SHUANGBAOTAI AWMS GHG MITIGATION PROJECT IN JIANGSU PROVNCE

Document Prepared by Profit Carbon Environmental Energy Technology (Shanghai) Co., Ltd.

Project Title	Shuangbaotai AWMS GHG Mitigation Project in Jiangsu Province
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CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Project

Shuangbaotai AWMS GHG Mitigation Project in Jiangsu Province (hereafter referred to as the project) installs new animal waste management systems (AWMSs) to treat the manure from 4 existing swine farms in Jiangsu Province, which are owned by Shuangbaotai Animal Husbandry Group Co., Ltd. Each subsidiary swine farm installs one AWMS, and the manure is treated on site. The purpose of the project activity is to treat the manure and wastewater to avoid methane etmissions generated in the baseline uncovered anaerobic lagoons.

This project is a newly constructed project, and the specific treatment process is as follows: The project activity uses flushing system to collect the manure automatically. All the manure and wastewater are collected and then be separated first. The separated solid are treated in aerobic composting system and the organic fertilizers are produced. The separated liquid is treated through anaerobic digestion process and the biogas generated during the treatment process is captured for electricity generation and surplus biogas is destroyed through the flaring system (if any). The electricity generated are all used by the AWMSs and the swine farms, for conservativeness, baseline emissions from power generation are neglected. It is estimated that total 1,481.072472*$10^4$$m^3$ biogas are expected to be generated annually and each generator is installed in each subsidiary swine farm, total installed capacity of the proposed project is 2.78 MW and the annual electricity production is estimated to be 19,254MWh. After anaerobic digestion. The sludge produced from anaerobic digestion are treated through aerobic composting together with the solid, the effluent is supplied to the farmers living around free for agriculture irrigation.

The common practice for the swine farm owners to manage the manure is to have uncovered anaerobic lagoons/ponds at their farms in the region. i.e., Prior to the implementation of the project, the animal manure waste was left to decay in uncovered open lagoon at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. As per “technical specification for sanitation treatment of livestock and poultry manure[1]”, In China, the uncovered anaerobic lagoons are a manure treatment method recognized by the state. In addition, 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, therefore the continue of this common practice to treatment the manure i.e., uncovered anaerobic lagoons is the most economic, viable and reasonable for livestock farm owners.

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

It is estimated that approximately 685 tons of animal manure are handled daily by the AWMS. The project activity reduces of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure and wastewater. It is estimated that 150,212 tCO_2e emission reductions will be produced annually and the total emission reductions in the fixed crediting period from 10-June-2020 to 09-June-2030 is 1,502,120 tCO_2e.

The project has been put into operation on 10-June-2020. This monitoring period for the project is 10-June-2020 to 31-December-2021, which is the first monitoring period. The total emission reductions achieved in this monitoring period is 186,241tCO_2e.

1.2 Sectoral Scope and Project Type

Therefore, the project falls into sectoral scope 01: Energy industries (renewable -/ non-renewable sources), sectoral scope 13: Waste handling and disposal and sectoral scope 15 (livestock and manure management). The project is not a grouped project.

The project type of this project belongs to Type III "Other project activities not included in Type I or Type II".

The applied methodology for this project is ACM0010"GHG emission reductions from manure management systems[2]"(Version 08.0).

1.3 Project Eligibility

As per section 2.1.1 of VCS Standard (version 4.2), the scope of the VCS Program include：

1) The six Kyoto Protocol greenhouse gases: The proposed project is designed to treat the manure and wastewater through introduce new AWMS in 4 existing swine farms to avoid the emission of methane in baseline uncovered anaerobic lagoons. Also, methane is one of the six Kyoto Protocol greenhouse gases, so the proposed project meets this item.

2) Ozone-depleting substances： NA.

3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process: NA.

4) Project activities supported by a methodology approved under an approved GHG program, unless explicitly excluded (see the Verra website for exclusions): The methodology ACM0010 (version 08.0) of the project utilized are methodologies approved under CDM Program, which is a VCS approved GHG program.

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

5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements: NA.

The scope of the VCS Program excludes projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction. The VCS Program also excludes the following project activities under the circumstances indicated in Table 1, below: The farms involved in the project are all existing farm, which has been put into operation for many years. The proposed project is the resource utilization of swine manure from the 4 existing farm to avoid methane emission in baseline scenario, and the generation of swine manure is a natural phenomenon. Therefore, the proposed project is not belonged to those projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal or destruction.

The proposed project is located in Jiangsu Province, China, which is not belongs to LDC[3] designated by the United Nations. Also, the proposed is not belongs to the projects excluded in Non-LDC in Table 1 of VCS Standard 4.2. Therefore, the project is eligible under the scope of VCS program.

1.4 Project Design

The project activity involves the construction and operation 4 animal manure management system in 4 existing swine farms in Jiangsu Province owned by Shuangbaotai Animal Husbandry Group Co., Ltd. with the treatment capacity of the AWMS in this project of 685 ton per day. It has been designed to install one animal manure management system in each swine farm. Total 4 swine farms are included in this project activity, which belongs to multiple project activity instances. This project is not a grouped project.

Eligibility Criteria

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

1.5 Project Proponent

Organization name	Shuangbaotai Animal Husbandry Group Co., Ltd.
Contact person	Yuan Xue
Title	Deputy General Manager

[3] https://www.un.org/development/desa/dpad/wp-content/uploads/sites/45/publication/ldc_list.pdf

Address	201, 2nd Floor, Office Building, No. 799, Torch Street, Nanchang High-paying Technology Industrial Development Zone, Nanchang City, Jiangxi Province
Telephone	/
Email	snowgirl1984@hotmail.com

1.6 Other Entities Involved in the Project

Organization name	Profit Carbon Environmental Energy Technology (Shanghai) Co., Ltd.
Role in the project	VCS Consultant
Contact person	Zhu Yanan
Title	Project Manager
Address	No.2815 Longteng Avenue, Baihui Park full river view office building, Shanghai, China
Telephone	+86 21 6127 2386
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1.7 Ownership

All the AWMSs were invested by the project owner Shuangbaotai Animal Husbandry Group Co., Ltd. who has the legal right to control and operate the project activities. The business license, approval of Environmental Impact Assessment (EIA) and the Major equipment (anaerobic tank, power generator etc.) purchasing contract are evidence for the ownership of the project and carbon credits generated.

1.8 Project Start Date

As per section 3.7 of VCS Standard (Version 4.2), the project start date of a non-AFOLU project is the date on which the project began generating GHG emission reductions or removals. The project activity is a non-AFOLU project, and all the Animal Manure Management System put into operation on 10-June-2020. Thus, the project start date is 10-June-2020.

1.9 Project Crediting Period

This project adopts fixed crediting periods of 10 years. The crediting period is 10 years 0 month from 10-June-2020 to 09-June-2030 (both days included)

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated volume of emission reduction from the project activity is 150,212 tCO_2e, which is less than 300,000 tonnes of CO_2e per year. As per section 3.9.1 of the VCS Standard (Version 4.2), the scale of the project activity is under "project" category.

