at the site is 15.7 ℃[27], which is higher than 5℃. (e) The project is a greenfield project. 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[28]. 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. The construction of anaerobic tanks is consistent with national standards "Technical specifications for completely mixed anaerobic reaction tank in wastewater treatment"[29]

[27] https://www.longyang.gov.cn/info/15875/13674609.htm

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

[29] https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/other/hjbhgc/201212/t20121231_244482.shtml

		So, no leakage of manure waste is possible.
Tool 02	The tool is applicable to all types of proposed project activities. However, 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.	The project activity is designed to introduce a new AWMS to a new-built swine farm to treat the swine manure to avoid methane emissions generated in the baseline uncovered anaerobic lagoons. Alternative scenarios, barrier analysis, investment analysis and common practice analysis will be carried out based on Tool 02. Refer to section 3.4 and 3.5 of the PD for more details.
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	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.

	(c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.	
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: (a)Scenario I: Electricity is supplied to the grid; (b)Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or (c)Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities.	This methodological tool is used to calculate emissions resulting from electricity consumption in project activities. Although the project itself generates electricity, it does not supply power to the CSPG. The electricity produced by the project will be used for the normal operation of the AWMS. Therefore, scenario (b) is applicable.
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.	Applicable. Tool 05 is only used to calculate project emissions of electricity consumption supplied by CSPG.
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	The biogas generated during the treatment process is captured for power generation, and the residual biogas is flared if there is any

	document in the CDM-PDD the type of flare used in the project activity.	surplus. One open flare is constructed in the swine farm.
Tool 06	This tool is applicable to the flaring of flammable greenhouse gases where: (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).	For this project, the source of the residual biogas is gas from a 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. Operating specifications were provided by the manufacturer of the flare.
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 activities generate electricity and supply it only to AWMS for normal operation, unrelated to supplying electricity to the grid that would displace electricity generated by fossil-fuel power. Therefore, this is not applicable.
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	The project activity consumes electricity from CSPG. The emission factor is calculated for grid power plants only and is published by Ministry of Ecology and Environment of the People’s Republic of China.

	1: Procedures related to off-grid power generation" should be met. Namely, the total capacity of off-grid power plants (in MW) should be at least 10 per cent of the total capacity of grid power plants in the electricity system; or the total electricity generation by off-grid power plants (in MWh) should be at least 10 per cent of the total electricity generation by grid power plants in the electricity system; and that factors which negatively affect the reliability and stability of the grid are primarily due to constraints in generation and not to other aspects such as transmission capacity.	
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 activity instances locate in China, a non-Annex I country.
Tool 07	Under this tool, the value applied to the CO_2 emission factor of biofuels is zero.	The project uses electricity comes only from CSPG. The latest available emission factor of CSPG issued by China DNA on 08/07/2024 was used to calculate emissions[30]. No biofuel is involved in 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 project will monitor and record the amount of produced and collected biogas in the anaerobic digesters.
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	The biogas generated during the treatment process including CH_4, H_2S, O_2, CO, CO_2, N_2 and H_2, of which CH_4 is the main component.

[30] https://www.ncsc.org.cn/SY/zywj/202407/W020240709709436742308.pdf

	determination and may not adopt this tool as material balances are the cost-effective way of monitoring flow of CO_2.	Therefore, this tool is adopted used for determining the mass flow of a greenhouse gas.
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; (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).	a) Methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied in the PD. b) The mass flow is determined in the monitoring plan of the PD. c) The flow of the gaseous stream will be 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.	The electricity generated by the project is used for the normal operation of the biogas system. Unless the project fails to generate electricity, the power required for the project is supplied by the grid company. The anaerobic digestion process of this project does not involve the use of fossil fuels. The biogas generated during the treatment process will be captured and sent to generator for electricity generation and surplus biogas will be destroyed through the flaring system. If there is any surplus biogas for flaring during the subsequent monitoring period, then the CH_4 emissions from flaring of biogas should be included into

		project emission. So, the project meets the (a), (c) and (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.	The project newly built two enclosed anaerobic digestion tanks. The biogas generated during the treatment process will be collected for power generation, with any surplus directed into a flare combustion system. The digested sludge from anaerobic treatment and the solid manure separated through solid-liquid separation will undergo composting via a passive windrow system, ultimately being converted into fertilizer. CH_4 and N_2O emission from composting of digestate will be considered and calculated together with the project emission from composting of solid manure according to ACM0010. So, (a) is applicable. The project does not utilize additional solid waste disposal or storage sites for sludge, thus eliminating the need to consider leakage emissions. No additional SWDS or storage yard was adopted by the project to store the sludge. So, leakage emissions (b) are not taken into account.
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	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.

	accounted in the methodologies referring to this tool.	
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.	Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) 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.
Tool 27	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", the guidelines "Non- binding best practice examples to demonstrate additionality for SSC project activities", or baseline and monitoring methodologies that use the investment analysis for the demonstration of additionality and/or the identification of the baseline scenario.	Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) is applied to identify the baseline scenario by the project. Investment analysis based on the " Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0), taking into account the latest approved tool 27 "Methodological tools: Investment analysis" (version 14.0), as detailed in section 3.5 of the PD.

	In case the applied approved baseline and monitoring methodology contains requirements for the investment analysis that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail.	The latest version of Combined tool to identify the baseline scenario and demonstrate additionality is referred by ACM0010 methodology.

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 project does not provide electricity for profitable use to displace electricity that would be generated by fossil-fuel power in the baseline scenario.
		CH_4	No	The project does not provide electricity for profitable use to displace electricity that would be generated by fossil-fuel power in the baseline scenario.
		N_2O	No	The project does not provide electricity for profitable use to displace electricity that would be generated by fossil-fuel power in the baseline scenario.
	Emissions from thermal	CO_2	No	The project does not use biogas for heating.

Source		Gas	Included?	Justification/Explanation
	Energy generation	CH_4	No	The project does not use biogas for heating.
		N_2O	No	The project does not use biogas for heating.
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.
	Emissions from thermal energy use	CO_2	No	This project does not use thermal energy.
		CH_4	No	This project does not use thermal energy.
		N_2O	No	This project does not use thermal energy.

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 Composting- Passive windrow, 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.

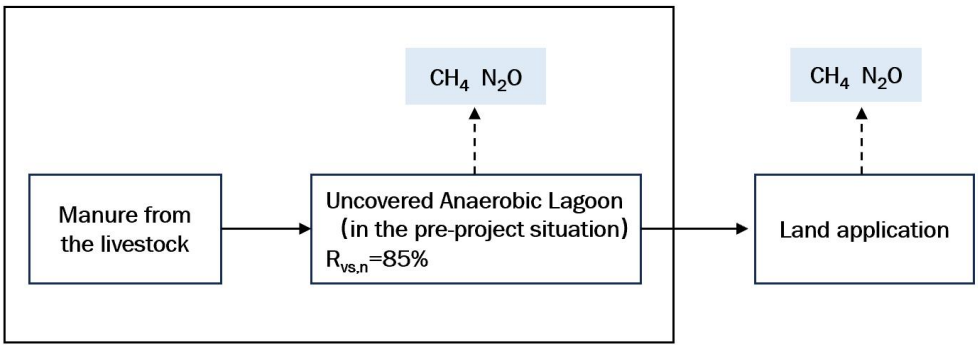

Figure 3-1 The baseline boundary

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

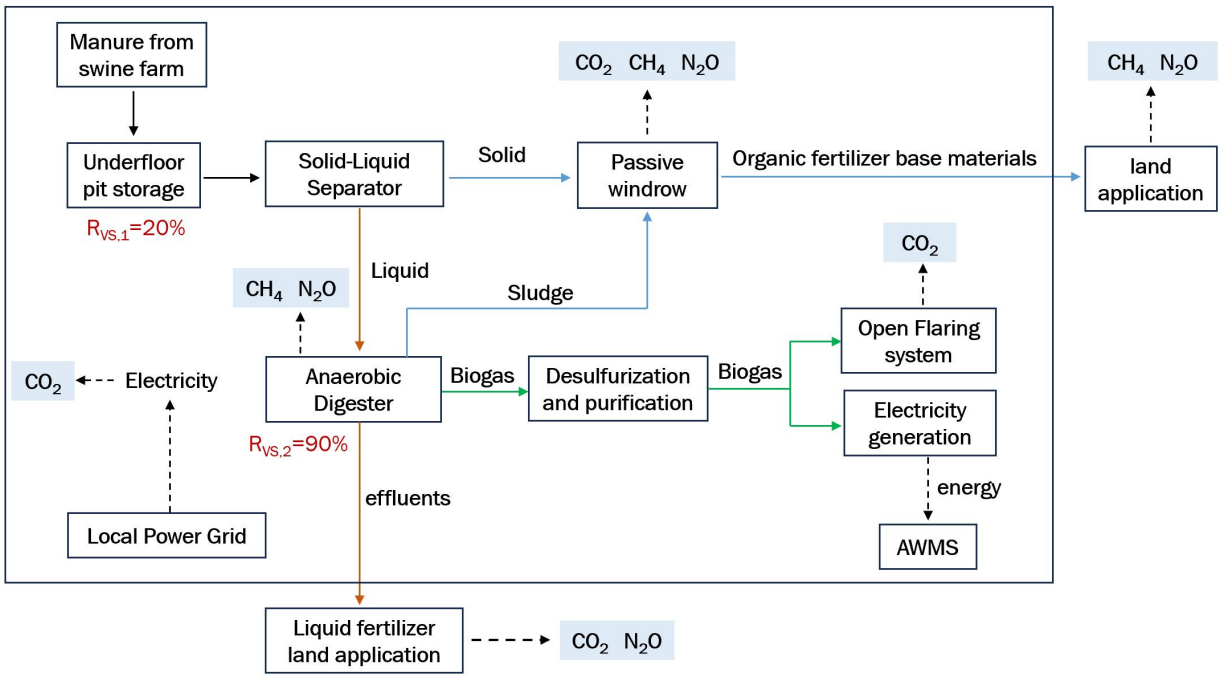

Figure 3-2 The project boundary

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

The project is greenfield facility to install 1 new set of AWMS to 1 new swine farm. There is no legal regulation to mandate animal waste treatment techniques and to capture and/or utilize methane generated at these lagoons, therefore in absence of the project, animal waste would have been left to decay in uncovered anaerobic lagoons to generate methane emitting to the atmosphere directly without any recovery or destruction. The uncovered anaerobic lagoons is the most economic and practical method for swine farms to handle the animal waste in China.

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 the use of leaky board 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	In dry climates animals may be kept on unpaved feedlots where the manure is allowed to dry until it is periodically removed. Upon removal the manure may be spread on fields. This system is not applicable to the conditions of these farms in the project. The proposed project is non-free captive mode. This method is only a storage method of manure, not a disposal method. So, this system is excluded.
5	The manure is disposed of as liquid/slurry.	Not Applicable	This method is only a storage method of manure, not a disposal method. Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year. Since the amount of discharged manure is very large even on a daily bases, storing the liquid manure in the tank to distribute them to the farmland requires a lot of labour work. Therefore, it is unrealistic to implement such a task for the farms under the competition of the market. Therefore, this option faces significant barrier and is excluded from the baseline scenario.
6	Uncovered anaerobic lagoon	Applicable	As per "Technical specification for sanitation treatment of livestock and poultry manure[31]", the uncovered anaerobic lagoon is a kind of harmless treatment of manure. According to documents from the Yunnan Provincial Bureau of Ecology and Environment[32],

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

[32] https://www.yn.gov.cn/zwgk/zfgb/2019/2019d1q/szfbgtwj/201812/t20181228_146059.html

			more than 70% of livestock farms in Yunnan Province use uncovered anaerobic lagoons to treat manure without solid-liquid separation. Following treatment in the uncovered anaerobic lagoon, the manure can be utilized for agricultural irrigation. Owing to the absence of a requirement for solid - liquid separation devices, its cost demonstrates a notable advantage over project activities. Prior to the implementation of the project, the animal manure waste was left to decay in uncovered anaerobic lagoons. Since there is no legal regulation to mandate the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques and to capture and/or utilize methane generated at these lagoons. So, the uncovered anaerobic lagoon is an alternatives baseline scenario.
7	Pit storage below animal confinements, <1month	Not Applicable	This method is only a storage method of manure, not a disposal method. The farms involved in this project are large-scale livestock farm and the manure quantity produced is too large to implement pit storage structure under the barns. In addition, the manure stored in below animal confinements were removed within 1 month requires a lot of labour work. So, this scenario is excluded.
	Pit storage below animal confinements,>1month	Not Applicable	This method is only a storage method of manure, not a disposal method. The farms involved in this project are 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 swine will be quickly killed by the accumulation of toxic fumes.
8	Anaerobic digester (Anaerobic digester Aerobic Composting 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. Combination of anaerobic digester - aerobic treatment system is considered as one of the most advanced manure management systems, but implementing such technology needs high invest and the proposed project will not be invested and constructed without any extra benefits such as being registered as a VCS project.
9	Burned for fuel	Not Applicable	According to the EIA reports and Guideline on Best Available Technologies for Pollution Prevention and Control of Livestock and Poultry Farms (on Trial)[33], water ratio of fresh swine manure is about 80%, moreover, daily urine production of swine is over 3 times of the manure amount, leading to a low dry matter content ratio (lower than 5% as estimated) of the animal waste, hence it is costly and unlikely to dry the dung before using as fuel.

[33] https://www.mee.gov.cn/gkml/hbb/bgg/201307/W020130726461701962978.pdf

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	The manure in this project is collected via scraping and flushing systems, resulting in liquid effluent with high moisture content. As Scenario 11 is exclusively designed for solid manure treatment, it cannot process the high-moisture raw manure directly. Even when implemented following solid-liquid separation, this technology still requires substantially higher capital investment (particularly in equipment) and operational expenditures compared to Scenario 14 (Composting – Passive windrow). Based on comprehensive evaluation of technical suitability and cost-effectiveness, this technical solution has been excluded.
12	Composting - Static pile	Not Applicable	The manure in this project is collected via scraping and flushing systems, resulting in a liquid form with high moisture content. As Scenario 12 is only applicable for solid manure treatment, it cannot directly process the high-moisture raw manure. Even when implemented after solid-liquid separation, this method still requires substantial electricity consumption for forced aeration, resulting in significantly higher operational costs compared to

			Scenario 14 (Composting – Passive windrow). Based on comprehensive evaluation of technical suitability and cost-effectiveness, this technical solution has been excluded.
13	Composting - Intensive windrow	Not Applicable	The manure in this project is collected via scraping and flushing systems, resulting in a liquid form with high moisture content. Scenario 13 is only suitable for solid manure treatment and cannot directly process this high-moisture liquid manure. Even with solid-liquid separation pretreatment, this method still requires substantial mechanical turning and aeration management costs, resulting in significantly higher operational expenses compared to Scenario 14(Composting – Passive windrow). Based on comprehensive evaluation of technical suitability and cost-effectiveness, this technical solution has been excluded.
14	Composting – Passive windrow （Anaerobic digester & Aerobic Composting system）	Applicable	The manure in this project is collected via scraping and flushing systems, presenting as a liquid with high moisture content and containing significant organic pollutants. Technical and economic analyses demonstrate that single composting processes are ineffective for treating this type of manure, as they would require large-scale treatment facilities with substantial capital investment, [34]. Currently, the integrated anaerobic digestion system (Scenario 8) combined with aerobic composting represents the optimal treatment solution. For solid

[34] https://www.bmlink.com/weidianjietialiao/news/2228783.html

			manure treatment, this project employs passive windrow composting, which offers both technical and cost advantages compared to Scenario 11 (Composting - In-vessel), Scenario 12 (Composting - Static pile), and Scenario 13 (Composting - Intensive windrow). However, successful registration as a VCS project to obtain carbon emission reduction benefits is essential, as the project would otherwise fail to meet investment return requirements.
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	Not Applicable	It is suitable to treat liquid manure, but in this project, the manure is in both liquid and solid form, which cannot be treated by aerobic treatment only. This option is excluded.