Project Scale	
Project	×
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
10-June-2020 to 31-December-2020	84,366[4]
01-January-2021 to 31-December-2021	150,212
01-January-2022 to 31-December-2022	150,212
01-January-2023 to 31-December-2023	150,212
01-January-2024 to 31-December-2024	150,212
01-January-2025 to 31-December-2025	150,212
01-January-2026 to 31-December-2026	150,212
01-January-2027 to 31-December-2027	150,212
01-January-2028 to 31-December-2028	150,212
01-January-2029 to 31-December-2029	150,212
01-January-2030 to 09-June-2030	65,846[5]
Total estimated ERs	1,502,120
Total number of crediting years	10

[4] The yearly total amount estimated emission reduction is 150,212 tCO_2e, so the values estimated emission reduction from 10-June-2020 to 31-December-2020 is 150,212 tCO_2e *205 days /365 days= 84,366 tCO_2e.

[5] The yearly total amount estimated emission reduction is 150,212 tCO_2e, so the values estimated emission reduction from 01-January-2030 to 09-June-2030 is 150,212 tCO_2e *160 days /365 days= 65,846 tCO_2e.

Average annual ERs	150,212

1.11 Description of the Project Activity

The project activity is designed to install 4 set of new AWMSs to a group of 4 swine farm to treat the manure and wastewater from the 4 existing swine farms to avoid methane generated in the baseline uncovered anaerobic lagoons.

The proposed project implemented 4 sets of AWMSs in 4 existing swine farms involving 99,450 heads of commercial pigs, 54,252 heads of breeding pigs. Live pigs are kept for 180 days in the farms before shipment and are estimated to produce 246,740 tons of manure and 1,481.072472*$10^4 m^3$ of biogas annually. All these 4 existing swine farms were put into operation before the implementation of this project, detailed operation start date can be referred below Table 1-1.

Table 1-1. the operation date of swine farm

Swine farm name	Operation start date
Siyang Aiyuan Farm	24-May--2018
Dongtai Jianggang Farm	25-July--2018
Sheyang Linhai Farm	03-June-2018
Siyang Nanliuji Farm	15-July-2018

Baseline scenario

Prior to the implementation of the project, all manure waste produced from the existing 4 swine farms was left to decay in 4 uncovered anaerobic lagoons at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. As per "technical specification for sanitation treatment of livestock and poultry manure[6]", In China, the uncovered anaerobic lagoons are a manure treatment method recognized by the state. In addition, 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.

After the implementation of the project, original 4 uncovered anaerobic lagoons had been removed, the volume for original uncovered anaerobic lagoons is described in below Table 1-3.

Project technology description

There are 4 existing swine farms for this project, and each AWMS is implemented in each swine farm. The specific process is as follows:

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

All the manure and wastewater are collected into waste collecting tanks and then be separated first by Solid-liquid separators. the solid are treated in aerobic composting system, which are used as fertilizer. The liquid is treated through anaerobic digestion and the biogas generated during the treatment process is captured for electricity generation. if there is surplus biogas, then the biogas is flared through the flaring system. The sludge produced from anaerobic digestion are treated through aerobic composting together with the solid, the effluent is used for agriculture irrigation. The process flow diagram of AMWSs is shown in Figure 1-1 and the process flow of each AWMS is the same, as well as the AWMS used in 4 farms also are the same.

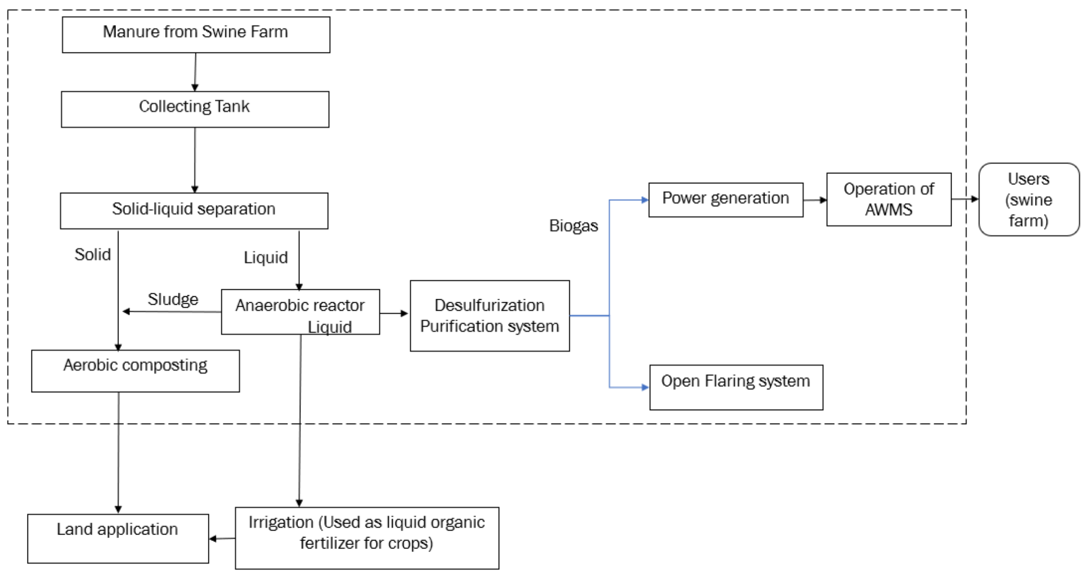


Figure 1-1 Process flow diagram of the project activity

Solid-liquid separation

The project activity uses flushing system to collect the manure automatically. All the manure and wastewater are collected and then be separated first. For solid-liquid separation, choose a compound screw extrusion solid-liquid separator. The solid are treated in aerobic composting system and the organic fertilizers are produced. The liquid is treated through anaerobic digestion and the biogas generated during the treatment process is captured for electricity generation.

Anaerobic digesters treatment process

Anaerobic tanks adopt Upflow Anaerobic Sludge Bed Reactor (UASB) as its anaerobic digester technology, and the biogas generated from the anaerobic digesters is entered the biogas generator set after desulfurization and purification system. The generated electricity is used for daily operation of AWMSs and the swine farms, and the waste heat of the generator is recycled for increasing the temperature of the anaerobic reactor. At the same time, and the residual biogas is flared through open flaring if there is any surplus biogas. The temperature of the anaerobic treatment unit of the project is designed as medium temperature, and the optimal temperature range is 35 ~ 38 ℃.

Comprehensive utilization of biogas

The biogas just produced by the anaerobic fermentation system is a mixed gas containing saturated steam. In addition to CH_4 and CO_2, it also contains H_2S and suspended particulate impurities. Therefore, desulfurization purification system is required. The purified biogas can enter the generator system for power generation and the electricity generated is used for the operation of AWMS and the 4 existing swine farm and the biogas is flared through the opened flaring if there is any surplus biogas.

Aerobic composting process

The separated solid after solid-liquid separated and the sludge produced from anaerobic digestion are transported to the aerobic composting workshop to be mixed with high-efficiency microbial fermentation bacteria. The aerobic composting process of this project adopts trough composting. The trough composting system combines controlled ventilation and regular turning. The composting process takes place in long and narrow passages called "troughs". The trough composting system is generally equipped with a vent pipe or a gas distribution device installed on the trough. When turning over, the air blower is used to supply the oxygen required for fermentation. The composting cycle of the blast trough composting system is 2-4 weeks.