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 & 14: Anaerobic Digester & Composting – Passive windrow, i.e., the proposed project activity not being registered as a VCS project activity.

Step 1b: Consistency with mandatory laws and regulations

Manure from livestock is prohibited to discharge directly into environment without any treatment as per Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming[35] issued by the State Council in Nov. 2013. However, there is no specific law or regulation which mandates the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques to treat the animal manure in China. According to "Technical specification for sanitation treatment of livestock and poultry manure[36]" and the "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)[37]", uncovered anaerobic lagoon is considered as a manure treatment method, requiring minimum financial cost and compliance with laws and regulations. And anaerobic digester, aerobic treatment or other biological treatment techniques to dispose 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 14: Anaerobic Digester & Composting – Passive windrow, are all consistent with mandatory laws and regulations. Therefore, the outcome of Step 1b is unchanged from Step 1a.

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.

According to the tool 02, Step 3 investment analysis is conducted to further identify the baseline and demonstrate additionality of the proposed project. It is concluded that the most financially attractive scenario is Scenario 6, i.e. anaerobic lagoon, which is concluded as the baseline scenario, please refer to section 3.5 for details.

3.5 Additionality

3.5.1 Regulatory Surplus

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

[35] http://politics.people.com.cn/n/2013/1126/c1001-23662445.html

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

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

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 in China that mandate livestock farm owners to implement anaerobic digestion, aerobic, or other biological treatment techniques to treat animal manure, nor are there relevant laws or regulations requiring the mandatory recovery of biogas.. 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.

In addition, the "Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming on a Large Scale"[38] encourage and support the recovery and use of biogas, but there is no mandatory requirement. Therefore, the project activity is not mandated by any law, statute, or other regulatory framework; it is regulatory surplus.

Therefore, Scenario 6 and Scenario 8 & 14 are 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 and Step 2 have been completed in Section 3.4 of the PD.

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

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

manure is disposed of in an uncovered anaerobic lagoon"; and Scenario 8&14: Anaerobic Digester & Composting – Passive windrow 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 equity 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"[39] issued by NDRC and the ministry of housing and urban-rural development of PRC on 15-Mar-2013. The Notice was valid and the most recent official source at the time when completing EIA (Mar-2021) and making the investment decision (signing of the AWMS construction contract, 21-Apr-2021). 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

[39] https://www.ndrc.gov.cn/fggz/gdzctz/tzfg/201907/t20190729_1197578.html

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&14: Anaerobic Digester & Composting – Passive windrow i.e., the proposed project activity not being registered as a VCS project activity.

The EIA was completed in Mar-2021; the investment decision was made on 21-Apr-2021 (when the AWMS construction contract was signed). The time lapse between the EIA and the investment decision was no more than two months to ensure that there were no significant changes in the investment parameters and therefore the inputs to the investment estimate report were 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)[40] 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 3 days (actually may be longer).

The project is a Greenfield project. Baoshan East Hope swine farm leased approximately 280714.74[41] 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 (-139.14) than the one without land cost (-135.41), 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

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

[41] According to the land lease agreement, the project covers an area of 421.07 acres, equivalent to 280,714.74 m^2.

"Design specifications for wastewater storage facility of animal farm (GB/T 26624-2011)". Thus, the annual land cost for baseline lagoon is 0.42 ×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, 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 EIA is reasonable.

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

Main Parameters		Unit	Value	10,000 CNY	Source
	1 Basic parameter				
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[42]		
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[43]

[42] =45,900m^3×12CNY/m^3

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

2.2	Construction period	Year	1		Data sources refer to the financial data in EIA
2.3	Operation period	Year	20		Data sources refer to the financial data in EIA
	3 Cost				
3.1	Annual O & M cost	10,000 CNY		10.99	EIA
3.1.1	Salary and welfare	10,000 CNY		10.58	EIA
	Employee number	Number	1		Analogy of the same industry situation
	Salary	10,000 CNY	7.5		Data sources refer to the financial data in EIA
	Welfare	%	41%		Data sources refer to the financial data in EIA
3.1.2	Annual Land cost	10,000 CNY		0.42	
3.1.2.1	Annual land price	CNY/m^2	0.54		Land lease contract
3.1.2.2	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-Composting – Passive windrow

Main Parameters			Unit	Value	Source
Total statistic investment			10,000 CNY	900	EIA
Annual O&M cost	Total		10,000 CNY	160.21	EIA
	Annual material cost		10,000 CNY	60	EIA
	Annual	Total	10,000 CNY	17.64	Calculated

	Electricity Fee	Electricity purchased	10,000 kwh	40.94[44]	Calculated
		Electricity price(With VAT)	CNY / kwh	0.430875[45]	EIA
	Annual salary and welfare		10,000 CNY	52.88	Calculated
	Average annual maintenance expenses		10,000 CNY	27	EIA
	Average annual insurance expenses		10,000 CNY	2.7	EIA
Annual sales of organic fertilizer	Total		10,000 CNY	216	EIA
	Annual sales volume of organic fertilizer		ton	18,000[46]	EIA
	price of organic fertilizers		CNY	120	EIA
Construction period			Year	1	EIA
Operation period			Year	20	EIA
Depreciation period			Year	20	EIA
Rate of residual value			%	5%	EIA
VAT rate (Revenue)			%	0%	EIA[47] & Notice of the Ministry of Finance and the State Taxation Administration on Exempting Organic Fertilizer Products from Value-Added Tax [48]

[44] In the EIA, the project consumes $50*10^4$kwh per year. The project's annual generation is $9.06*10^4$kwh, thus, $40.94*10^4$kwh (=$50*10^4$kwh-$9.06*10^4$kwh) is purchased from the grid.

[45] https://www.yn.gov.cn/ztgg/yhyshj/zcwj/hddl/202203/t20220315_238689.html

[46] The total design production of organic fertilizer for the project is 18,000 tons, and since the amount of free distribution to local farmers cannot be predicted, the NPV calculation is based on 18,000 organic fertilizer sales, which is conservative.

[47] Notice of the Ministry of Finance and the State Taxation Administration on Exempting Organic Fertilizer Products from Value-Added Tax
https://fgk.chinatax.gov.cn/zcfgk/c102416/c5203334/content.html

[48] Notice of the Ministry of Finance and the State Taxation Administration on Exempting Organic Fertilizer Products from Value-Added Tax
https://fgk.chinatax.gov.cn/zcfgk/c102416/c5203334/content.html

Income tax rate (first 3 operation years)	%	0%	EIA & Enterprise Income Tax Law of the People's Republic of China [49]
Income tax rate (4-6 operation years)	%	12.5%	
Income tax rate (the rest operation years)	%	25%	
VAT rate (equipment & material)	%	9%	EIA & Announcement on Relevant Policies on Deepening Value-added Tax Reform (Ministry of Finance General Administration of Taxation General Administration of Customs Announcement No. 39 of 2019)[50]
Urban maintenance and construction tax	%	5%	EIA & Law of the People's Republic of China on Urban Maintenance and Construction Tax [51]
Surtax for education	%	3%	EIA & Interim Provisions on the Collection of Education Surcharge[52]
Emission reduction	tCO_2e	49,328	ER spreadsheet
VCU Price	CNY/ton	18	Expected[53]

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

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

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

[49] Enterprise Income Tax Law of the People's Republic of China
https://fgk.chinatax.gov.cn/zcfgk/c100009/c5193018/content.html

[50]

https://12366.chinatax.gov.cn/bzds/118/118-1-8.html

[51] Law of the People's Republic of China on Urban Maintenance and Construction Tax
https://fgk.chinatax.gov.cn/zcfgk/c100009/c5193055/content.html

[52] Interim Provisions on the Collection of Education Surcharge
https://www.gov.cn/gongbao/content/2011/content_1860811.htm

[53] https://app-na1.hubspotdocuments.com/documents/3298623/view/125182374?accessId=a759f9

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	10.99	10.99	10.99	10.99
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	10.99	10.99	10.99	10.99
- Salary and welfare	0.00	10.58	10.58	10.58	10.58
- 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	-10.99	-10.99	-10.99	-10.99
NPV (discount rate=9.5%)	-139.14				

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

Table 3-5 The results of financial analysis of Anaerobic Digester-Composting – Passive windrow （10^4 RMB）

Year		1	2	3-4	5-7	8-11	12-20	21
1	Cash in		216.00	216.00	216.00	216.00	216.00	281.00
	Income		216.00	216.00	216.00	216.00	216.00	216.00
	Recovery of residual value of fixed assets							45

	Recovery of current capital							20
2	Cash out	900	180.21	160.21	161.84	163.47	163.47	163.47
	Equity Investment in fixed assets	900						
	Current capital		20					
	Operational and maintenance cost		160.21	160.21	160.21	160.21	160.21	160.21
	Tax		0.00	0.00	0.00	0.00	0.00	0.00
	Income tax		0	0	1.63	3.26	3.26	3.26
3	Net cash flows without VCUs revenue (after-tax)	-900	35.79	55.79	54.16	52.53	52.53	117.53
4	NPV (discount rate=9.5%)	-395.89						
5	Net cash flows with VCUs revenue	-900	124.58	144.58	142.95	141.32	52.53	117.53
6	NPV with VCUs revenue (discount rate=9.5%)	113.24						

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 -395.89 CNY, which is lower than the benchmark NPV of 0 CNY, indicating that the project is financially unfeasible due to insufficient net cash inflows. However, when considering the income from VCUs, the NPV of the proposed project rises to 113.24 CNY, exceeding the benchmark NPV and becoming positive, making the proposed project financially feasible.

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

	Without VCUs	With VCUs
NPV (discount rate=9.5%)	-395.89	113.24

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 sales volume of organic fertilizer
- Organic fertilizer Price
- Annual O&M cost

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	-129.58	-134.24	-139.14	-144.30	-149.70
Annual O&M cost	-122.60	-130.66	-139.14	-148.05	-157.39

Table 3-8 Sensitivity analysis of the project

	Variation				
Indicator	90%	95%	100%	105%	110%
NPV (discount rate=9.5%)					
Total static investment	-225.34	-308.56	-395.89	-487.33	-582.88
Annual sales of organic fertilizer	-553.81	-469.62	-395.89	-322.16	-248.43
Organic fertilizer Price	-553.81	-469.62	-395.89	-322.16	-248.43
Annual O&M cost	-286.51	-341.20	-395.89	-450.58	-508.91

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 25.02%.
- Annual sales volume of organic fertilizer: increase about 26.85%
- Organic fertilizer Price: increase about 26.85%
- O&M cost: decrease about 36.20%.

a) Total static investment

The NPV would exceed the baseline NPV value when the total static investment decreases by 25.02%. 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[54], and this trend seems unlikely to be changed before the 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 1,249.69*10^4 CNY, which is higher than the value estimated according to the Environmental impact assessment (900.00*10^4 CNY). Therefore, the NPV cannot be increased by changes in total static investment.

b) Annual sales volume of organic fertilizer

Annual organic fertilizers production increasing about 26.85%: the organic fertilizers are produced through the Composting- Passive windrow system, which is determined by the manure

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

of the swine farm. Since the scale of the swine farm will stay stable in the future, therefore the increase of annual organic fertilizers generation to threshold is impossible to achieve.

Based on the Project's organic fertilizer sales records for the years 2024, the actual sales volume is 17,578 tons. By comparing the actual sales volume of organic fertilizer of the project in 2024 with EIA estimates, it is evident that actual sales fell short of projections. Moreover, with the local cultivated land area fixed, demand for organic fertilizer will remain stable, making it unlikely for annual sales volume to increase to the target threshold.

c) Organic fertilizer price

Fertilizer price increase of approximately 26.85%: According to the organic fertilizer sales agreement between PP and the village committee, as the project's short composting time, the fertility of organic fertiliser is lower than that of bio-organic fertiliser in the market and is not competitive in the market, it is sold to the farmers around the project at a price lower than the market price. As clearly stipulated in the agreement, the unit sales price of the organic fertilizer is fixed at CNY 120 per ton, and this price will remain valid throughout the entire project life cycle. In addition, according to public information[55], the price of organic fertilizer in Yunnan Province has remained stable throughout the year without significant fluctuations. Therefore, it is impossible for the price of the organic fertilizer to rise to a critical point.

d) Annual O&M cost

The NPV would exceed the baseline NPV value when the annual O&M cost decreases by 36.20%. Based on Chinese Statistic Yearbook[56] , 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[57]. 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 2024 is $162.28*10^4$ CNY, which is higher than the value estimated according to the environmental impact assessment ($160.21*10^4$ 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

[55] https://www.chinabgao.com/jiage/15300605.html

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

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

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 -395.89. The project can apply for carbon credits under VCS project, the NPV can reach to 113.24 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.

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 57,534 heads of marketing swine are included, and are estimated to produce 26,718 tons of manure every year, therefore. The Swine Farm Animal Manure Management System GHG Mitigation projects that can handle manure from 13,359 tons to 40,077 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;

26,718 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 13,359 tons to 40,077 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 start date of the project activity (the date of actual action under the CDM) is 21-Apr-2021, which is earlier than the project design document is published for global stakeholder consultation.

Therefore, only projects which started commercial operation before 21-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 13,359 tons to 40,077 tons, and starting commercial operation before 21-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[58] and Department of Agriculture and Rural Affairs of Yunnan Province[59], 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.

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.

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

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

4 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The baseline is the AWMS identified through the baseline selection procedure in Section 3.4 of this PD. 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:

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

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.

There is no published country specific data available, so we could not use Option 1. The energy intake of the swine is not available, so we could not use Option 2. Option 3 utilizes the average weight of the swine; this data is available and therefore **Option 3** is adopted to calculate $VS_{LT,y}$. As per methodology, Option 1 to Option 4 are presented in the order of preference, since Option 3 is available, Option 4 shall not be applied.

As per the latest VCS Standard, it is required that all the default values sourced from IPCC 2006 Guidelines shall be updated with the IPCC 2019 Refinement data, thus all the default values from IPCC are from the IPCC 2019 Refinement in this project.

The swine farm is 100 percent market oriented with high level of capital input requirements and high level of overall herd (flock) performance. The feed of swine is purchased from local or international market or intensively produced on farm. Swines are improved through the PP' breeding practices in commercial production in other farms and then introduced to Baoshan East Hope Swine Farm. According to 2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4, the swine farm belongs to high-productivity systems.

Parameter	Value	Unit	Source	Clarification
W_{site}	115	kg	PP experimental design data	Average weight of the livestock is calculated based on the design data from PP
$W_{default}$	56	kg	2019 Refinement to the 2006 IPCC Guidelines table 10.a5, chapter 10, volume 4	Default values of animal weight, finishing swine (market swine) and breeding swine, high PS, Asia.
$VS_{default}$	0.2856[60]	kg-dm/animal/day	2019 Refinement to the 2006 IPCC Guidelines, volume 4, chapter 10, tbl. 10.13A	Volatile solid for type LT entering AWMS, default high PS value of finishing swine (market swine) in Asia.
nd_y	365	Days per year	EIA	The treatment facility is in operation the whole year

（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:

[60] Default values of $VS_{default}$ from 2019 Refinement to the IPCC 2006 Guidelines of market swine is 5.1kg/1000kg animal/day, after transfer the unit, $VS_{default}$ = 5.1/1000×56 = 0.2856 kg/hd/day for markets swine

$$N_{LT} = N_{da,LT} \times \left(\frac{N_{p,LT}}{365}\right)$$ 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:

$$N_{LT} = \frac{\sum_1^{365} N_{AA,LT}}{365}$$ 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 swine. For market swine, since there is no way to trace the daily stock, so the Option 1 is adopted to calculate for market swine. Therefore, Option 1 is used to calculate the N_{LT} of market pigs.

Parameter	Value	Unit	Source	Clarification
$N_{P,LT}$	125,000	head	EIA	Number of animals of type LT produced annually for the year y
$N_{da,LT}$	168	days	EIA	Number of days animal of type LT is alive in the farm in the year y
N_{LT}	57,534	head	Calculated	Annual average number of animals of type LT for the year y

（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 Wangzhai Village, Xiyi Township, Longyang District, Baoshan City, Yunnan Province, China, Asia. The swine farm is 100 percent market-oriented with high-level capital input requirements and a high level of overall herd (flock) performance. The feed for swine is purchased locally or intensively produced on-farm. Swines are improved through the PP' breeding practices in commercial production in other farms and then introduced to Baoshan East Hope Swine Farm. According to the 2019 Refinement to the 2006 IPCC Guidelines, Table 10.16, Chapter 10, Volume 4, the swine farm belongs to high-productivity systems, so the maximum methane-producing potential ($B_{0,LT}$) for market swine in the Asia region is 0.45 m^3 CH_4/kg-dm.

（D）Annual methane conversion factor (MCF_j) for the baseline $AWMS_j$

（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 average annual temperature in the region is 15.7 °C, with an average annual precipitation of 975.6 mm and an average annual evaporation of 1612.6 mm[61]. 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.

For this project, the IPCC default values provided in table 10.17 of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 are used. The value applied for MCF_j is as follows.

Project location	**Site annual average temperature**	**MAP**	**PET**	**Ratio of potential evapotranspiration to precipitation**	**Climate zone**	**MCF_j**	**MCF_j with conservative factor (MCF_i*0.94)**
Baoshan City, Yunnan Province	15.7˚C	975.6 mm	1612.6 mm	1.65(>1)	Warm temperature moist	73%	68.62%

[61] https://www.longyang.gov.cn/info/15875/13674609.htm

（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)

Parameter	Value	Unit	Source	Clarification
$EF_{N20,D}$	0	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	The baseline scenario is uncovered anaerobic lagoon and the corresponding default value is applied.
$EF_{N20,ID}$	0.01	kg N_2O/kg N	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	Methodology required default value
$F_{gasMS,j,LT}$	40%	/	2019 Refinement to the 2006 IPCC Guidelines default value of Uncovered anaerobic lagoon, swine, table 10.22, chapter 10, volume 4	The baseline scenario is an uncovered anaerobic lagoon, and the livestock is swine; the corresponding default value is applied.

$MS\%_{BL,J}$	100%	/	/	In the baseline scenario, all the manure is treated in uncovered anaerobic lagoon.

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 project has adopted Option 2 to calculate $NEX_{LT,y}$ due to several key factors: First, the protein content of purchased feed is not fixed as feeders adjust feed type and quantity based on pig growth, while pig feed intake cannot be determined, making protein intake data unobtainable. Additionally, no national or Yunnan-specific data exists for nitrogen excretion (NEX) calculations, meaning neither detailed N intake information nor localized reference data is available. Furthermore, nitrogen intake-based methods would require measurement of feed parameters like GE and CP, which involve high testing costs and 3-7 day laboratory analyses, rendering them impractical for dynamic calculations. By contrast, animal weight (W_{site}) data is routinely collected through standard farm management practices (including slaughter weighing and inventory checks), providing readily available information without additional costs. Importantly, China's pig weight range (100-150kg) closely matches IPCC baseline values, allowing weight-based calibration to effectively minimize errors while maintaining adjustment flexibility for regional variations. This approach enhances operational feasibility and aligns perfectly with the project's practical farming management requirements, making Option 2 the optimal calculation method.

Parameter	Value	Unit	Source	Clarification
$NEX_{IPCC,default}$	12.88	kg N/animal/year	Calculated	The project involves swine breeding and production in China, related default values are applied.
$N_{rate(T)}$	0.63	kg N/1000kg animal mass/day	2019 Refinement to the 2006 IPCC Guidelines default value, vol. 4, ch.10, tbl. 10.19, default value of finishing swine, breeding swine, High PS, Asia	
TAM	56	kg	2019 Refinement to the 2006 IPCC Guidelines, volume 4, ch.10, tbl. 10A.5, finishing swine (market swine) and breeding swine, high PS, Asia.	
$NEX_{LT,y}$	26.44	kg N/animal/year	Calculated	/

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

$$BE_{elec/heat,y} = BE_{EC,y} + BE_{HG,y}$$ 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)

The baseline scenario of this project is uncovered anaerobic lagoon, and no heat used in the baseline, only minor electricity will be used, so the emission can be excluded for simplification. In addition, the biogas generated during the treatment process in this project will be captured for electricity generation and all the electricity generated from this project will be used by the daily operation of AWMS. The electricity t generated will not be connected to another user. So, the baseline CO_2 emission from electricity and/or heat used in the baseline is 0, which is conservative.

4.2 Project Emissions

Three stages are involved in the manure treatment for the project activity: :(1) underfloor pit storage; (2) anaerobic digester; (3) passive windrow 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 $PE_{EC/FC,y}$, at one time and are not repeated in other parts. Therefore, the project emissions from electricity consumption associated with the anaerobic digester are 0, i.e., $PE_{EC,y}$ = 0.

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., $PE_{AD,y} = PE_{CH4,y} + PE_{flare,y}$.

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:

$$PE_{CH4,y} = Q_{CH4,y} \times EF_{CH4,default} \times GWP_{CH4} \quad \text{Equation (16)}$$

Where:

$PE_{CH4,y}$	Project emissions from flaring of the residual gas in year y (t CO_2e)
$Q_{CH4,y}$	Quantity of methane produced in the anaerobic digester in year y (t CH_4)
$EF_{CH4,default}$	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester (fraction)
GWP_{CH4}	Global warming potential of CH_4 (t CO_2 / t CH_4)

(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. At the swine farms with biogas utilization, the collected biogas is utilized and if there is excess biogas, it is flared. Three flowmeters are installed at these swine farms, i.e., the outlet of the biogas collection system, the inlet of the combustion system and the inlet of the biogas power plant, to continuously measure the biogas flow. In the swine farms where biogas is directly destroyed by flaring, only one flowmeter is installed at the inlet of the combustion system. For more information, please refer to section 5.3. 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 relevant values applied are as follows:

Parameter	Value	Unit	Source	Clarification
$EF_{CH4,default}$	0.10	tCH_4 leaked / tCH_4 produced	Default value of Tool 14	The project adopts covered anaerobic lagoons, the corresponding default value from Tool 14 is applied.
GWP_{CH4}	28	t CH_4 / t CO_2	IPCC AR5	As per latest VCS Standard, GWP from IPCC AR5 shall be applied.
$Q_{CH4,y}$	24.29	tCH_4	Calculated	Based on volume flow of biogas, methane

				content, and methane density at normal temperature and pressure

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; 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°C (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 °C. Therefore, if the gas temperature measured by the flowmeter does not exceed 60 °C, it can be demonstrated that the gaseous stream is dry.

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

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad \text{Equation (17)}$$

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation (18)}$$

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)

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 open flares. According to tool 06 paragraph 18: In the case of open flares, the flare efficiency in the minute m (flame,m) is 50% when the flame is detected in the 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:

$$PE_{flare,y} = GWP_{CH4} \times \sum_{m=1}^{525600} F_{CH4,RG,m} \times \left(1 - \eta_{flare,m}\right) \times 10^{-3} \quad \text{Equation (19)}$$

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 17 and 18, so the project emissions from flaring can be calculated by:

$$PE_{flare,y} = GWP_{CH4} \times V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \times \left(1 - \eta_{flare,m}\right) \times 10^{-3} \quad \text{Equation (20)}$$

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/m^3 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 $\upsilon_{i,t,db}$ and $\rho_{i,t}$ the of residual gas will be

same as the biogas produced in the anaerobic digester.

According to the EIA, nearly all the biogas generated in the AWMS will be collected for electricity generation, and none of the biogas will be flared in the pre-calculation. During the monitoring period, the project emissions from the flaring of biogas will be calculated according to the actual situation.

Estimation of various variables and parameters for above equations:

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

$$F_{i,t} = V_{t,db} \times v_{i,t,db} \times \rho_{i,t} \quad \text{Equation (21)}$$

$$\rho_{i,t} = \frac{P_t \times MM_i}{R_u \times T_t} \quad \text{Equation (22)}$$

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

(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.

$$PE_{Aer,y} = GWP_{CH4} \times D_{CH4} \times 0.001 \times F_{Aer} \times \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] \times \sum_{j,LT}\left(B_{0.LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j\right) + PE_{sl,y}$$

Equation（23）

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 Composting- Passive windrow will be used for land application, which will be calculated as leakage emission, so $PE_{Sl,y}$=0. So,

$$PE_{Aer,y} = GWP_{CH4} \times D_{CH4} \times 0.001 \times F_{Aer} \times \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] \times \sum_{j,LT}\left(B_{0.LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j\right)$$

Equation（24）

where:

GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (t CO_2e/tCH_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) and (6)
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)

The relevant values applied are as follows:

Parameter	Value	Unit	Source	Clarification
$R_{vs,1}$	20%	/	Appendix 1 of applied methodology ACM0010 (version 08.0)	Before the manure is treated, all the manure is stored in underfloor pit storage.
$R_{vs,2}$	90%	/	Appendix 1 of applied methodology ACM0010 (version 08.0)	The anaerobic digester has been assumed as two-cell lagoon.
F_{Aer}	100%	/	Direct measurement or calculated based on measurements from more than one electricity meters.	As this parameter is not monitored in the actual operation, to be conservative, the value of this parameter in the emission reduction calculation is 100%.
MS%j	50%	/	50% of the swine manure enters the aerobic composting system after solidliquid separation.	According to the technical requirements of the "Construction Standards for Livestock and Poultry Farm Waste Resource Utilization Facilities (Trial)" (Document No. Nong Ban Mu [2018])[62] issued by the Office of the Ministry of Agriculture and Rural Affairs of China, after

[62] https://www.moa.gov.cn/govpublic/XMYS/201801/t20180111_6134801.htm#

				solid-liquid separation of swine manure, approximately 12.9% of the solid manure volume theoretically needs to be treated in an aerobic composting system. Since this parameter was not monitored during the actual operation of the project, a conservative value of 50% of the separated solid manure volume was adopted for entry into the aerobic composting system. The actual adopted value (50%) far exceeds the theoretical calculation (12.9%), thereby covering potential risks of process fluctuations or monitoring gaps.
MS%j	50%	/	50% of the swine manure undergoes solid-liquid separation and is fed into anaerobic digestion systems for biogas production.	50% of the swine manure undergoes solid-liquid separation and is fed into anaerobic digestion systems for biogas production.

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

$$PE_{N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(E_{N20,D,y} + E_{N20,ID,y}\right) \quad \text{Equation (25)}$$

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)
$E_{N20,D,y}$	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)

Option1:

$$E_{N20,D,y} = \sum_{j,LT} EF_{N2O,D,j} \times NEX_{LT,y} \times N_{LT} \times MS\%_j \quad \text{Equation (26)}$$

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)

$$E_{N20,ID,y} = \sum_{j,LT} EF_{N2O,ID,j} \times F_{gasMS,j,LT} \times NEX_{LT,y} \times N_{LT} \times MS\%_j \quad \text{Equation (27)}$$

Where:

$E_{N20,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)
$EF_{N2O,ID,j}$	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:

$$E_{N20,D,y} = \sum_{j} EF_{N20,D,j} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right) \quad \text{Equation (28)}$$

$$E_{N20,ID,y} = EF_{N20,ID} \times \sum_{j,LT} F_{gasMS,j,LT} \times \sum_{m=1}^{12} \left(Q_{EM,m} \times [N]_{EM,m}\right) \quad \text{Equation (29)}$$

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 $PE_{N2O,y}$.

Parameter	Value	Unit	Source	Clarification
$EF_{N20,D,1}$	0.002	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 10.21, chapter 10, volume 4	Before the manure is treated, all the manure is stored in underfloor pit storage.
$EF_{N20,D,2}$	0.0006	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table	The liquid manure after solid-liquid separation is treated in anaerobic

			10.21, chapter 10, volume 4	digester first, the default value is applied.
$EF_{N2O,D,3}$	0.005	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 10.21, chapter 10, volume 4	The solid manure after solid-liquid separation is treated in composting - passive windrow, the default value is applied.
$EF_{N2O,ID}$	0.01	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 10.21	Methodology required default value.
$MS\%_j$	100%	/	EIA	Before the manure is treated, all the manure is stored in underfloor pit storage.
$MS\%_j$	50%	/	Conservative value	The manure is treated in solid-liquid separation with efficiency of 50%, the liquid is treated in covered anaerobic lagoons and the solid is treated by passive windrow composting.
$MS\%_j$	50%	/	Conservative value	
$F_{gasMS,1,LT}$	0.25	/	2019 Refinement to the 2006 IPCC Guidelines table 10.22	Before the manure is treated, all the manure is stored in underfloor pit storage, the default value is applied.
$F_{gasMS,2,LT}$	0.50	/	2019 Refinement to the 2006 IPCC Guidelines table 10.22	The liquid manure after solid-liquid separation is treated in anaerobic digester first, the default value is applied.
$F_{gasMS,3,LT}$	0.60	/	2019 Refinement to the 2006 IPCC Guidelines table 10.22	The solid manure after solid-liquid separation is treated in composting — passive windrow; the default value is applied.

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

Since the electricity consumption of the anaerobic digester cannot be measured separately from the entire AWMS system, the electricity emissions related to the anaerobic digester and the emissions from projects unrelated to the anaerobic digester are calculated together here.

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):

$$PE_{EC,y} = \sum_{j,LT} EC_{PJ,j,y} \times EF_{EF,j,y} \times (1 + TDL_{j,y}) \qquad \text{Equation (30)}$$

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

For ex-ante estimation, since the electricity consumption of AWMS cannot be separated from the whole swine farm, thus the design data of whole swine farm electricity consumption from EIA reports are applied.

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" ($EF_{EF,j,y}$ = $EF_{grid,CM,y}$).

As per "Methodological Tool 07: Tool to calculate the emission factor for an electricity system", $EF_{grid,CM,y}$ is calculated by following six steps:

Step 1: Identify the relevant electricity systems;

Step 2: Choose whether to include off-grid power plants in the project electricity system(optional);

Step 3: Select a method to determine the operating margin (OM);

Step 4: Calculate the operating margin emission factor according to the selected method;

Step 5: Calculate the build margin (BM) emission factor;

Step 6: Calculate the combined margin (CM) emission factor.

As China MEE has published the calculation method for emission factor of grid, the published data and method have been applied for this project to calculate operating margin (OM) and build margin, as following steps:
Step 1: Identify the relevant electricity systems.