The proposed project was implemented in 4 swine farms and the technology implemented at each swine farm was same. while the treatment capacities of each AWMS and the size of each swine farm and corresponding design of the AWMS was different. The processing capacity and equipment of the system are designed according to the size of the farm. The volume for original uncovered anaerobic lagoons and the equipment parameters used of each swine farm are shown in the following Table 1-3:

The start construction date, start commissioning date and the start operation date of the 4 swine farm involved in this project are shown in the Table 1-2:

Table 1-2 the Start construction date, commissioning date, operation date of the 4 swine farm

Swine farm	Start construction date	Start Commissioning date	Start operation date
Siyang Aiyuan Farm	25-February-2020	29-May-2020	10-June-2020
Dongtai Jianggang Farm	01-March-2020	01-June-2020	10-June-2020
Sheyang Linhai Farm	27- February-2020	30-May-2020	10-June-2020
Siyang Nanliuji Farm	25-February-2020	28-May-2020	10-June-2020

In this monitoring period from 10-June-2020 to 31-December-2021, The proposed project involving average 94,708 heads of commercial pigs, 51,847 heads of breeding pigs. Live pigs are kept for 180 days in the farms before shipment and are totally to produce 337,920 tons of manure and 20,275,217.28 m^3 of biogas produced in this monitoring period.

Table1-3 The main technical parameters of equipment involved in this project

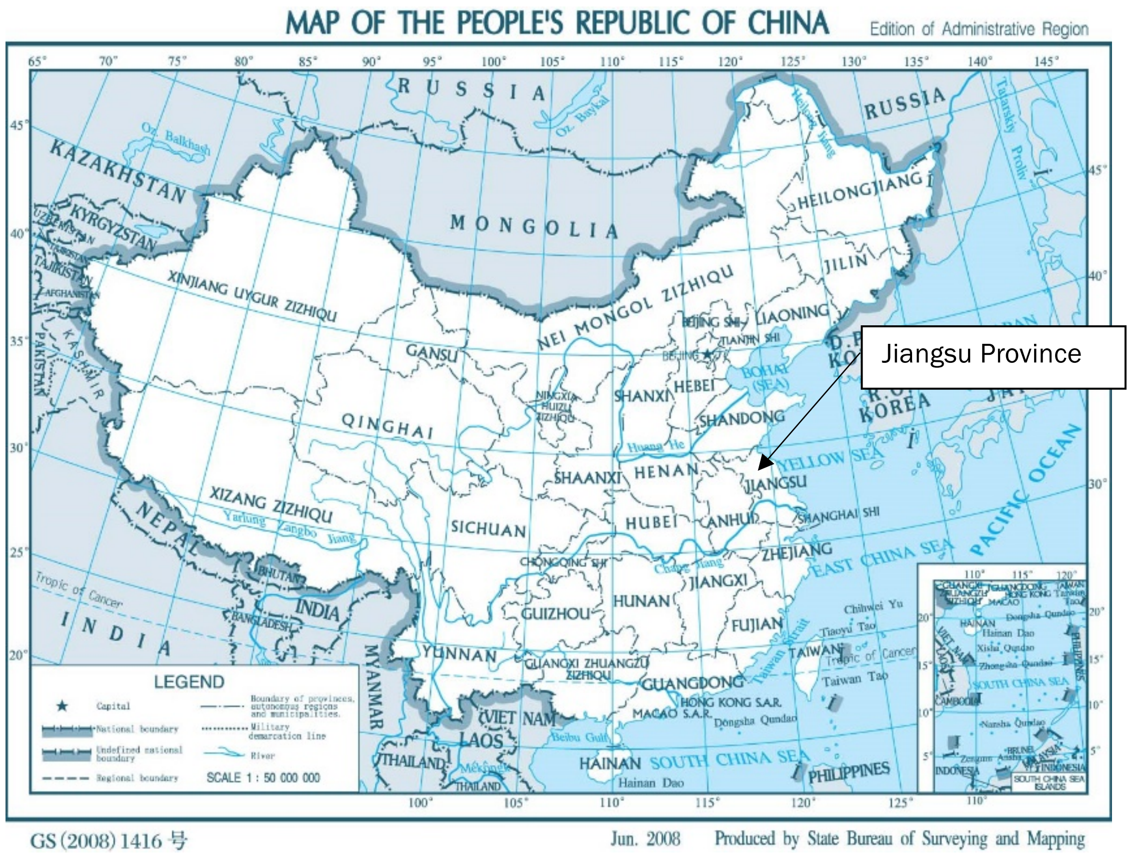
Farm name	Siyang Aiyuan farm	Dongtai Jianggang Farm	Sheyang Linhai farm	Siyang Nanliuji farm
Treatment capacities of AMMS(t/d)	120	180	85	300
Baseline anaerobic lagoon				
Size of baseline anaerobic lagoon (m^3)	50*80*3	80*70*3	50*80*3	80*90*3
technical life	No Less than 15 years			
Biogas Generator				
Type	C480D5E	C750D5E	C350D5E	C1200D5E
Electricity power(kw)	480	750	350	1200
Rated Current (A)	450	450	450	450
Rated speed (rpm)	1500	1500	1500	1500
Equipment Quantity	1	1	1	1
Equipment technical life	No Less than 30 years			
Anaerobic tank				
Design capacity (m^3)	2000	3000	1500	5000
Anaerobic technology	UASB	UASB	UASB	UASB
Stay time(day)	15.5-16	15.5-16	15.5-16	15.5-16
Fermentation temperature(℃)	35-38	35-38	35-38	35-38
Equipment Quantity	1	1	1	2
Equipment technical life	No Less than 15 years			
Turnover machine				
Type	FP-2800	FP-2800	FP-2800	FP-3800
Speed of work(m/h)	6.85	6.85	6.85	6.85
walking width (mm)	2800	2800	2800	3800
flip speed (rpm/min)	50	50	50	50
Equipment Quantity	1	1	1	1
Equipment technical life	No Less than 15 years			
Flared system				
Open flare	Open flare	Open flare	Open flare	Open flare
Material	304 stainless steels	304 stainless steels	304 stainless steels	304 stainless steels
Height (m)	3.5	3.5	3.5	3.5
Main wall thickness (mm)	3	3	3	3
Equipment technical life	No Less than 15 years			

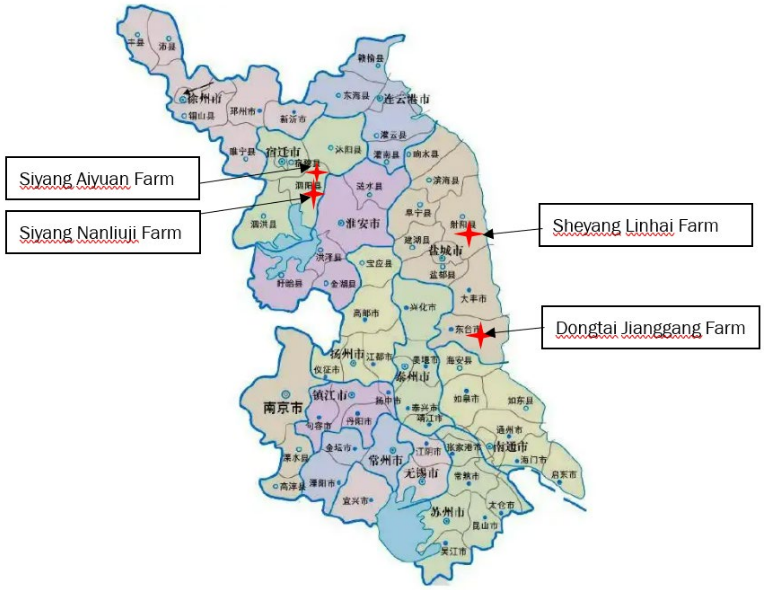
1.12 Project Location

The project is located in Jiangsu Province, China. There are four subsidiary farms involved in the project. Among the 4 farms, 1 farm is a fattening farm with only commercial pigs (Siyang Nanliuji farm), and the remaining 3 farms including market swine and breeding swine: Siyang Aiyuan farm, Dongtai Jianggang farm and Sheyang Linhai farm. The specific location of the four subsidiary farms is shown in table 1-4 and Figure 1-2:

Table 1-4 The location of the nine subsidiary farms in this project

Swine farm	Location	North latitude	East longitude
Siyang Aiyuan Farm	Aiyuan village, Siyang county, Suqian City	33.954582091°	118.655479148°
Dongtai Jianggang Farm	Jianggang Town, Dongtai City	32.713709053°	120.891217509°
Sheyang Linhai Farm	Linhai Town, Sheyang County, Yancheng City	34.061443924°	120.264208749°
Siyang Nanliuji Farm	Nanliuji Village, Siyang county, Suqian City	33.800379189°	118.677887823°





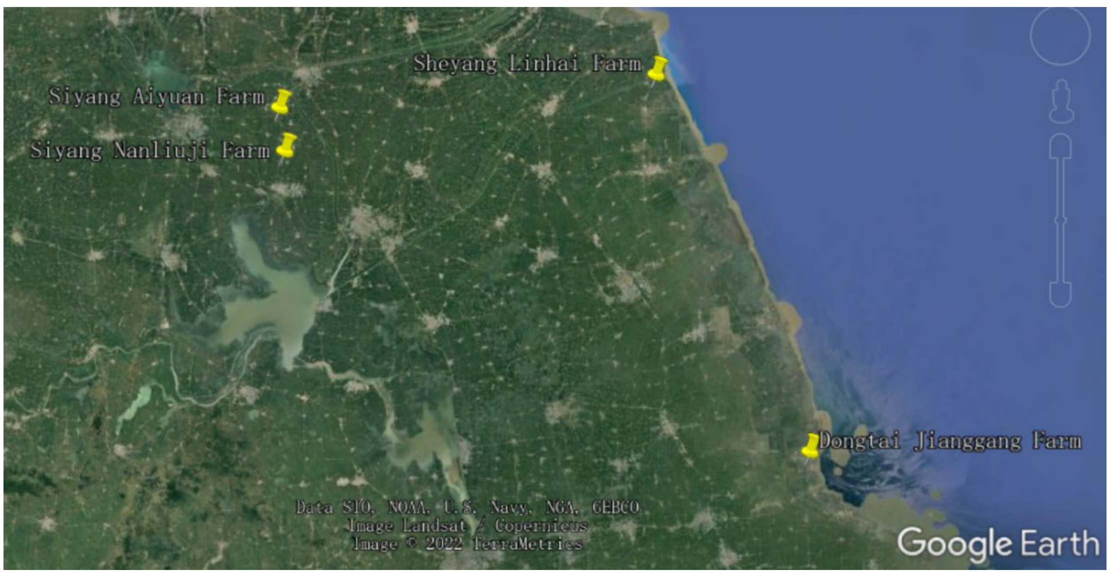


Figure1-2. The Geographic location of the four subsidiary farms in this project

1.13 Conditions Prior to Project Initiation

The project is a Greenfield project. Thus, there are no project activities at the project sites before the construction of the proposed project activities. The baseline scenario is the same as the conditions existing prior to the project initiation. Refer section 3.4 of the JPM for detailed baseline scenario.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

According to the approval of Environmental Impact Assessment (EIA) of the project, the project complies with all Chinese relevant laws and regulations. Mainly include:

1. Farmland Irrigation Water Quality Standard (GB5084-2005);

2. Odor Pollutant Discharge Standard (GB14554-93);

3. Comprehensive Emission Standards for Air Polluted Areas (GB16297-1996);

4. Boiler Air Pollutant Emission Standard (GB13271-2014);

5. Environmental Noise Emission Standard for Industrial Enterprise Boundary (GB12348-2008);

The project obtained the EIA approval from governmental authorities: Jiangsu Provincial Department of Environmental Protection. The approvals well demonstrate that local government permits the construction of the project. Consequently, the project is compliance with laws, status and other regulatory frameworks.

1.15 Participation under Other GHG Programs

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

The project has neither been registered nor seeking registration under any other GHG programs. The project is seeking registration only in VCS program.

1.15.2 Projects Rejected by Other GHG Programs

The project activity is not participating in other environment credits, other GHG programs and has not been rejected by any other GHG Programs.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The project proponent 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. The Project does not reduce GHG emissions from activities that are included in an emissions trading program or any other mechanism that includes GHG allowance trading. There is a cap & trade scheme in China. However, China's national emissions trading scheme (ETS), which is at its very early stage, only includes 2,225 fossil fuel-fired power plants in the power sector[7], and the project proponent is not included in the list. China's ETS is expected to include all companies with annual GHG emissions greater than 26,000 tCO2e in eight emission-intensive industries including power generation, petrochemicals, chemicals, building materials,

[7] http://mee.gov.cn/xxgk2018/xxgk/xxgk03/202012/W020201230736907682380.pdf

non-ferrous metals, papermaking, steel and aviation[8]. As the annual GHG emissions of the project proponent will not be greater than 26,000 tCO_2e, it will not be included in the national ETS; no emission cap will be enforced on the project proponent, nor can it participate in carbon transactions in the national ETS. Therefore, 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.

In addition, the project owner has signed the Declaration of No Double Counting Statement and Declaration of neither been registered and rejected nor seeking registration under any other GHG programs and not participating in other environment credits, other GHG programs other than VCS.

1.16.2 Other Forms of Environmental Credit

The project hasn't sought or received another form of environmental credits.

1.17 Sustainable development contributions

1.17.1 Sustainable Development Contributions Activity Description

The project activity implemented by the project owner can contribute to sustainable development as defined by and tracked against the United Nations Sustainable Development Goals (SDGs). The specific analysis is as follows:

SDG13: Climate Action

Prior to the implementation of the project, the animal manure waste was left to decay in uncovered open lagoon at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure. So, the impact parameter of the proposed project on SDG13 is the amount of GHGs emission reductions. It is estimated that 150,212 tCO_2e emission reductions can be produced annually.

SDG7 Affordable and Clean Energy

The biogas generated during the treatment process are captured for power generation, the electricity generated are all used by the AWMSs and the 4 swine farms, which is supplied by the grid company in baseline scenario. The grid company is dominated by thermal power generation. Therefore, the project activity can provide clean energy and the impact parameter of the proposed project on SDG7 is the amount of electricity generated. It is estimated that 19,254 MWh of electricity generated annually by the project.

SDG8 Decent Work and Economic Growth

[8] http://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html

Temporary and permanent job opportunities are created for locals during the construction and operation period of the project. So, the impact parameter of the proposed project on SDG8 is the number of full-time jobs created. 18 local residents (9 females and 9 males) are employed permanently during the operation period of the project during project implementation and monitoring activities.