Step 2: Choose whether to include off-grid power plants in the project electricity system(optional).

Step 3: Select a method to determine the operating margin (OM).

Step 4: Calculate the operating margin emission factor according to the selected method.

Step 5: Calculate the build margin (BM) emission factor.

Step 6: Calculate the combined margin (CM) emission factor.

Step 1. Identify the relevant electricity systems

According to the Tool to calculate the emission factor for an electricity system (Version 07.0), project participants may delineate the project electricity system using any of the following options:

Option 1. A delineation of the project electricity system and connected electricity systems published by the DNA or the group of the DNAs of the host country(ies), In case a delineation is provided by a group of DNAs, the same delineation should be used by all the project participants applying the tool in these countries;

Option 2. A delineation of the project electricity system is defined by the dispatch area of the dispatch center responsible for scheduling and dispatching electricity generated by the project activity. Where the dispatch area is controlled by more than one dispatch center (i.e., a layered dispatch area), the higher-level area shall be used as a delineation of the project electricity system. For example, where regional dispatch centers are required to comply with dispatch orders of the national dispatch center, the area controlled by the national dispatch center shall be used;

Option 3. A delineation of the project electricity system defined by more than one independent dispatch areas, e.g. multi-national power pools.

The Chinese DNA has published a delineation of the project electricity system and connected electricity systems. Option 1 is applied for the project. According to the delineation, the China Southern Power Grid (CSPG) is identified as the relevant electric power system of the project, which includes Guangdong, Guangxi, Yunnan, Guizhou, Hainan Provincial Power Grids. According to the "2023 Baseline Emission Factors for Regional Power Grids in China[63]", there is net electricity imported from the Central China Power Grid (CCPG) and East China Power Grid (ECPG)

[63]http://www.ncsc.org.cn/search/?searchscope=doctitle&searchword=%E4%B8%AD%E5%9B%BD%E5%8C%BA%E5%9F%9F%E7%94%B5%E7%BD%91%E5%9F%BA%E5%87%86.

to the China Southern Power Grid (CSPG). Therefore, Central China Power Grid (CCPG) and East China Power Grid (ECPG) are chosen as the connected electric power systems.

Step 2. Choose whether to include off-grid power plants in the project electricity system (optional) Project participants may choose between the following two options to calculate the operating margin and build margin emission factor:

Option I: Only grid power plants are included in the calculation.

Option II: Both grid power plants and off-grid power plants are included in the calculation.

Based on China's real situation, only grid power plants are included in the calculation.

Step 3. Select a method to determine the operating margin (OM)

The calculation of the operating margin emission factor ($EF_{grid,OM,y}$) is based on one of the following methods:

(a) Simple OM, or

(b) Simple adjusted OM, or

(c) Dispatch data analysis OM, or

(d) Average OM.

In China, specific data from the grid or each power plant is treated as business confidential and thus not publicly available. Therefore, method (b) and method (c) are not suitable for the project.

The Simple OM method (a) can only be applied when low-cost/must run resources constitute less than 50% of total grid generation in average of the five most recent years. According to the data from China Electric Power Yearbook2017-2021, from year 2017 to year 2021, for the CSPG the project activity connected to, the low-cost/must-run electric power resources generation accounts for the total grid total are 50.09%, 50.25%, 50.96%, 51.47% and 46.99%, respectively, average value is lower than 50%, which satisfied the applicability of the method (a), therefore, the simple OM method is chosen for the calculation of the OM emission factor $EF_{grid,OM,y}$.

As per the latest version of "Tool to calculate the emission factor for an electricity system" (version 07.0), one of the following methods should be chosen to calculate the simple OM emission factor:

• Ex ante option: If the ex-ante option is chosen, the emission factor is determined once at the validation stage, thus no monitoring and recalculation of the emissions factor during the crediting period is required. For grid power plants, use a 3-year generation-weighted average, based on the most recent data available at the time of submission of the VCS- PD to the DOE for validation, or

• Ex post option: If the ex-post option is chosen, the emission factor is determined for the year in which the project activity displaces grid electricity, requiring the emissions factor to be updated

annually during monitoring. If the data required calculating the emission factor for year y is usually only available later than six months after the end of year y, alternatively the emission factor of the previous year (y-1) may be used. If the data is usually only available 18 months after the end of year y, the emission factor of the year proceeding the previous year (y-2) may be used. The same data vintage (y, y-1 or y-2) should be used throughout all crediting periods. Based on the most recent data available at the time of this project description submission, the first option (ex-ante) for the calculation of the OM emission factor is chosen for the project, in line with BEF 2023 published by the Chinese DNA. The generation data for various power generating sources for the most recent three years (2019-2021) are applied.

Here the ex-ante option is selected, and the $EF_{grid,OM}$ is fixed during the crediting period.

Step 4. Calculate the operating margin emission factor according to the selected method

Based on the analysis of the step 3, the simple OM method is used to calculate the CSPG OM emission factor in this step. The simple OM emission factor is calculated as the generation weighted average CO_2 emissions per unit net electricity generation (tCO_2/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/ units.

The simple OM may be calculated by one of the following two options:

Option A: Based on the net electricity generation and a CO_2 emission factor of each power unit; or

Option B: Based on the total net electricity generation of all power plants serving the system and the fuel types and total fuel consumption of the project electricity system. Option B can only be used if:

1) The necessary data for Option A is not available; and

2) Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is known; and

3) Off-grid power plants are not included in the calculation (i.e. if Option I has been chosen in Step 2)

The data of each power plant serving the system is difficult to obtain. In this case, Option A is not preferred. In addition, according to the China Energy Statistical Yearbook, only nuclear and renewable power generation are considered as low-cost / must-run power sources and the quantity of electricity supplied to the grid by these sources is known, and off-grid power plants are not included in the calculation. Therefore, Option B is chosen to calculate the OM emission factor.

For Option B, the Simple OM emission factor is calculated based on the net electricity supplied to the grid by all power plants serving the system, not including low-cost / must-run power plants / units, and based on the fuel type(s) and total fuel consumption of the project electricity system, as follows:

$$EF_{grid,OMsimple,y} = \frac{\sum_k (FC_{i,y} \times NCV_{i,y} \times EF_{CO2,i,y})}{EG_y} \quad \text{Equation (31)}$$

Where:

$EF_{grid,OMsimple,y}$	Simple operating margin CO_2 emission factor in year y (tCO_2e/MWh)
$FC_{i,y}$	Amount of fuel type i consumed in the project electricity system in year y (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) of fuel type i in year (GJ / mass or volume unit)
$EF_{CO2,i,y}$	CO_2 emission factor of fuel type i in year y (tCO_2 /GJ)
EG_y	Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost / must-run power plants / units, in year y (MWh)
i	All fuel types combusted in power sources in the project electricity system in year y
y	The three most recent years for which data is available at the time of submission of the VCS-PD to the VVB for validation.

If available, $NCV_{i,y}$ and $EF_{CO2,i,y}$ from the fuel supplier of the power plants in invoices may be used; or regional or national average default values may be used. In this PD, $NCV_{i,y}$ of different fuels are obtained from China Energy Statistical Yearbook (2018-2022). Emission factors ($EF_{CO2,i,y}$) of each type of fossil fuel come from 2019 refinement to 2006 IPCC default values.

The Simple OM Emission Factor ($EF_{grid,OMsimple,y}$) of the project is calculated based on the fuel consumption data for electricity generation of the China Southern Power Grid, not including those of low-operating cost and must-run power plants, such as wind power, hydropower and nuclear etc. These data are obtained from the China Electric Power Yearbook (2017~2021, published annually) and China Energy Statistical Yearbook (2018~2022). Based on these data, the Simple OM Emission Factor ($EF_{grid,OMsimple,y}$) of the China Southern Power Grid is calculated as 0.7738 tCO_2/MWh. Details of the calculations and the published data from the Chinese DNA[64], which uses official national statistics.

Step 5. Calculate the build margin (BM) emission factor

In terms of vintage of data, project participants can choose between one of the following two options:

[64]http://www.ncsc.org.cn/search/?searchscope=doctitle&searchword=%E4%B8%AD%E5%9B%BD%E5%8C%BA%E5%9F%9F%E7%94%B5%E7%BD%91%E5%9F%BA%E5%87%86.

(a) Option 1 - for the first crediting period, calculate the build margin emission factor ex ante based on the most recent information available on units already built for sample group m at the time of CDM-PDD submission to the DOE for validation. For the second crediting period, the build margin emission factor should be updated based on the most recent information available on units already built at the time of submission of the request for renewal of the crediting period to the DOE. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used. This option does not require monitoring the emission factor during the crediting period.

(b) Option 2 - For the first crediting period, the build margin emission factor shall be updated annually, ex post, including those units built up to the year of registration of the project activity or, if information up to the year of registration is not yet available, including those units built up to the latest year for which information is available. For the second crediting period, the build margin emissions factor shall be calculated ex ante, as described in Option 1 above. For the third crediting period, the build margin emission factor calculated for the second crediting period should be used.

In line with 2023 Baseline Emission Factors for Regional Power Grids in China, Option 1 is chosen for the project; the BM emission factor is calculated ex ante based on the most recent information available on units already built for sample group m at the time of this project description submission.

The sample group of power units m used to calculate the build margin should be determined as per the following procedure, consistent with the data vintage selected above:

(a) Identify the set of five power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently ($SET_{5\text{-units}}$) and determine their annual electricity generation ($AEG_{SET\text{-}5\text{-}units}$, in MWh);

(b) Determine the annual electricity generation of the proposed project electricity system, excluding power units registered as CDM project activities (AEG_{total}, in MWh). Identify the set of power units, excluding power units registered as CDM project activities, that started to supply electricity to the grid most recently and that comprise 20% of AEG_{total} (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) ($SET_{\geq 20\%}$) and determine their annual electricity generation ($AEG_{SET \geq 20\%}$, in MWh);

(c) From $SET_{5\text{-units}}$ and $SET_{\geq 20\%}$ select the set of power units that comprises the larger annual electricity generation (SET_{sample});

Identify the date when the power units in SET_{sample} started to supply electricity to the grid. If none of the power units in SET_{sample} started to supply electricity to the grid more than 10 years ago, then use SET_{sample} to calculate the build margin. In this case ignore Steps (d), (e) and (f).

Otherwise:

(d) Exclude from SET_{sample} the power units which started to supply electricity to the grid more than 10 years ago. Include in that set the power units registered as CDM project activities, starting with power units that started to supply electricity to the grid most recently, until the electricity generation of the new set comprises 20% of the annual electricity generation of the proposed project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation) to the extent is possible. Determine for the resulting set ($SET_{sample-CDM}$) the annual electricity generation ($AEG_{SET-sample-CDM}$, in MWh); If the annual electricity generation of that set comprises at least 20% of the annual electricity generation of the proposed project electricity system (i.e. $AEG_{SET-sample-CDM} \geq 0.2 \times AEG_{total}$), then use the sample group $SET_{sample-CDM}$ to calculate the build margin. Ignore steps (e) and (f).

Otherwise:

(e) Include in the sample group $SET_{sample-CDM}$ the power units that started to supply electricity to the grid more than 10 years ago until the electricity generation of the new set comprises 20% of the annual electricity generation of the proposed project electricity system (if 20% falls on part of the generation of a unit, the generation of that unit is fully included in the calculation);

(f) The sample group of power units m used to calculate the build margin is the resulting set ($SET_{sample-CDM->10yrs}$).

The BM emissions factor is the generation-weighted average emission factor (tCO_2/MWh) of all power units m during the most recent year y for which electricity generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m (EG_{m,y} \times EF_{EL,m,y})}{\sum_m EG_{m,y}} \quad \text{Equation (32)}$$

Where:

$EF_{grid,BM,y}$	Build margin emission factor of CSPG (t CO_2/MWh)
$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year y (t CO_2/MWh)
m	Power units included in the build margin
y	The most recent year for which the generation data is available

As it is difficult to obtain the detailed data on the power generation, fuel consumption and thermal efficiency of each newly built power unit from public documents, a deviation of TOOL07 "Tool to calculate the emission factor for an electricity system" (07.0) is adopted following the clarifications65 given by the CDM EB concerning the BM emission factor calculation:

[65] Request for clarification on use of approved methodology AM0005 for several projects in China, the EB's guidance on DNV deviation request.

(1) The CDM EB suggested using the efficiency level of the best technology commercially available in the provincial/regional or national grid of China, as a conservative proxy, for each fuel type in estimating the fuel consumption to estimate the build margin.

(2) The EB agreed the use of capacity additions during last 1~3 years for estimating the build margin emission factor for grid electricity.

(3) The EB also agreed to use of weights estimated using installed capacity in place of annual electricity generation.

The newly built power plants in the past few years are bundled into "grouped new power plant" according to their construction year, their province and their fuel type. The annual net electricity generation in the year y of each "grouped new power plant" $\mathrm{EG}_{\mathrm{m,y}}$ is estimated according to their total capacity and the average utilization hours, as the following equation:

$$EG_{m,y} = CAP_m \times H_{m,y} \quad \text{Equation (33)}$$

Where:

$EG_{m,y}$	Annual net electricity generation the unit m in year y(MWh)
CAP_m	Installed capacity of the unit m (MW)
$H_{m,y}$	Utilization hour of the unit m in the year y (h), determined according to the average utilization hour of the same type of unit in the same province
y	The most recent year for which the generation data is available. For the calculation of BM in2023, y = 2021
m	grouped new power plant

Since the newly built power plants in the same province (A), in the same year (t) and using the same fuel type (k) are grouped into "a grouped new power plant", CAP_m represents the total installed capacity of fuel type k power plants located in the provinces A and in the year t:

$$CAP_m = CAP_{A,t,k} \quad \text{Equation (34)}$$

Where:

CAP_m	Installed capacity of the unit m (MW), with m representing the specified combination of A, t, and k
$CAP_{A,t,k}$	Total installed capacity of fuel type k power plants located in the province A and in the year t

https://cdm.unfccc.int/filestorage/A/M/_/AM_CLAR_QEJWJEF3CFBP1OZAK6V5YXPQKK7WY

A	Provinces covered by the CSPG, namely, Guangdong Province, Yunnan Province, Guizhou Province, Hainan Province and Guangxi Province.
t	Years related to the grouped new power plants, for the 2023 calculation, t represents 2021, 2020, 2019…. Until the aggregated electricity generation of the grouped new power plants reaches 20% of the total electricity generation of the CSPG
k	Fuel type of the grouped new power plants, including hydro, thermal (coal, gas, oil, waste incineration, other thermal), nuclear, wind, solar and others.

Figure 5 shows the procedure to determine the sample group of power units m.

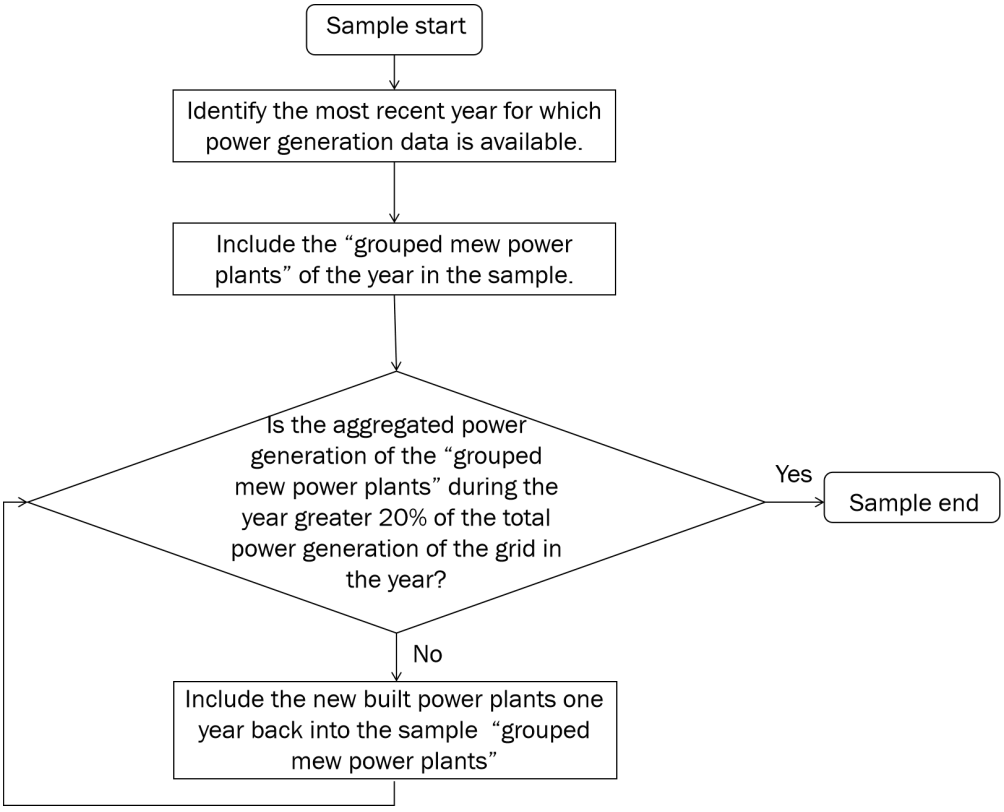

Figure 5: Procedure to determine the sample group of power units m used for the BM emission factor calculation

The emission factors of each fuel type are determined according to the Option A2 in the TOOL07, as the following equation:

$$EF_{EL,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{m,y}} \quad \text{Equation (35)}$$

Where:

Among the fuel types, the emission factors of hydro, nuclear, wind, solar, other thermal and others are 0. Concerning the emission factors of coal, gas, oil and waste incineration, the formula (10) takes the following form due to conservativeness:

$EF_{EL,m,y}$	CO_2 emission factor of power unit m in year y (t CO_2/MWh)
$EF_{CO2,m,i,y}$	Average CO_2 emission factor of fuel type i used in power unit m in year y (t CO_2/GJ)
$\eta_{m,y}$	Average net energy conversion efficiency of power unit m in year y (ratio)
m	All power units serving the grid in year y except low-cost / must-run power units
3.6	Conversion factor (GJ/MWh)

$$EF_{best,m,y} = \frac{EF_{CO2,m,i,y} \times 3.6}{\eta_{best,y}} \quad \text{Equation (36)}$$

Where:

$EF_{best,m,y}$	Emission factor of power unit m with the best technology commercially available in year y (t CO_2/MWh)
$\eta_{best,y}$	Power generation efficiency of the best technology commercially
m	Power units serving the grid with coal, gas, oil or waste incineration in year y

The calculation result of the BM emission factor for the CSPG is 0.1981 tCO_2/MWh Details of the calculations and the published data from the Chinese DNA[66])

Step 6: Calculate the combined margin (CM) emission factor.

As per the "tool to calculate the emission factor for an electricity system", the combined margin emission factor ($EF_{grid,CM,y}$) is calculated 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 in (ii) a country with less than 10 registered CDM projects at the starting date of validation; or (iii) a Small Island Developing States (SIDS); and

The data requirements for the application of step 5 above cannot be met.

[66]http://ncsc.org.cn/search/?searchscope=doctitle&searchword=%E4%B8%AD%E5%9B%BD%E5%8C%BA%E5%9F%9F%E7%94%B5%E7%BD%91%E5%9F%BA%E5%87%86.

The PD choose option A.

The combined margin emissions factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times w_{OM} + EF_{grid,BM,y} \times w_{BM} \quad \text{Equation (37)}$$

Where:

$EF_{grid,OM,y}$	Operating margin CO_2 emission factor in year y (tCO_2/MWh)
$EF_{grid,BM,y}$	Build margin CO_2 emission factor in year y (tCO_2/MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

The combined margin emissions factor $EF_{grid,CM,y}$ should be calculated as the weighted average of the Operating Margin emission factor ($EF_{grid,OM,y}$) and the Build Margin emission factor ($EF_{grid,BM,y}$), where OM = 0.5 and BM = 0.5 for all other projects (owing to their intermittent and non-dispatchable nature) for the first crediting period and w_{OM}=0.25 and w_{BM} =0.75 for the second and third crediting period.

For the project, the weight w_{OM} and w_{BM} are both 0.5 by default for the fixed crediting period.

Thus, $EF_{grid,CM,y}$=0.7738 tCO_2/MWh*0.5+0.1981tCO_2/MWh*0.5 = 0.4860 (tCO_2/MWh)

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

Parameter	Value	Unit	Source	Clarification
$EC_{PJ,j,y}$	409.4	MWh	EIA	/
$EF_{grid,OM,y}$	0.7738	tCO_2/MWh	Official data from Ministry of Ecology and Environment of the P.R.C.	The project consumes electricity from CSPG of China.
$EF_{grid,BM,y}$	0.1981	tCO_2/MWh	Tool 07	Default value other than wind and solar projects.
ω_{OM}	0.5	/	Tool 07	
ω_{BM}	0.5	/	Calculated	/
$EF_{EF,j,y}$	0.4860	tCO_2/MWh	Tool 05	Default value
$TDL_{j,y}$	20%	/	Ex-ante calculation	/

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 is 0, i.e., $PE_{FC,y}$=0.

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.

$$LE_y = \left(LE_{PJ,N20,y} - LE_{BL,N20,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right) + LE_{AD,y} \quad \text{Equation (38)}$$

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, $LE_{BL,N2O,y}$

$$LE_{BL,N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y}\right) \quad \text{Equation (39)}$$

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (40)}$$

$$LE_{N20,runoff,y} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (41)}$$

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (42)}$$

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)

Parameter	Value	Unit	Source	Clarification
$R_{N,0}$	80%	/	Annex 1 of methodology ACM0010 (version 08.0)	The baseline scenario is manure treated in uncovered anaerobic lagoons, which is similar to one cell lagoon in

				Annex 1 of ACM0010.
F_{leach}	0.24	/	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	Methodology required default value.
F_{gasm}	0.21	/	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	Methodology required default value.
EF_1	0.01	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 11.1, chapter 11, volume 4	Methodology required default value.
EF_5	0.011	kg N_2O-N/kg N	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	Methodology required default value.
EF_4	0.01	kg N-N_2O/kg NH_3-N+NO_X-N	2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4	Methodology required default value.
GWP_{N20}	265	/	IPCC AR5	As per VCS Standard, GWP from IPCC AR5 shall be applied.

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

$$LE_{PJ,N20,y} = GWP_{N20} \times CF_{N20-N,N} \times \frac{1}{1000} \times \left(LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y}\right) \quad \text{Equation (43)}$$

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}\left(1 - R_{N,n}\right) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (44)}$$

$$LE_{N20,runoff,y} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (45)}$$

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{Equation (46)}$$

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 $Q_{DM} \times N_{DM}$.

The relevant values applied are as follows:

Parameter	Value	Unit	Source	Clarification
$R_{N,1}$	5%	/	Estimated from Table provided in Annex 1 (underfloor pit storage) of ACM0010	Before the manure is treated, all the manure is stored in underfloor pit storage, the default value is applied.
$R_{N,2}$	50%	/	Estimated from Table provided in Annex 1 (anaerobic digester as "two cell lagoons") of ACM0010	The project adopts covered anaerobic lagoons, which is similar to two cell lagoons in Annex 1 of ACM0010.

(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:

$$LE_{BL,CH4,y} = GWP_{CH4} \times D_{CH4} \times MCF_d \times \left[\prod_{n=1}^{N}(1-R_{VS,n})\right] \times \sum_{j,LT} B_{0,LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j \quad \text{Equation (47)}$$

$$LE_{PJ,CH4,y} = GWP_{CH4} \times D_{CH4} \times MCF_d \times \left[\prod_{n=1}^{N}(1-R_{VS,n})\right] \times \sum_{j,LT} B_{0,LT} \times N_{LT} \times VS_{LT,y} \times MS\%_j \quad \text{Equation (48)}$$

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

For subsequent treatment stages, the reduction of the 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).

In the baseline scenario, the relevant values applied are as follows:

Parameter	Value	Unit	Source	Clarification
$R_{VS,n}$	85%	/	Estimated from Table provided in Annex 1 (uncovered anaerobic lagoon as "one cell lagoon") of ACM0010	The baseline scenario is manure treated in uncovered anaerobic lagoons, which is similar to one cell lagoon in Annex 1 of ACM0010.
$MS\%_j$	100%	/	/	In the baseline scenario, all the manure is treated in uncovered anaerobic lagoon.

For the project, the relevant values applied are as follows:

Parameter	Value	Unit	Source	Clarification
$R_{VS,1}$	20%	/	Estimated from Table provided in Annex 1 of ACM0010	Before the manure is treated, all the manure is stored in underfloor pit storage, the default value is applied.
$R_{VS,2}$	90%	/	Estimated from Table provided in Annex 1 of ACM0010	The separated liquid is treated in covered anaerobic lagoons which is similar to two cell lagoons.
$R_{VS,3}$	40%	/	Estimated from Table provided in Annex 1 of ACM0010	The separated liquid is treated in composting-passive windrow, which is similar to heated digester effluent prior to storage.
$MS\%_j$	50%	/	/	The manure is treated in solid-liquid separation with efficiency of 50%, the liquid is treated in covered anaerobic lagoons and the solid is treated by passive windrow composting.

(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:

$$LE_{AD} = LE_{stroage,y} + LE_{comp,y} \quad \text{Equation (49)}$$

Where:

$LE_{AD,y}$	Leakage emissions associated with the anaerobic digester in year y(t CO_2e/yr)
$LE_{stroage,y}$	Leakage emissions associated with storage of digestate in year y (t CO_2e/yr)
$LE_{comp,y}$	Leakage emissions associated with composting of digestate in year y (t CO_2e/yr)

According to the Tool 14 "Project and leakage emissions from anaerobic digesters (Version 03.0)

", Section 6.2

Step 1: Determination of leakage emissions associated with storage digestate ($LE_{storage,y}$)

This step applies in the case that the digestate is stored under the following anaerobic conditions:

(a)In an un-aerated lagoon that has a depth of more than one meter; or

(b)In a SWDS, including stockpiles that are considered a SWDS as per the definitions section.

Storage of digestate under anaerobic conditions can cause CH_4 emissions due to further anaerobic digestion of the residual biodegradable organic matter. The procedure for determining $LE_{storage,y}$is distinguished for liquid digestate and solid digestate.

After the anaerobic digestion process, the liquid digestate is used for irrigation and the solid digestate(sludge) is used as fertilizer after aerobic composting, The machines used in the irrigation and aerobic composting are easy to maintained and replaced by standby machines or manpower, there is impossible where the solid and liquid digestate would be stored under anaerobic condition. Therefore, the $LE_{storage,y}$ is considered as zero, only $LE_{comp,y}$ shall be calculated.

For $LE_{comp,y}$ of methodological tool 14, the term $PE_{comp,y}$+$LE_{comp,y}$ in the methodological tool 13 “Project and leakage emissions from composting” provides the value for $LE_{comp,y}$ of this tool. For the value for $PE_{comp,y}$,:

$$PE_{comp,y}=PE_{EC,y}+PE_{FC,y}+PE_{CH4,y}+PE_{N20,y}+PE_{RO,y} \quad \text{Equation (50)}$$

where:

$PE_{comp,y}$	=	Project emissions associated with composting in year y (t CO_2e/yr)
$PE_{EC,y}$	=	Project emissions from electricity consumption associated with composting in year y (t CO_2/yr)
$PE_{FC,y}$	=	Project emissions from fossil fuel consumption associated with composting in year y (t CO_2/yr)
$PE_{CH4,y}$	=	Project emissions of methane from the composting process in year y(t CO_2e/yr)
$PE_{N20,y}$	=	Project emissions of nitrous oxide from the composting process in year y(t CO_2e/yr)
$PE_{RO,y}$	=	Project emissions of methane from run-off wastewater associated with co-composting in year y (t CO_2e/yr)

The project employs a fully enclosed anaerobic digestion system, with all biogas generated during the process collected for heat generation or flaring. The digested sludge is subsequently treated together with solid manure in an aerobic composting system and utilized as fertilizer. In accordance with the ACM0010 methodology, $PE_{EC,y}$, $PE_{CH_4,y}$, and $PE_{N_2O,y}$ emissions from sludge composting have been calculated in combination with emissions from solid manure composting

and incorporated into the project emissions (PE_y), ensuring no double-counting. As the composting process does not involve fossil fuel consumption or co-composting, the related emissions ($PE_{FC,y}$ and $PE_{RO,y}$) are zero, resulting in zero project emissions from composting ($PE_{comp,y}$=0).

Livestock manure undergoes anaerobic digestion to produce liquid digestate and solid digestate(sludge). The liquid digestate is utilised for irrigation and does not enter the composting process, while the solid digestate(sludge) is transferred to the aerobic composting system.

The liquid digestate is directly delivered to surrounding farmland via a closed pipeline irrigation system, with temporary storage in aerated aerobic pond[67] equipped with continuous aeration to maintain aerobic conditions throughout. This model not only reduces reliance on natural water bodies for irrigation but also improves soil quality, demonstrating sustainability and local applicability. To ensure the liquid digestate remains under aerobic conditions, PP monitors the oxygen concentration in the aerated aerobic pond. Specific details are described in Section 5.2.

According to the environmental impact assessment (EIA) report, all project compost is used for farmland improvement without undergoing anaerobic storage or entering a solid waste disposal system (SWDS). And PP ensures that the compost is not subjected to anaerobic conditions during storage/disposal and/or sale/distribution. PP turns over unsold organic fertiliser monthly on project site and PP sells organic fertiliser not in sealed packages, but delivers it to users by truck. During sales and transportation, users are located near the project site, resulting in short transport distances, and the fertiliser remains exposed to air and does not form anaerobic conditions. Furthermore, based on typical storage conditions for general users, organic fertiliser typically requires over one month to reach an anaerobic state[68]. PP advises users in the organic fertiliser sales contract to use the product within 30 days and to turn the fertiliser at varying intervals to prevent anaerobic fermentation, which could avoid producing toxic gases and reduce fertiliser efficacy[69]. PP has also surveyed all users and found that they purchase exact quantities according to their needs. In most cases, the fertiliser is used immediately after purchase. In a minority of cases, it is stored temporarily, but storage conditions are basic and do not create anaerobic conditions. Moreover, PP added two parameters “Wj,x” and “The status of digestate” to monitor that the compost is not under anaerobic conditions. Therefore, in compliance with the methodology requirements, both composting leakage emissions ($LE_{comp,y}$) and storage leakage emissions ($LE_{storage,y}$) are zero.

[67] PP conservatively calculated the temporary storage capacity of the aerated aerobic pond for liquid digestate in accordance with the Design Specification for Wastewater Treatment Facilities in Livestock and Poultry Farms (GB/T 26624-2011).