1.17.2 Sustainable Development Contributions Activity Monitoring

For this monitoring period covering 570 days, the actual emission reduction is 186,241tCO_2e and 26,889.44 MWh of electricity (please refer to monitored parameter "$EG_{d,y}$" in Section 6.1 of JPM for detail) is generated by the project. Total 18 jobs for local people were created (including 9 females and 9 males). Please see below Table 1-5 for details.

Table 1-5 Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	7.2	7.2.1 renewable energy share in the total final energy consumption	Implemented activities to increase	During this monitoring period, 26,889.44 MWh of electricity through capturing biogas is generated by the project.	This is the 1st monitoring period, therefore, from the operation start date of the project activity to the end of this monitoring period, 26,889.44 MWh of electricity through capturing biogas is generated by the project.
2)	8.3	8.3.1 Proportion of informal employment in non-agriculture employment, by sex	Implemented activities to increase	During this monitoring period, total 18 jobs for local people were created (including 9 females and 9 males) by the project.	The project activity generates permanent job opportunities for 18 persons including 9 females and 9 males during the operation period. From the operation start date of the project activity to the end of this monitoring period, 18 jobs for local people were created (including 9 females and 9 males) by the project.
3)	13.0	Tonnes of greenhouse gas	Implemented activities to increase	During this monitoring period, the project has achieved GHG	This is the 1st monitoring period, therefore, from the operation start date of the project activity

		emissions avoided or removed		emission reductions of 186,241tCO_2e.	to the end of this monitoring period, the project has achieved GHG emission reductions of 186,241tCO_2e.

1.18 Additional Information Relevant to the Project

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.

Commercially Sensitive Information

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

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

The Environmental Impact Assessment (EIA) Report for the Project has been approved by Jiangsu Provincial Department of Environmental Protection. Every aspect of environmental impact has been considered in the EIA report with corresponding measures during project development, the construction of the project is in line with national policies and no net harm has been detected. Meanwhile, the implementation of the project will improve local-socio economic development through creating career opportunities.

2.2 Local Stakeholder Consultation

Local stakeholder consultation was conducted by project owner before the construction of the project and during the monitoring period through the means of meeting and questionnaire.

Local stakeholder consultation before the construction of the project

Invitation procedure

The stakeholder consultation was conducted by Shuangbaotai Animal Husbandry Group Co., Ltd. with assistance from Profit Carbon Environmental Energy Technology (Shanghai) Co., Ltd. Stakeholder groups were identified, and they were informed through oral and written means about the meeting. The invitation letter was sent by email to participants. This invitation email was done 2 weeks before the meeting date.

Place and date of the meeting

The stakeholder consultation was held at a meeting room of Shuangbaotai Animal Husbandry Group Co., Ltd. on 18-February-2020.

Meeting Participants

The meeting was attended by local residents and representatives from the following stakeholder categories:

(i) Local residents/farmers

(ii) Local government representatives

(iii) Representative of the project owner

There were 18 participants who accepted the invitation, attended the meeting and returned the questionnaire. The Information about the stakeholders is summarized as below:

Table 2-1 Information of stakeholder attending the meeting

Items		**Amount**
Gender stakeholders surveyed	Male	9
	female	9
Age	<25	5
	25-55	10
	>55	3
Education	Junior high school or below	2
	Senior high school	12
	College or above	4
Occupation	Worker	4
	Farmer	11
	Management personnel	1
	Civil servant	2

Meeting procedure

- Registration (15 min)

- Opening of the meeting
- Introduction the project in non-technical terms
- Description of the project and environmental impacts and discuss any potential risks and positive impacts of the project
- Purpose of VCS, and relation of the project and VCS
- Question and answer session about the project
- Closure of the meeting

In the stakeholder consultation, all attendees were invited to express their comments. All attendees agreed the construction of the project and believed that the implementation of the project is beneficial. Only some feedback and comments were received, however, these feedbacks mainly focus on the questions of project technology, project mechanism operation and the environmental impact. All the received comments were responded by PP during the meeting and the feedback and response were summarized in Table 2-2. There were no comments on project design and monitoring methods. The minutes of stakeholder meeting was recorded by PP.

Table 2-2 Feedback and response during the meeting

No.	Stakeholder feedback	Response by PP
1	Is it possible for the electricity generated by the project to be used by our local residents?	NO. The electricity generated currently is still not enough to supply to the swine farms. If there is surplus electricity in the future and it will be supplied to local residents within permitted conditions.
2	How to deal with the biogas residue?	After anaerobic digestion, the biogas residue will be treated in aerobic composting system, which will be used as fertilizer. Wastewater from the new animal waste management systems will be treated aerobically and then used for agriculture irrigation.
3	Will the odour of swine farm be improved?	All the manure will be put into closed anaerobic digestion to treat, which will significantly reduce the odour, and improve the working environment of the employees.
4	What is the main energy consumed by the project activity?	Only electricity will be used for the project activity. No Other fossil fuel is need.
5	Will the organic fertilizer produced after the manure treatment be distributed to nearby farmers for free?	Yes. The amount of organic fertilizer produced by the project is determined based on the amount of manure. The organic fertilizer produced will first be distributed to nearby farmers for free. If necessary, please come to receive it. Only surplus fertilizer will

		be sold externally, and the sales price will be lower than the market price.
6	Who is the legal ownership of the carbon credits generated under VCS?	The project is invested and constructed by the project owner, therefore the legal ownership of the credits generated under VCS belongs to the project owner.
7	How long is the total creating period?	10 years from 10-June-2020 to 09-June-2030

Local stakeholder consultation during the monitoring period

In this monitoring period from 10-June-2020 to 31-December -2021, A questionnaire survey was adopted for stakeholder consultation by PP. From 12-June-2020 to 15-June-2020, the project proponent put up public announcements at the villages near every swine farm involved in this project; Also, the project proponent contacted the local authorities (mainly the Ecology and Environment Bureau, Agriculture and Rural Affairs Bureau) by phone. The general information about the introduction of project, the survey date and the purpose of the questionnaire survey as well as the project proponent's phone number and email address were clearly conveyed via these public announcements and phone calls. A questionnaire survey was conducted by project proponent from 22-June-2020 to 28-June-2020. Total 60 questionnaires were distributed, and all questionnaires have been recollected. The basic information about the survey respondents is listed in Table 2-3. Responses and comments from these questionnaires are summarized in Table 2-4.