[68] Traditional farm households often require several months for organic manure to achieve anaerobic fermentation.

https://wenku.baidu.com/view/4116c789950590c69ec3d5bbfd0a79563c1ed43e.html?_wkts_=1769139061492

[69] https://xmsyj.moa.gov.cn/gzdt/202502/t20250226_6470614.htm

After anaerobic digestion, the fermented sludge will be sent to the composting site and treated together with solid manure in an aerobic composting system and used as fertilizer. Therefore, $PE_{EC,y}$, $PE_{CH4,y}$, and $PE_{N20,y}$ from sludge composting were calculated together with the emissions from composting of solid manure according to ACM0010.

$PE_{EC,y}$, $PE_{CH4,y}$ and $PE_{N20,y}$ have been calculated in project emission (PE_y), which are not double-counted. And the proposed project does not involve fossil fuel consumption and co-composting in the aerobic composing process. Thus, $PE_{FC,y}$=0, $PE_{RO,y}$=0. Overall, the $PE_{comp,y}$=0 and should not be double-counted.

Leakage emissions from composting ($LE_{comp,y}$) shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS[70]. $LE_{comp,y}$ shall be estimated to account for methane emissions from the anaerobic decay of compost, using the methodological tool "Emissions from solid waste disposal sites". The following is required when applying the tool:

(a) $PE_{comp,y}$ corresponds to the parameter $LE_{CH4,SWDS,y}$ in the tool;

(b) $W_{j,x}$ in the tool is the amount of compost produced that is disposed of in a SWDS or subjected to anaerobic storage, where:

(i) J is compost and therefore the procedure in the tool to determine the amount of different waste types j disposed in the SWDS does not need to be followed ($W_{j,x}$= W_x); and

(ii) x refers to each year since the start of the first crediting period, up to and including year y.

According to the EIA, the compost is sent directly to nearby farmland and used for land application. The compost is not subjected to anaerobic storage or disposed of in SWDS; there is no situation where the compost will be stored in anaerobic conditions. Thus $LE_{comp,y}$ of Tool 13 is not applicable and the value is 0. Thus, $LE_{comp,y}$=$PE_{comp,y}$+$LE_{comp,y}$=0

So, the Estimation of leakage emissions associated with the anaerobic digester is 0. i.e., $LE_{AD,y}$ =$LE_{storage,y}$ + $LE_{comp,y}$=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:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (51)}$$

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}	57,534	No of heads
W_{site}	115	kg
$W_{default}$	56	kg
$VS_{default}$	0.2856	kg-dm/animal/day
$VS_{LT,y}$	214.07	kg-dm/animal/year
$MS\%_{BI,j}$	100%	%
nd_y	365	days
$BE_{CH4,y}$	**71,347**	**t CO_2e**

Parameter	Value	Unit
$EF_{N2O,D,j}$	0	kg N_2O-N/kg N

$EF_{N2O,ID}$	0.01	kg N_2O/kg N
$N_{rate(T)}$	0.63	kg N/1000kg animal mass/day
$NEX_{IPCC\ default}$	12.88	kg N/animal/year
TAM	56	kg
W_{site}	115	kg
$W_{default}$	56	kg
$NEX_{LT,y}$	26.44	kg N/animal/year
N_{LT}	57,534	No of heads
$MS\%_{BI,j}$	100%	%
$E_{N2O,D,j}$	**0**	kg N_2O-N/year
$E_{N2O,ID,j}$	6085	kg N_2O-N/year
$F_{gasMS,j,LT}$	40%	/
GWP_{N2O}	265	t CO_2/t N_2O
$CF_{N2O,N-N}$	1.57	/
$BE_{N2O,y}$	**2,533**	**t CO_2e**

Baseline Emissions: $BE_{CH4,y} + BE_{N2O,y}$=71,347 tCO_2e + 2,533 tCO_2e =73,880 tCO_2e

Calculation of the project emission:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{EC/FC,y}$$

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

$\eta_{flare,m}$	0.5	/
$PE_{flare,y}$	**0***	**t CO_2e**

*As all the biogas generated in the AWMS is collected for electricity 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.

$PE_{AD,y} = PE_{CH4,y} + PE_{flare,y}$ = 69 tCO_2e + 0 tCO_2e = 69 tCO_2e

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
	0.001	/
F_{Aer}	100%	/
$1\text{-}R_{VS,1}$	80%	/
$1\text{-}R_{VS,2}$	10%	/
$B_{0,LT}$	0.45	m^3 CH_4 /kg VS
N_{LT}	57,534	No of heads
$VS_{LT,y}$	214.07	kg-dm/animal/year
$MS\%_j$	50%	/
$PE_{Aer,y}$	**46**	**t CO_2e**

Parameter	Value	Unit
$EF_{N2O,D,1}$	0.002	kg N_2O-N/kg N
$EF_{N2O,D,2}$	0.0006	kg N_2O-N/kg N
$EF_{N2O,D,3}$	0.005	kg N_2O-N/kg N
$NEX_{LT,y}$	26.44	kg N/animal/year
N_{LT}	57,534	No of heads
MS%j	100%	/
$E_{N2O,D,y}$	7,303	kg N_2O-N/year

Parameter	Value	Unit
$EF_{N2O,ID}$	0.01	kg N_2O-N/kg N
$F_{gasMS,1,LT}$	0.25	/
$F_{gasMS,2,LT}$	0.50	/
$F_{gasMS,3,LT}$	0.60	/
$NEX_{LT,y}$	26.44	kg N/animal/year
N_{LT}	57,534	No of heads
MS%j	50%	/
$EF_{N2O,ID,y}$	12,172	kg N_2O-N/year

Parameter	Value	Unit
GWP_{N2O}	265	tCO_2/tN_2O
$CF_{N2O-N,N}$	1.57	/
$PE_{N2O,y}$	**8,110**	**t CO_2e**

Parameter	Value	Unit
$EC_{PJ,j,y}$	409.4	MWh/year
$EF_{grid,OM,y}$	0.7738	tCO_2/MWh
$EF_{grid,BM,y}$	0.1981	tCO_2/MWh
ω_{OM}	0.5	/
ω_{OM}	0.5	/
$EF_{EF,j,y}$	0.4860	tCO_2/MWh
$TDL_{j,y}$	20%	/
$PE_{EC,y}$	**239**	**tCO_2e**
$PE_{FC,y}$	**0**	tCO_2e
$PE_{EC/FC,y}$	**239**	tCO_2e

Project Emissions: $PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{EC/FC,y}$ = 69 tCO_2 + 46 tCO_2 +8,110 tCO_2 + 239 tCO_2 = 8,464 tCO_2

Calculation of leakage:

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

Parameter	Value	Unit
N_{LT}	57,534	No of heads
$NEX_{LT,y}$	26.44	Kg N/animal/year
$R_{N,0}$	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-N_2O/kg NH_3-N+NO_X-N
F_{leach}	0.24	/
F_{gasm}	0.21	/
GWP_{N2O}	265	tCO_2/tN_2O
$LE_{N2O,land,y}$	3,043	kg N_2O-N/year
$LE_{N2O,runoff,y}$	803	kg N_2O-N/year
$LE_{N2O,vol,y}$	639	kg N_2O-N/year
$LE_{BL,N2O,y}$	**1,867**	**t CO_2e**

Parameter	Value	Unit
N_{LT}	57,534	No of heads
$NEX_{LT,y}$	26.44	Kg N/animal/yr
$R_{N,n1}$	5%	/
$R_{N,n2}$	50%	/
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-N_2O/kg NH_3-N+NO_X-N

F_{leach}	0.24	/
F_{gasm}	0.21	/
GWP_{N2O}	265	tCO_2/tN_2O
$LE_{N2O,land,y}$	7,227	kg N_2O-N/yr
$LE_{N2O,runoff,y}$	1,908	kg N_2O-N/yr
$LE_{N2O,vol,y}$	1,518	kg N_2O-N/yr
$LE_{PJ,N2O,y}$	**4,437**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
MCF_d	1	/
$VS_{LT,y}$	214.07	kg-dm/animal/yr
N_{LT}	57,534	No of heads
B_0	0.45	m^3 CH_4 /kg VS
$R_{vs,n}$	85%	/
$MS\%_j$	100%	/
$LE_{BL,CH4,y}$	**15,596**	**t CO_2e**

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
D_{CH4}	0.00067	t/m^3
MCF_d	1	/
$VS_{LT,y}$	214.07	kg-dm/animal/yr
N_{LT}	57,534	No of heads
B_0	0.45	m^3 CH_4 /kg VS
$R_{vs,1}$	20%	/

$R_{vs,2}$	90%	/
$R_{vs,3}$	40%	/
$MS\%_j$	50%	/
$LE_{PJ,CH4,y}$	**29,114**	**t CO_2e**

$LE_y=(LE_{PJ,N2O,y} - LE_{BL,N2O,y})+(LE_{PJ,CH4,y} - LE_{BL,CH4,y})+LE_{AD,y}=(4,437 - 1,867)\ tCO_2 + (29,114 - 15,596)\ tCO_2 + 0\ tCO_2 = 16,088\ tCO_2$

$ER_y = BE_y - PE_y - LE_y = 73,880\ tCO_2 - 8,464\ tCO_2 - 16,088\ tCO_2 = 49,328\ tCO_2$

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-August-2023 to 31-Dec-2023	26,111	2,991	5,686	17,434	0	17,434
01-Jan-2024 to 31-Dec-2024	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2025 to 31-Dec-2025	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2026 to 31-Dec-2026	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2027 to 31-Dec-2027	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2028 to 31-Dec-2028	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2029 to 31-Dec-2029	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2030 to 31-Dec-2030	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2031 to 31-Dec-2031	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2032 to 24-Dec -2032	73,880	8,464	16,088	49,328	0	49,328
01-Jan-2033 to 24-August-2033	47,769	5,473	10,402	31,894	0	31,894
Total	**738,800**	**8,4640**	**160,880**	**493,280**	**0**	**493,280**

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 $CO_2e/t\ N_2O$
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 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	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(with the conservative value)
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 average annual temperature in the region is 15.7 °C, with an average annual precipitation of 975.6 mm and an average annual evaporation of 1612.6 mm. 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	$MS\%_{BL,j}$
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	56
Justification of choice of data or description of measurement methods and procedures applied	The swine farms involved in this project are 100% market-oriented with high levels of capital input requirements and high levels of overall herd (flock) performance. Feed is purchased from the local market. Animals are improved through breeding practices for commercial production; thus, the swine farms belong to the High Productivity System of the IPCC 2019 Refinement. The project is located in Yunnan Province, China, Asia, thus, the default values for market swine in Asia area given by IPCC are applied. The default values are applied.
Purpose of data	Used in baseline emission calculations
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	0.2856
Justification of choice of data or description of measurement methods and procedures applied	The project involves the breeding of market swine, confined livestock farms located in Baoshan, Yunnan, P.R.C., which belong to High Productivity Systems in Asia according to 2019 Refinement to the IPCC 2006 Guidelines. The default values applied are 5.1 kg VS/1000 kg animal/day for market swine, the $VS_{default}$ for this project is calculated as follows: $VS_{default} = VS_{rate(T)} * TAM/1000 = 5.1/1000*56 = 0.2856$
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	12.88
Justification of choice of data or description of measurement methods and procedures applied	The $NEX_{IPCC\ default}$ is calculated as equation 10.30 in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse 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	0.63
Justification of choice of data or description of measurement methods and procedures applied	The project involves the breeding of market swine in large, confined livestock farms located in Yunnan Province, China, P.R.C., which belong to High Productivity Systems in Asia. Default value from 2019 Refinement to the IPCC 2006 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	56
Justification of choice of data or description of measurement methods and procedures applied	The swine farms involved in this project are 100% market oriented with high level of capital input requirements and high level of overall herd (flock) performance, Feed is purchased from local market. Animals are improved through breeding practices for commercial production; thus, the swine farms belong to High Productivity System according to 2019 Refinement to the IPCC 2006 Guidelines. The project is located in Yunnan Province, China, Asia, thus, the default values for market swine and breeding swine in Asia area given by IPCC are applied. The default values are 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	$F_{gas\ MS,0,LT} = 0.4$ for Uncovered anaerobic lagoon in baseline (corresponding to the treatment method in Table 10.22 of IPCC2019 as Uncovered anaerobic lagoon); $F_{gas\ MS,1,LT} = 0.25$ for the underfloor pit storage step of this project (corresponding to the treatment method in Table 10.22 of IPCC2019 as Underfloor pit storage); $F_{gas\ MS,2,LT} = 0.50$ for the anaerobic digestion step of this project (corresponding to the treatment method in Table 10.22 of IPCC2019 as Anaerobic digester); $F_{gas\ MS,3,LT} = 0.60$ for the Composting- Passive windrow step of this project (corresponding to the treatment method in Table 10.22 of IPCC2019 as Composting- Passive windrow).
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are applied.
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 Uncovered anaerobic lagoon in baseline.

	$EF_{N2O,D,1}$=0.002 for the Underfloor pit storage. Step of this project (corresponding to the treatment method in Table 10.21 of IPCC2019 as Underfloor pit storage. $EF_{N2O,D,2}$=0.0006 for the Anaerobic digestion step of this project (corresponding to the treatment method in Table 10.21 of IPCC2019 as Anaerobic digester. $EF_{N2O,D,3}$=0.005 for the Composting- Passive windrow step of this project (corresponding to the treatment method in Table 10.21 of IPCC2019 as Composting- Passive windrow.
Justification of choice of data or description of measurement methods and procedures applied	Site-specific data is unavailable; therefore, default values are applied.
Purpose of data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$EF_{N2O,ID}$
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 for baseline and project scenario
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore the default value is applied as methodology required.
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
Justification of choice of data or description of measurement methods and procedures applied	Digesters with unlined concrete/ferrocement/brick masonry arched type gas holding section; monolithic fixed dome digesters, covered anaerobic lagoon
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.

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	85% for the Uncovered anaerobic lagoon in the baseline (one-cell of lagoon in Annex 1 of ACM0010) 20% for the underfloor pit storage (underfloor pit storage in Annex 1 of ACM0010) 90% for the anaerobic digester (covered two cell lagoons in Annex 1 of ACM0010) 40% for the Composting- Passive windrow (heated digester effluent prior to storage in Annex 1 of ACM0010)
Justification of choice of data or description of measurement methods and procedures applied	For the proposed project, before the treated manure is applied to the land, it undergoes underfloor pit storage and an anaerobic digestion process. So, the $R_{VS,n}$ is 20%, which is the most conservative value. The anaerobic digester technology belongs to two cell lagoons in the Appendix 1 of applied methodology ACM0010 (version 08.0), so the $R_{VS,n}$ 90% which is the most conservative value. The separated solid is treated by passive windrow, which is similar to the heated digester effluent prior to storage. So, the $R_{VS,n}$ 40% which is the most conservative value. For proposed 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.
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	$R_{N,1}$ = 5% for underfloor pit storage $R_{N,2}$ = 50% for anaerobic digester $R_{N,0}$ = 80% for uncovered anaerobic lagoon
Justification of choice of data or description of measurement methods and procedures applied	The anaerobic digester has been assumed as a two-cell lagoon. An uncovered anaerobic lagoon has been assumed as lagoon. The most conservative value for the given technology must be applied.
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
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	$EF_{grid,OM,y}$
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
Value applied	0.7738
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	Calculation of project emission
Comments	N/A

Data / Parameter	$EF_{grid,BM,y}$
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
Value applied	0.1981
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	Calculation of project emission
Comments	N/A

Data / Parameter	w_{OM}
Data unit	/
Description	Weighting of operating margin emission factor
Source of data	TOOL07: Tool to calculate the emission factor for an electricity system (Version 07.0)
Value applied:	50%
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	N/A

Data / Parameter	w_{BM}

Data unit	/
Description	Weighting of build margin emission factor
Source of data	TOOL07: Tool to calculate the emission factor for an electricity system (Version 07.0)
Value applied:	50%
Justification of choice of data or description of measurement methods and procedures applied	Default value
Purpose of Data	Calculation of baseline emissions and project emissions
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[71]
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	$Pa.m^3/kmol.K$

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

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	8,314
Justification of choice of data or description of measurement methods and procedures applied	Default value from methodological tool 08" Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)".
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	Default value from methodological tool 08" Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)" .
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	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

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

5.2 Data and Parameters Monitored

Data / Parameter	$N_{P,LT}$
Data unit	Number
Description	Number of animals of type LT produced annually for the year y
Source of data	Project proponent
Description of measurement methods and procedures to be applied	$N_{p,LT}$ is recorded by VCS-trained monitoring team members who conduct daily counts of market swine inventory at the farm, while simultaneously deducting the number of sick and deceased pigs to determine the actual daily population, with monthly aggregation and verification.
Frequency of monitoring/recording	Monthly
Value applied	125,000 heads of total market swine
Monitoring equipment	N/A
QA/QC procedures to be applied	The sale records will be used as crosscheck and archive electronically during project plus 5 years.
Purpose of data	Used for the calculation of N_{LT}, which used in the calculation of the baseline emission. Project emission and leakages emission.
Calculation method	N/A
Comments	Indirect information (Daily running statistics and sale records) will be crosschecked.

Data / Parameter	$N_{da,LT}$
Data unit	Number

Description	Number of days animal of type LT is alive in the farm in the year y
Source of data	Project proponent
Description of measurement methods and procedures to be applied	In this project, each pig is equipped with a dedicated electronic ear tag, a device specifically designed for animal identification and digital management. The system assigns a unique identification number to each pig and records its registration details, including entry and exit dates, as well as the deactivation date when the pig is sold or dies from illness.
Frequency of monitoring/recording	Monitored monthly
Value applied	The design data is from Environmental Impact Assessment provided by the project proponent, and the actual data will be monitored. For ex-ate calculation: 168 days for market swine
Monitoring equipment	N/A
QA/QC procedures to be applied	The sale records will be used as crosscheck and archive electronically during project plus 5 years.
Purpose of data	Used for the calculation of N_{LT}, which used in the calculation of the baseline emission. Project emission and leakages emission.
Calculation method	N/A
Comments	Indirect information (Daily running statistics and sale records) will be crosschecked.

Data / Parameter	N_{LT}
Data unit	Number
Description	Annual average number of animals of type LT for the year y
Source of data	Project proponent

Description of measurement methods and procedures to be applied	For market swine, since there is no way to trace the daily stock, so the Option 1 is adopted to calculate for market swine based on ACM0010. Calculated by $N_{da,LT}$ Number of days animal of type LT is alive in the farm in the year y (number) and $N_{p,LT}$ Number of animals of type LT produced annually for the year y (number) $N_{LT} = N_{da,LT} \times \left(\frac{N_{p,LT}}{365}\right)$
Frequency of monitoring/recording	Monthly
Value applied	57,534 heads of market swine
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of the baseline emission. Project emission and leakages emission.
Calculation method	$N_{LT} = N_{da,LT} \times \left(\frac{N_{p,LT}}{365}\right)$
Comments	N/A

Data / Parameter	W_{site}
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Source of data	The design data is sourced from EIA reports. Actual data will be monitored by project proponent.
Description of measurement methods and procedures to be applied	Parameter W_{site} used stratified random sampling method to determine the number of swine to be sampled each month based on the monthly market swine inventory. The sampling method in details referred to monitoring plan in Section 5.3. After determining the number of swine to be sampled each month, they are weighed and recorded by trained VCS monitoring team members used weight measurer with the accuracy of class III level, which was calibrated annually to ensure accurate results. Based on the records of sampling measurement each month,

	average animal weight in different phases (lactation, growth , maturity) will be calculated.
Frequency of monitoring/recording	Monthly
Value applied	For ex-ante calculation: 115 The actual data is monitored during the crediting period
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 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 according to JJG 539-2016" Verification Regulation of weight measurer" in China every year with accuracy grade of M1 level.
Purpose of data	Used for estimating $VS_{LT,y}$
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	The design data is sourced from EIA reports. Actual data will be monitored by project proponent.

Description of measurement methods and procedures to be applied	The number of operational days for the wastewater treatment plant shall be manually recorded by the monitoring (VCS) team members. A day shall only be counted when both the aerobic composting and anaerobic digestion systems at the swine farm meet normal operating conditions. If either system experiences a malfunction (e.g., equipment downtime exceeding 2 hours or failure to meet key parameter thresholds), that day shall not be counted, and the specific malfunction causes along with repair times must be documented in detail in the "Operation Log".
Frequency of monitoring/recording	Daily
Value applied	365 days for ex-ante estimation. The actual number of days when both the aerobic compost and anaerobic digester of the swine farm operation successfully in the monitoring periods will be monitored by project proponents.
Monitoring equipment	N/A
QA/QC procedures to be applied	Operation records can be considered as crosscheck, such as the breeding record, manure collection record, solid-liquid separation record, etc.
Purpose of data	Calculation of Baseline emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh
Description	The electricity supplied by the grid for 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	As per the project monitoring plan, designated personnel will record the grid electricity consumption used by the AWMS through Electricity Meter 1.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	409.4 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	N/A
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	According to Tool 05” Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation”
Frequency of monitoring/recording	Annually. In the absence of data from the relevant year, most recent figures should be used, but not older than 5 years
Value applied	20%
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	/
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 Environmental Impact Assessment.
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
Calculation method	N/A
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 flowmeters from project proponents
Description of measurement methods and procedures to be applied	Volumetric flow measurement should always refer to the actual pressure and temperature. Monitored continuously by flowmeter 1 installed at the outlet of the anaerobic digestion, flowmeter 2 installed at the inlet of the biogas electricity generator and flowmeter 3 installed in inlet of flare

<table>
<tr><td>Frequency of monitoring/recording</td><td>Continuous measurement</td></tr>
<tr><td>Value applied</td><td>Biogas was estimated based on the amount of manure for ex ante estimation and will be monitored during the monitoring period.</td></tr>
<tr><td>Monitoring equipment</td><td>Electronic flowmeter
<table>
<tr><td>No.</td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Model</td><td>SDLUGB-DN100</td><td>SDLUGB-DN100</td><td>SDLUGB-DN100</td></tr>
<tr><td>Factory No</td><td>WJ20232702</td><td>WJ20232703</td><td>WJ20232704</td></tr>
<tr><td>Calibration frequency</td><td>Annually</td><td>Annually</td><td>Annually</td></tr>
<tr><td>Period of validity of Calibration Certificates</td><td>25/08/2023~ 24/08/2024
25/08/2024~ 24/08/2025</td><td>25/08/2023~ 24/08/2024
25/08/2024~ 24/08/2025</td><td>25/08/2023~ 24/08/2024
25/08/2024~ 24/08/2025</td></tr>
</table></td></tr>
<tr><td>QA/QC procedures to be applied</td><td>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 with accuracy grade of 1.5.</td></tr>
<tr><td>Purpose of data</td><td>Calculation of project emissions</td></tr>
<tr><td>Calculation method</td><td>N/A</td></tr>
<tr><td>Comments</td><td>N/A</td></tr>
</table>

Data / Parameter	$\upsilon_{i,t,db}$
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 from project proponents

Description of measurement methods and procedures applied	Gas analyser is set at the outlet desulfurization and purification system and operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature.
Frequency of monitoring/recording	Continuous measurement
Value applied:	The volumetric fraction of methane design value from EIA reports is 60% and is used for ex-ante calculation. The actual monitoring data will be applied during the crediting period.
Monitoring equipment	Gas analyzers
QA/QC procedures applied	The gas analyzers will be calibrated according to JJG693-2011 "Combustible Gas Detection Alarm" annually.
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 instrument
Description of measurement methods and procedures to be applied	Instruments with recordable electronic signals (analog or digital) are required. Examples include thermocouples, thermistors, etc.
Frequency of monitoring/recording	Continuous unless differently specified in the underlying methodology
Value applied	20˚C 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 will be monitored by the recordable electronic signal.

Monitoring equipment	Instruments with recordable electronic signal (analogical or digital)
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications
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 instrument
Description of measurement methods and procedures to be applied	Instruments with recordable electronic signal (analogical or digital) are required. Examples include pressure transducers, etc.
Frequency of monitoring/recording	Continuous unless differently specified in the underlying methodology
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	Instruments with recordable electronic signal (analogical or digital)
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. Calibration and frequency of calibration is according to manufacturer's specifications
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	F_{Aer}
Data unit	Fraction
Description	Fraction of volatile solids directed to aerobic treatment
Source of data	EIA reports
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	$MS\%_j$
Data unit	Fraction
Description	Fraction of manure handled in system j in project activity
Source of data	EIA
Description of measurement methods and procedures to be applied	100% for all the manure is stored in underfloor pit storage. The manure is separated by solid-liquid separator with an efficiency of 50%.

	50% for the aerobic treatment for ex-estimated. 50% for the anaerobic treatment for ex-estimated. In the monitoring period, the amount of manure direct into covered anaerobic digester and organic fertilizer base material production depends on the demand of biogas by the project owner, the project owner may choose to direct more than 50% or even all the manure to covered anaerobic digester for more biogas generation.
Frequency of monitoring/recording	N/A
Value applied	100% for all the manure is stored in underfloor pit storage. 50% for the aerobic treatment for ex-estimated. 50% for the anaerobic treatment for ex-estimated.
Monitoring equipment	N/A
QA/QC procedures to be applied	The manure flew into digesters by pipes
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$B_{0,LT}$
Data unit	m^3 CH_4 / kg-dm
Description	Maximum methane producing potential of the volatile solid generated by animal type LT
Source of data	2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4
Description of measurement methods and procedures to be applied	The swine farm is 100 percent market oriented with high level of capital input requirements and high level of overall herd (flock) performance. The feed of swine is purchased from local or intensively produced on farm. Swine are improved through the PP' breeding practices in commercial production in other farms and then introduced to Baoshan East Hope Swine Farm. According to 2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4, the swine farm belongs to High-productivity systems.

Frequency of monitoring/recording	Monitored monthly
Value applied	0.45
Monitoring equipment	N/A
QA/QC procedures to be applied	The value is sourced from published sources. The parameter value should be updated on latest available public data source.
Purpose of data	Calculation of baseline emission, project emissions and leakage emissions.
Calculation method	N/A
Comments	/

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	15.7 °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., 15.7 °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

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: $NEX_{LT,y} = \frac{W_{site}}{W_{default}} \times NEX_{IPCC\ default}$
Description of measurement methods and procedures to be applied	Calculated based on the weight of swine of this project by the project proponent
Frequency of monitoring/recording	Annually
Value applied	For pre-calculation 26.44 In monitoring period, the actual value is calculated based on the weight of swine of this project by the project owner
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Used in project emission/baseline calculations
Calculation method	$NEX_{LT,y} = \frac{W_{site}}{W_{default}} * NEX_{IPCC\ default}$
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 2 years.
Frequency of monitoring/recording	Once for each monitoring period
Value applied	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	If any change in the type of barn and AWMS happened in the crediting period, it will be reported by the project proponent.
Purpose of data	Confirm the type of barn and AWMS which could relate to the selection of some default values.
Calculation method	N/A
Comments	N/A

Data / Parameter	$VS_{LT,y}$
Data unit	kg-dm/animal/year
Description	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis
Source of data	Calculated as the equation below: $VS_{LT,y} = \left(\frac{W_{site}}{W_{default}}\right) \times VS_{default} \times nd_y$
Description of measurement methods and procedures to be applied	Calculated based on the weight of swine and the operation days of treatment plant of this project by the project proponent
Frequency of monitoring/recording	Annually
Value applied	For pre-calculation 214.07 In monitoring period, the actual value is calculated based on the weight of swine of this project by the project owner
Monitoring equipment	N/A

QA/QC procedures to be applied	N/A
Purpose of data	Used in project emission/baseline calculations
Calculation method	$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}}\right) \times VS_{default} \times nd_y$
Comments	N/A

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 at room temperature 20 ˚C and 1 atm pressure (default value provided in methodology ACM0010) is used for ex-ante calculation. During monitoring, this parameter will be calculated based on a temperature of 20 °C and a pressure of 1 atm since the gas volumetric flow rate will be converted to values for room conditions, i.e. 20 °C and 1 atm
Monitoring equipment	N/A
QA/QC procedures to be applied	Calculated value according to the pressure and temperature
Purpose of data	Calculation of project emissions
Calculation method	Calculated based on temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t
Comments	N/A

Data / Parameter	Sale of swine

Data unit	/
Description	Annual sale of swine
Source of data	Project proponent
Description of measurement methods and procedures to be applied	Record the price quantity and destination of the swine sold
Frequency of monitoring/recording	Annually
Value applied	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	Cross check with the local price and $N_{p,LT}$ and invoice or receipt
Purpose of data	Watch the relationship between the production of swine and the price of swine. Confirm the swine farm is 100 percent market oriented to prove the swine farm in the monitoring period still meets the requirement of high productivity systems in the Volume 4-Chapter 10, of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Calculation method	N/A
Comments	N/A

Data / Parameter	Purchase of Feed
Data unit	/
Description	Annual Purchase of Feed
Source of data	Project proponent
Description of measurement methods and procedures to be applied	Record the Purchase of Feed and the invoice
Frequency of monitoring/recording	Annually
Value applied	N/A

Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Confirm the feed of the swine farm is purchased from local or international market or intensively produced on farm to prove the swine farm in the monitoring period still meet the requirement of high productivity systems in the Volume 4, Chapter 10, of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Calculation method	N/A
Comments	N/A

Data / Parameter	Swine improved through breeding practices
Data unit	/
Description	Demonstrate animals are improved through breeding practices for commercial production.
Source of data	Project proponent
Description of measurement methods and procedures to be applied	Record the number of swine introduced that have been improved through breeding practices in commercial production
Frequency of monitoring/recording	Recorded each time and summarized annually.
Value applied	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	To demonstrate animals are improved through breeding practices for commercial production to prove the swine farm in the monitoring period still meet the requirement of high productivity systems in the Volume 4-Chapter 10, of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Calculation method	N/A
Comments	N/A

Data / Parameter	$W_{j,x}$
Data unit	t
Description	Total amount of waste disposed in a SWDS in year x
Source of data	Measurements by project proponent
Description of measurement methods and procedures to be applied	Recording the total amount of waste disposed in a SWDS in year x. Because the solid waste is designed to be treated under aerobic conditions in windrows, there would not be solid waste disposed in a SWDS; the $W_{j,x}$ = 0 for estimated. PP monitors the storage/disposal and/or sale/distribution of compost in accordance with the monitoring requirements for the parameter '*The status of digestate*'. If compost is found to be under anaerobic conditions, this portion of compost shall be weighed and $LE_{comp,y}$ calculated.
Frequency of monitoring/recording	Continuously, aggregated at least annually for year x
Value applied	0 for estimated, as this parameter is monitored in the actual operation.
Monitoring equipment	Weight measurer
QA/QC procedures to be applied	The weight measurer will be calibrated according to JJG 539- 2016 " Verification Regulation of weight measurer[72]" in China every year with accuracy grade of M1 level.
Purpose of data	To demonstrate the total amount of waste disposed in a SWDS
Calculation method	N/A
Comments	N/A