Table 2-3 Structure of stakeholder survey

Items		Amount
Gender stakeholders surveyed	Male	30
	female	30
Age	<25	6
	25-55	36
	>55	18
Education	Junior high school or below	6
	Senior high school	44
	College or above	10
Occupation	Worker	12
	Farmer	31
	Management personnel	10
	Civil servant	7

Table 2-4 Summary of the survey results in monitoring period

No	Question	Response	Amount
1	Do you know the purpose of this project?	Very much	54

		A little	5
		Not at all	1
2	What do you think is the impact of the implementation of this project on the local environment?	Reduce odor	36
		Improve water quality	14
		Reduce waste pollution	10
		none	0
3	What impact do you think the implementation of this project will have on your life?	Improve the quality of surrounding environment	21
		providing employment opportunities	22
		Free use of fertilizer	17
4	Are you satisfied with the environmental protection measures that the proposed project has made?	Satisfied	60
		Dissatisfied	0
		Indifferent	0
5	What do you think is the impact of the proposed project on local employment?	*Positive*	55
		Negative	0
		None	5
6	What do you think is the impact of the proposed project on local economy?	Positive	59
		Negative	0
		None	1
7	In general, what is your attitude towards the Project construction?	Supportive	60
		Against	0
		Indifferent	0
8	Do you think other regions should also vigorously promote this type of technology?	Yes	51
		No	0
		No idea	9

In order to set up the mechanism for on-going communication with local stakeholders, a grievance book was put in Front Desk Administration of the PP. All stakeholders are allowed to record their grievances or comments in the book at any time.

In all, all the villagers and local government attending the meeting are all supportive of the Project and to date there has been no need to modify the due to the comments received.

2.3 Environmental Impact

The Environmental Impact Assessment (EIA) Report for the Project has been approved by Jiangsu Provincial Department of Environmental Protection. The environmental impacts and mitigation measures during the construction period and the operation period are summarized as follows:

Air pollution in construction period

During the construction period, the exhaust gas from the construction site is mainly dust. The dust was generated in the process of site cleaning, concrete mixing, transportation and stacking of building materials in the construction process, more dust will be generated in dry and rainless weather. The key to reducing the impact of construction dust lies in the management of construction site. The specific measures include: Set a continuous enclosure with a height of no less than 1.8m, Clean and wet all temporary roads. The entrance and exit of the construction site must be equipped with vehicle flushing pool and automatic flushing device for standardized vehicles to ensure that transport vehicles do not carry mud on the road. The main roads on the construction site shall be watered and cleaned in time to prevent dust.

Noise in construction period

The noise during the construction period can be mainly divided into mechanical noise, construction operation noise and construction vehicle noise. The measures that can be taken include: the main mechanical equipment used during construction shall be low-noise mechanical equipment; Arrange noise equipment in a decentralized manner and avoid sensitive points such as residential buildings; The construction time shall be reasonably arranged in strict accordance with the emission standard of environmental noise at the boundary of construction site (gb12523-2011); When entering and leaving the site, vehicles shall be at low speed, no singing and avoid sensitive points;

Wastewater in construction period

Wastewater during the construction period is mainly construction wastewater and domestic sewage of construction personnel. The construction waste water includes the flushing water after pouring concrete, the waste water generated by the ground flushing in the construction area and the flushing of construction machinery, stone and other building materials. For those waste water, temporary sewage simple treatment facilities such as temporary sump and sedimentation tank can be set up on the construction site to treat the construction waste water and reuse it or sprinkle water on the construction site. It is strictly prohibited to discharge it into the surface water body. For domestic wastewater, it can be cleaned regularly after being treated in septic tank and used for fertilization of surrounding farmland to realize resource utilization.

Solid waste in construction period

The solid wastes generated during the construction period are mainly excavated earth, construction waste and domestic waste; The excavated earthwork of the project can be excavated and filled in balance, and the construction waste and domestic waste can be regularly sent to the waste disposal site near the plant site. Therefore, the solid waste during the construction period will not have a significant impact on the surrounding environment.

Wastewater in operation period

Strengthen the prevention and control of wastewater pollution. The project shall implement the separation of sewage and rainwater. The waste liquid generated from gas-water separation and gas purification and plant domestic sewage will be remitted to the biogas facility for treatment. digested effluent will be used to irrigate the surrounding crops after treatment and is not allowed to be discharged to the surrounding water bodies.

Gas pollution in operation period

Strengthen the prevention and control of waste gas pollution. The collection pond and anaerobic digestion should seal well in order to reduce emission of malodorous gases. In the process of organic fertilizer production, waste gas collection and treatment measure shall be implemented as design plan. Strengthen solid waste pollution prevention. All biogas residues are used for organic fertilizer production.

Solid waste in operation period

Strengthen solid waste management. All digestate is used for organic fertiliser production. Waste desulfurizers should be collected centrally and disposed of properly in accordance with the relevant regulations on solid waste management. The company's solid waste temporary storage site should be impermeable, rainwater scouring and have sewage collection measures to avoid secondary pollution.

In conclusion, the project will not have a significant negative impact on the surrounding environment during both construction and operation period. On the contrary, the implementation of the project will significantly improve the quality of the local environment, achieve environmentally sound treatment of agricultural organic waste, reduce the impact of agricultural organic waste on surface water and groundwater, and reduce greenhouse gas emissions. In addition, biogas incineration saves fossil fuels used to generate electricity and contributes to sustainable development.

2.4 Public Comments

The proposed project (VCS ID: 2706) was open for public comments for 30-days from 04-January-2022 to 03-February-2022 on the website of Verra Registry[9]. During the publicity period, no comments were received for the Project.

2.5 AFOLU-Specific Safeguards

Not applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The following methodologies are applicable to the project activity.

ACM0010" GHG emission reductions from manure management systems (Version 08.0)[10]".

The latest version of the following tools will also be used in this Project activity:

[9] https://registry.verra.org/app/projectDetail/VCS/2706

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

Tool 02: “Combined tool to identify the baseline scenario and demonstrate additionality(version07.0)[11]”

Tool 05:” Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 3.0)[12]”

Tool 06:” Project emissions from flaring (Version 4.0)[13]”

Tool 08: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version03.0)[14]”

Tool 14: “Project and leakage emissions from anaerobic digesters (Version 02.0)[15]”

Tool 24:” Common practice (Version 03.1)[16]”

3.2 Applicability of Methodology

Justification for the choice of the selected methodology is shown in the following table:

Table 3-1 Applicability of methodology

ACM0010 (Version 08.0)” GHG emission reductions from manure management systems”	
Applicability Criteria	**Justification**
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.	For this project, 4 sets of new AWMS are installed in 4 existing swine farms in order to treat the manure and wastewater from these swine farms, which avoids methane emissions generated in the baseline uncovered anaerobic lagoons. The biogas generated during the treatment process is be captured for power generation and all the electricity is used by the operation of AWMSs and 4 swine farms and is not connected to another user or to the regional power grid.
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.	The project activity will replace the current open anaerobic lagoons with 4 new AWMSs. After solid-liquid separation, the solid are treated in aerobic composting system, which are used as fertilizer. The liquid is treated through anaerobic digestion and the biogas generated during the treatment process is captured for power generation, the sludge produced from anaerobic digestion are treated through aerobic composting together with the solid, the effluent is used for agriculture irrigation. The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure and wastewater.