Data / Parameter	The status of digestate
Data unit	/
Description	Monitoring of storage/disposal and/or sale/distribution of compost and digestate
Source of data	Measurements by project proponent

[72] https://www.doc88.com/p-4334928166611.html

Description of measurement methods and procedures to be applied	Livestock manure undergoes anaerobic digestion to produce liquid digestate and solid digestate(sludge). The liquid digestate is utilised for irrigation and does not enter the composting process, while the solid digestate(sludge) is transferred to the aerobic composting system. Both liquid digestate and solid digestate are not in anaerobic conditions. To ensure this, PP implements the following measures: ● Liquid digestate: Monitor the oxygen concentration in the aerated aerobic pond to ensure the liquid digestate remains under aerobic conditions. ● Solid digestate: 1. Unsold organic fertiliser: Monitor the turning dates of organic fertiliser and record them in the operational log to ensure that PP turns unsold organic fertiliser at least once per month to maintain an aerobic environment. 2. Sales and Transportation of Organic Fertiliser: Monitor the method of transporting organic fertiliser and record this on sales records. Ensure organic fertiliser is sold to users located near the project site and transported by truck, thereby guaranteeing the entire sales process keeps the fertiliser exposed to air within an aerobic environment. 3. Users applying organic fertiliser Monitor user application times and storage methods (turning fertilizer at varying intervals) carried out through follow-up visits within 30 days of organic fertiliser purchase, monitoring results are recorded in sales records to ensure the fertiliser remains aerated throughout the user's application process. If compost is found to the storage/disposal and/or sale/distribution of organic fertiliser in anaerobic conditions, it shall be weighed and recorded in accordance with the $W_{j,x}$ measurement method.
Frequency of monitoring/recording	Continuously, aggregated at least annually
Value applied	All in compost process for ex-estimated, as this parameter is monitored in the actual operation.
Monitoring equipment	/

QA/QC procedures to be applied	/
Purpose of data	To demonstrate the status of digestate
Calculation method	N/A
Comments	N/A

Data / Parameter	The status of biogas destruction
Data unit	/
Description	Monitoring of operational status of biogas destruction devices (flare and electricity)
Source of data	Measurements by project proponent
Description of measurement methods and procedures to be applied	Recording the electricity production from methane captured and the operation of the flare by means of a flame detector to demonstrate the actual destruction of methane, Emission reductions will not accrue for periods in which the destruction device is not operational
Frequency of monitoring/recording	Continuously, aggregated at least annually
Value applied	/
Monitoring equipment	UV detector and electricity meters
QA/QC procedures to be applied	The UV detector will be calibrated by an independent qualified third party as per China national standard GB 12791-2006 Point Type Ultraviolet Detectors. The electricity meters were calibrated by an officially accredited entity in compliance with JJG 596-2012.
Purpose of data	To demonstrate the actual destruction of methane to prove the methane will be destroyed in 100 percent
Calculation method	N/A
Comments	N/A

Data / Parameter	High level of capital input
Data unit	/
Description	The capital that the PP used to improve the productivity

Source of data	Project proponent
Description of measurement methods and procedures to be applied	Record the capital used in the production process
Frequency of monitoring/recording	Annually
Value applied	N/A
Monitoring equipment	N/A
QA/QC procedures to be applied	Cross check with the OM cost and sales revenue
Purpose of data	Confirm the production of the swine farm is with high level capital to prove the swine farm in the monitoring period still meet the requirement of high productivity systems in the Volume 4, Chapter 10, of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
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:

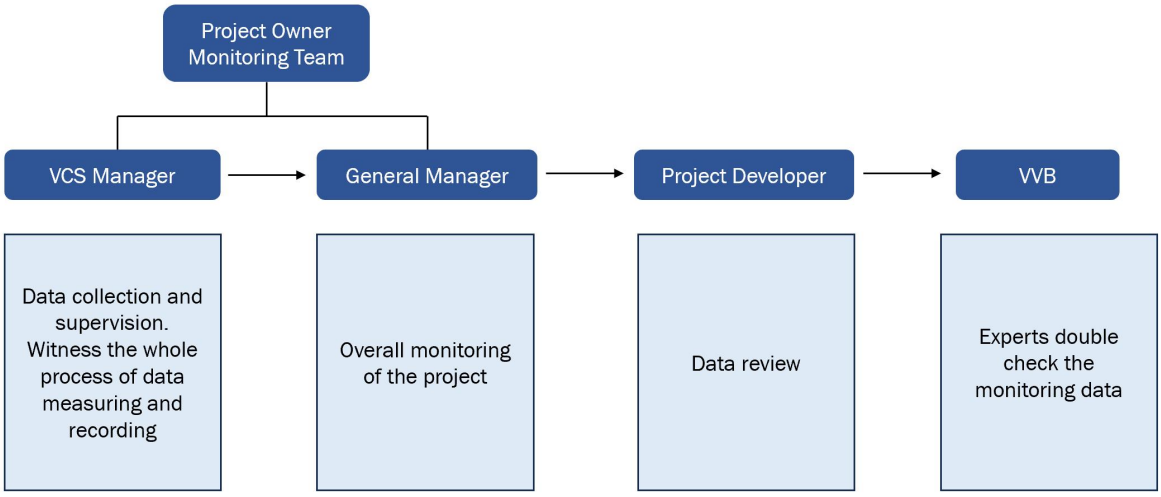

Figure 5-1 Operation and management structure of the Project

(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
1	$N_{P,LT}$	The annual production quantity of LT-type swine ($N_{p,LT}$) is determined through the following protocol: Trained monitoring team members conduct daily records of swine inventory, from which the actual daily stock is calculated by deducting sick and deceased pigs. This data undergoes monthly aggregation and verification to produce final figures, which are further cross-checked against sales records.
2	$N_{da,LT}$	For number of days animal of type LT is alive in the farm in the year y is sourced from the monthly sales record of market swine, the data is 168 days.

3	N_{LT}	The parameter is calculated by $N_{P,LT}$ and $N_{da,LT}$ as the equation of option 1 of methodology ACM0010 Version 08.0. As for the parameter $N_{P,LT}$ and $N_{da,LT,}$ they are monitored during the monitoring period; please refer to the monitoring parameter $N_{P,LT}$ and $N_{da,LT,}$.
4	W_{site}	Parameter W_{site} used stratified random sampling method to determine the number of swine to be sampled each month based on the monthly market swine inventory. The sampling method in details referred to monitoring plan in Section 5.3. After determining the number of swine to be sampled each month, they are weighed and recorded by trained VCS monitoring team members used weight measurer with the accuracy of class III level, which was calibrated annually to ensure accurate results. Based on the records of sampling measurement each month, average animal weight in different phases (lactation, growth , maturity) will be calculated.
5	nd_y	The number of operational days for the wastewater treatment plant shall be manually recorded by the monitoring (VCS) team members. A day shall only be counted when both the aerobic composting and anaerobic digestion systems at the swine farm meet normal operating conditions. If either system experiences a malfunction (e.g., equipment downtime exceeding 2 hours or failure to meet key parameter thresholds), that day shall not be counted, and the specific malfunction causes along with repair times must be documented in detail in the “Operation Log”. Typically, the plant operates year-round, i.e., 365 days, unless a malfunction occurs.
6	$EC_{PJ,j,y}$	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.
7	$TDL_{j,y}$	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.
8	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.

9	$V_{t,db}$	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.
10	$V_{i,t,db}$	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.
11	T_t P_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.
12	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%.
13	$MS\%_j$	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, 100% for all the manure is stored in underfloor pit storage. The manure is separated by solid-liquid separator with an efficiency of 50%. 50% for the aerobic treatment for ex-estimated. 50% for the anaerobic treatment for ex-estimated. In the monitoring period, the amount of manure direct into covered anaerobic digester and organic fertilizer base material production depends on the demand of biogas by the project owner, the project owner may choose to direct more than 50% or even all the manure to covered anaerobic digester for more biogas generation.
14	$B_{0,LT}$	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.
15	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.

16	$NEX_{LT,y}$	The parameter is calculated as the equation of option 2 in Appendix 2 of methodology ACM0010 Version 08.0, and the value of the 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}.
17	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.
18	$VS_{LT,y}$	Annual volatile solid excretions for livestock LT entering all AWMS on a dry matter weight basis.
19	Sale of swine	In the monitoring period, record the price quantity and destination of the swine sold to prove the swine farm in the monitoring period still meet the requirement of high productivity systems in the Volume 4-Chapter 10, of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
20	Purchase of Feed	Record the Purchase of Feed and the invoice. In the monitoring period, record the purchase of feed and the invoices sold to prove the swine farm in the monitoring period still meets the requirement of high-productivity systems in Volume 4, Chapter 10 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
21	$W_{j,x}$	In the monitoring period, the total amount of waste disposed in a SWDS in year x will be recorded.
22	The status of digestate	Recording the destination and number of days of digestate after anaerobic process, Because the waste is designed to be treated under aerobic condition in windrow, so all the digestate should be in compost process, in case of the aerobic process failed, it will be monitored the destination and number of days of digestate after anaerobic process.
23	Status of biogas	Recording the electricity production from methane captured and the operation of the flare by means of a flame detector to demonstrate the actual destruction of methane, Emission

	destruction device	reductions will not accrue for periods in which the destruction device is not operational.
24	High level of capital input	In the monitoring period, the capital used in the production process was recorded to prove the swine farm in the monitoring period still meets the requirement of high productivity systems in Volume 4, Chapter 10 of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

(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 in Figure 5-2. To ensure measurements with a low degree of uncertainty, all monitoring devices used (including weight measurers, electric meters, flow meters, and gas analyzers) 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 its normal operation and, in accordance with the corresponding calibration standards for each monitoring device, will entrust a qualified third-party calibration unit to perform calibration on schedule. The calibration records will be appropriately maintained and made available for review by VVB.

If 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.

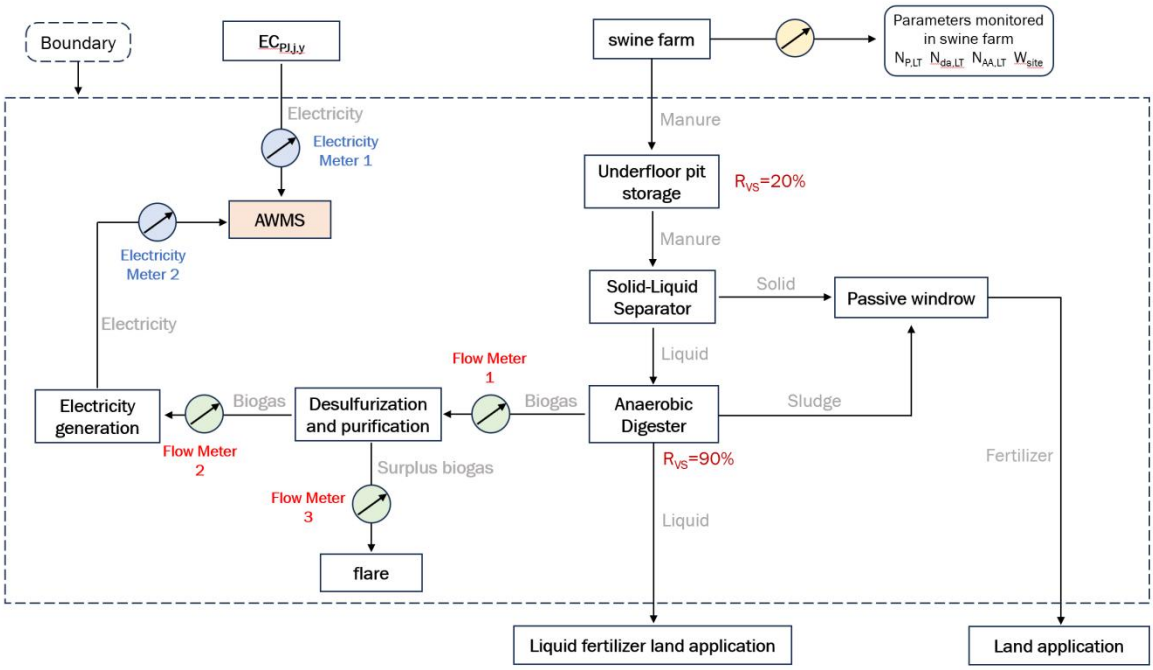

Figure 5-2 Installation and Configuration of meters

(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 programs 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 Programs of Activities (Version 09.0),” PP shall use a 95/10 confidence/precision as the criterion 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 swine 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 168 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 at least once monthly.
Target population and sampling frame	For the ex-ante calculation, a total of 125,000 market 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 Environmental Impact Assessment. As the applied value of 125,000 market swine (N_{LT}= 57,534 as calculated in section 4.1) is the design scale, the total amount of swine in stock shall be the number of market swine, which is N = 57,534, during the monitoring periods, the actual breeding scale of the farm will not exceed the design value, so 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 market swine in stock. Since this project involves one swine farm, namely Market 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 first calculate the overall sample size based on the population of swine in stock. As the project involves one swine farm, the sample size in this swine farm should be determined based on the proportion of the total number of swine in the farm. Similarly, the sample size of each age group of Market Swine in the farm was also calculated based on the proportion of the number of each age group of Market Swine to the total number of swine in the farm. After the sample size for each age group of Market Swine in this swine farm is determined, sampling 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 the corresponding 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 "Sampling and Surveys for CDM Project Activities and Programs 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 sample size will be calculated as outlined in Appendix 6 of the guidelines of "Sampling and Surveys for CDM Project Activities and Programs 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 57,534. Since the application of 57,534 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:

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

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

$$n_3 = B \times n_2$$

$$n_4 = n_3/r$$

$$n = n_4 \times 110\%$$

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 12,5000;

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 57,534, N in the calculation of sample size is 57,534, and the calculation result is as follows:

Z	V	e	N	B	r
1.96	1	10%	57,534	1	100%
n_1	Z^2V^2/e^2	385			
n_2	$n_1N/(N+n_1)$	383			
n_3	Bn_2	383			
n_4	n_3/r	383			
n	n_4（110%）	423			

The calculation result of n is 423. Therefore, 423 samples should be sufficient to meet the desired confidence and accuracy. According to the method of stratified sampling, 423 samples were taken from the sampling box every month.

Stratified sampling (with samples of 423) was used for the monitoring of the W_{site}. The sample size of market swine of all ages on swine farms was calculated according to the proportion of market swine of all ages in the total number of swine on swine farms. Each identified stock of livestock should be divided into at least three age categories. Market swine 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 168 days. The average animal weight of the designated herds at the project site will be monitored on swine farms 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 to the total number of swine on the farm. To be conservative, the sample number for the farm is adjusted to an integer value.

Finally, 423 pig samples were selected for W_{site} monitoring,

Sample	Phase	farm	**total**
Market	lactation period	141	423

	growth period	141	
	maturity period	141	

According to the conditions of the swine farm for the month, after determining the sample size of the farm's market swine of all ages, sampling was conducted at the swine farm. Since swine of different ages are raised in different swine houses, a random sample was drawn from swine 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 at 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 is 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 period, 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 a 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 without 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.