11 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-7.0.pdf/history_view
12 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-3.0.pdf/history_view
13 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-3.0.pdf/history_view
14 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-3.0.pdf/history_view
15 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v2.pdf/history_view
16 https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf

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-permeable layer at the lagoon bottom.	(a) This project introduces new AWMSs to a group of 4 swine farms owned by by Shuangbaotai Animal Husbandry Group Co., Ltd. [17], which is one of the leading national leading agricultural enterprises with the largest scale of swine farming in the country, also, all the swine farms of the project have obtained the licenses for production and operation of the breeding livestock and poultry issued by local government. So, the farms in the project boundary contain swine populations. All swine is managed under confined conditions, which can be confirmed during site visit. (b)The swine manure is dumped into open anaerobic lagoons and it is prohibited to discharge into any natural water resources without treatment according to Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming. (c) The open anaerobic lagoons considered in the baseline scenario are designed for deep storage and has a depth of 3-5 meters in accordance with the" design code for wastewater stabilization ponds (GJJ/T54-93)". (d) The annual average ambient temperature at the site is 15.3°C[18], which is higher than 5°C. (e)The minimum retention time of manure waste in the open anaerobic lagoons is not less than 45 days, i.e., as least 60 days in the baseline scenario[19]. (f) In the project case, the manure is utilized to produce fertilizer after methane capture. Also, the related equipment such as anaerobic tank adopts anti leakage and anti-permeability materials. So, no leakage of manure waste is possible.

Table 3-2 Applicability of Tool 02

Tool 02: "Combined tool to identify the baseline scenario and demonstrate additionality(version07.0)"	
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 install new AWMS to a group of 4 swine farms to treat the swine manure and wastewater from the 4 swine farm to avoid methane emissions generated in the baseline uncovered anaerobic lagoons. Alternative scenarios, barrier analysis, investment analysis and common practice analysis is carried out based on Tool 02. Refer to section 3.4 and 3.5 of the JPM for more details.

[17] http://www.sbtjt.com/gysbt.jhtml?page=0
[18] http://jiangsu.china.com.cn/html/jsnews/around/4842719_1.html
[19] https://mbd.baidu.com/newspage/data/landingsuper?context=%7B%22nid%22%3A%22news_9639404512015689726%22%7D&n_type=-1&p_from=-1

Table 3-3 Applicability of Tool 05

Tool 05: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)"	
If emissions are calculated for electricity consumption, the tool is only applicable if one out of the following three scenarios applies to the sources of electricity consumption: (a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer; (b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or (c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid.	The electricity generated by the project was used firstly for the operation of AWMSs normally, then the excess electricity was supplied to the swine farms. In the condition of no electricity generated, the electricity used by the project is supplied by East China Power Grid (ECPG)[20], 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.
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 applied for calculating for emission by electricity consumption in project activity. So, this criterion is not applicable.
This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO_2 emissions.	Tool 05 is only used to calculate project emissions of electricity consumption supplied by ECPG. For conservativeness, baseline emissions of captive biogas power generation system are ignored. Only CO_2 emissions will be accounted.

Table 3-4 Applicability of Tool 06

Tool 06: "Project emissions from flaring (version04.0)"	
This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.	The biogas generated during the treatment process is captured for power generation and the residual biogas is flared if there is any surplus biogas. One opened flare is constructed in each swine farm; Total 4 flares are used by the project activity.

[20] https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/t20201229_815386.shtml

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).	The source of the residual biogas of the project activity is from anaerobic treatment process of the swine manure (biogenic source). As per Project Evaluation Report of the project, methane accounts for 60% of the biogas, which is the highest concentration in the flammable residual gas.
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. As per Project Evaluation Report of the project, methane accounts for 60% of the biogas. And methane is a kind of flammable gas. Operating specifications were provided by the manufacturer of the flare.

Table 3-5 Applicability of Tool 08

Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version03.0)"	
Typical applications of this tool are methodologies where the flow and composition of residual or flared gases or exhaust gases are measured for the determination of baseline or project emissions.	The amount of biogas produced from the anaerobic digestion is collected and monitored. Refer to section 5.2 of the JPM for more details.
Methodologies where CO_2 is the particular and only gas of interest should continue to adopt material balances as the means of flow determination and may not adopt this tool as material balances are the cost-effective way of monitoring flow of CO_2	The biogas generated during the treatment process including CH_4, H_2S、O_2 and etc, therefore this tool is adopted used for determining the mass flow of a greenhouse gas.
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 JPM. b) The mass flow is determined in the monitoring plan of the JPM. 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.

Table 3-6 Applicability of Tool 14

Tool 14: "Project and leakage emissions from anaerobic digesters (Version 02.0)"	
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	The electricity generated by the project was used firstly for the operation of AWMSs normally, then the excess electricity was supplied to the swine farms. Unless no electricity generation for this project, the electricity consumption of the project was supplied by the grid company, and the anaerobic digestion process of this project does not involve the use of fossil fuels. The project activity uses flushing system to collect the manure automatically. All the manure and wastewater are collected and then be separated first. The solid are treated

(d) CH_4 emissions from flaring of biogas.	in aerobic composting system and the organic fertilizers are produced, most of the fertilizer is distributed to local farmers for free and only a small portion are sold as fertilizer. The liquid is treated through anaerobic digestion and the biogas generated during the treatment process is captured for electricity generation. The sludge produced from anaerobic digestion are treated through aerobic composting together with the solid, the effluent is supplied to the farmers living around free for agriculture irrigation. There was no biogas for flaring during this monitoring period. If there is any surplus biogas for flaring during in 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).
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 activity replaces the current open anaerobic lagoons with 4 new closed anaerobic digesters. The biogas generated during the treatment process is captured for power generation. After anaerobic digestion, the fermented sludge is treated in aerobic composting system, which are used as fertilizer. In this project, there was no additional storage yard to store the sludge produced from anaerobic digestion. Therefore The leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) should not be taken into account for this project.
Emission sources associated with N_2O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid digestate and land application of the digestate are neglected because these are minor emission sources or because they are accounted in the methodologies referring to this tool.	Emission sources associated with N_2O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid digestate and land application of the digestate are neglected because these are minor emission sources.

Table 3-7 Applicability of Tool 24

Tool 24: Methodological tool: "common practice (version03.1)"	
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 (Version07.0) is applied to identify the baseline scenario by the project.
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 Combined tool to identify the baseline scenario and demonstrate additionality is referred by ACM0010 methodology.

3.3 Project Boundary

As per ACM0010" GHG emission reductions from manure management systems" (version 08.0), the spatial extent of the project boundary encompasses the site of the AWMS(s), including the flare or energy and/or heat generation equipment and the power/heat source.

The proposed project boundary considers the GHG emissions that come from AWMS, including the GHG emissions from the anaerobic digesters, GHG emissions from the power generation equipment, GHG emissions from sludge treatment by aerobic composting and GHG emissions from opened flaring system in 4 swine farms. The baseline situation is shown in Figure 3-1 below.

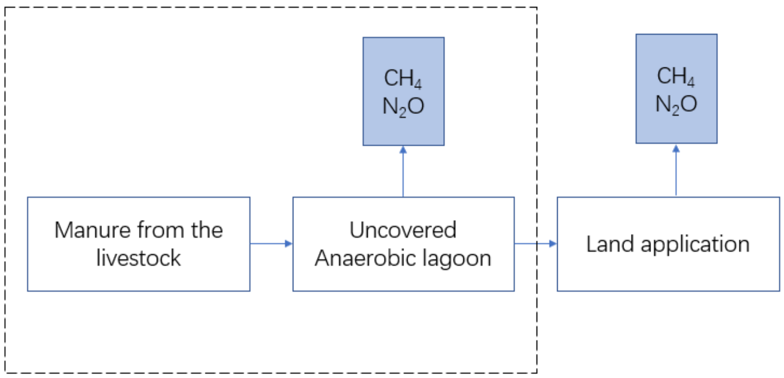


Figure 3-1 The baseline situation in the swine farms

The project activity boundary is defined as Figure 3-2 below.

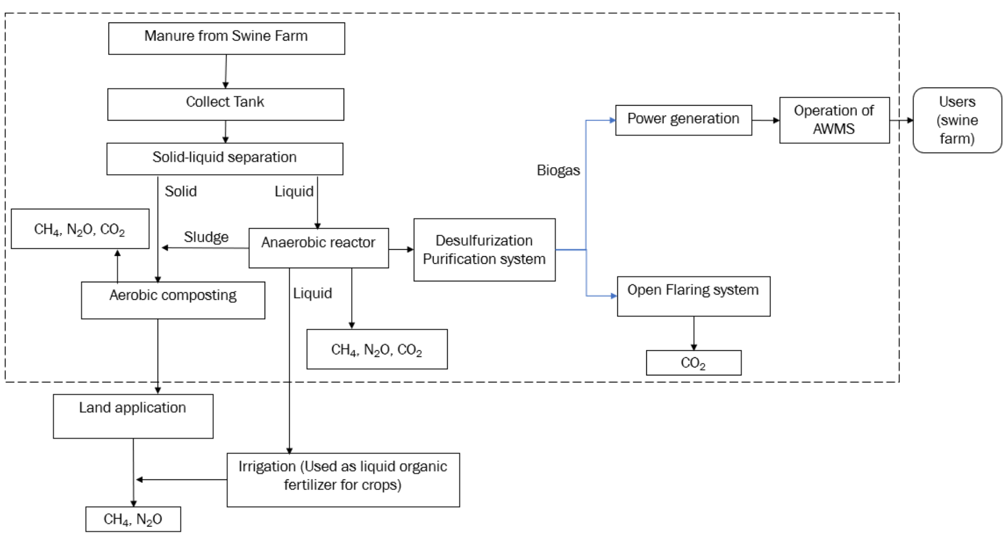


Figure 3-2 The project boundary of the project (It is the same for each farm since the same technology applied for the 4 swine farms)

Furthermore, as per the paragraph 49 of the applied methodology ACM0010(Version 08.0), leakage covers the emissions from land application of treated manure as well as the emissions related to anaerobic digestion in a digester, occurring outside the project boundary. Therefore, leakage should be calculated as per the requirement of applied methodology.

The greenhouse gases included or excluded from the project boundary are summarized in Table3-8 below.

Table 3-8 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	Excluded for simplification. This is conservative.
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from thermal energy generation	CO_2	No	Excluded for simplification. This is conservative.
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project	Emissions from thermal energy use	CO_2	No	Excluded for simplification. This project does not use thermal energy.
		CH_4	No	Excluded for simplification. This project does not use thermal energy.
		N_2O	No	Excluded for simplification. This project does not use thermal energy.
	Emissions from on-site electricity use	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.

Source		Gas	Included?	Justification/Explanation
	Emissions from the waste treatment processes	N_2O	Yes	Direct and indirect N_2O emissions are accounted
		CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Yes	The emission from anaerobic digesters and aerobic treatment

3.4 Baseline Scenario

Baseline scenario has been identified using the methodological tool 02 "Combined tool to identify the baseline scenario and demonstrate additionality (Version07.0)" considering the requirements of the methodology and assessing the possible waste management options as described in 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 4, Chapter 10, Table 10.17).

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" (Version07.0), this step is optional. So, it is not necessary to analyse this step.

Step1: Identification of alternative scenarios

Step 1a: Define alternative scenarios to the project activity

Prior to the implementation of the project, all manure waste produced from the existing 4 swine farms was left to decay in 4 uncovered anaerobic lagoons at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. The uncovered anaerobic lagoons were replaced by 4 sets of AWMSs in these 4 swine farms for this project. Therefore, it belongs to the existing facilities.

According to methodology, baseline alternatives for managing the manure for the existing facilities, shall take into consideration, inter alia, the complete set of existing/possible manure management systems listed in 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 3-9 as 2006 IPCC:

Table 3-9 The baseline and available alternatives for the manure management listed in 2006 IPCC

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 to remove the manure and apply on a daily basis. Therefore, this manure management system is not in an economically attractive prospect. So, the exclusion of this potential baseline scenario can be justified.
3	Solid Storage: The manure is disposed by solid storage.	Not Applicable	This involves the storage of manure, typically for a period of several months, in unconfined piles or stacks. It is only a storage method of manure, not a disposal method. In addition, it is suitable for small family farms. The proposed project involves large-scale swine farms and the use of a scraping and flushing approach to remove manure which has large volumes of water. So, 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 the swine farms in the project. This method is only a storage method of manure, not a disposal method. So, this system is excluded.
5	The manure is disposed 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. 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”, the uncovered anaerobic lagoon is a kind of harmless treatment of liquid manure. After being treated in the uncovered anaerobic pond, the liquid can be used for agricultural irrigation, the solid can be composted, and the fertilizer can be used by local farmers for farming. Animal waste that has been treated by uncovered anaerobic lagoon can satisfy the above regulations. However, these regulations have not yet imposed any restrictions on GHG emissions. So, the

			uncovered anaerobic lagoon is a 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 Treatment system）	Applicable	A single Anaerobic digester is suitable for treating manure, but to implement such technology need high invest compared to 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. At present a combine Anaerobic Digester-Aerobic Treatment system is considered to be one of the most advanced manure management systems, but to implement such technology need high invest and the proposed project will not be invested and constructed without being registered as a VCS project.
9	Burned for fuel	Not Applicable	The farms involved in this project are large scale swine farm, the manure is flushed to the anaerobic digester, the dung and urine generated from the farm is too large even on a daily basis, so it is unlikely to dry the dung before using as fuel.
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 nocuous 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, the deep bedding practice is excluded from consideration. This system is more applicable to small scale farms.
	Cattle and Swine deep Bedding, >1month	Not Applicable	

11	Composting - In-vessel	Not Applicable	It is suitable to treat solid manure and is not applicable to the manure with large amount of water. Manure in this project is collected by using scraping and flushing system. Manure in this project is in liquid with large volume of water. Therefore, it is excluded from the possible baseline scenario.
12	Composting - Static pile	Not Applicable	Composting in piles with forced aeration but no mixing will consume a great deal of electricity for forced aeration because of the large quantity of swine manure. It is suitable to solid treat manure, not applicable for manure with larger volume of water. Therefore, it is excluded from the list of possible baseline scenarios.
13	Composting - Intensive windrow	Not Applicable	Composting in windrows with regular turning for mixing and aeration emits a large quantity of odor and GHGs during turning and consumes a lot of electricity for the aeration operation. It is suitable to treat solid manure. So, it is excluded from the list of possible baseline scenarios.
14	Composting – Passive windrow	Not Applicable	Composting in windrows with infrequent turning for mixing and aeration takes a long time and occupies a large area of land. This kind of solid manure management system emits strong odors and GHGs during turning. For this reason, it is excluded from the list of possible baseline scenarios.
15	Poultry manure with litter	Not Applicable	The farms involved in this project are large-scale swine farm, not the Poultry farm, so no poultry manure produced. This system is excluded.
16	Poultry manure without litter	Not Applicable	The farms involved in this project are large-scale swine farm, not the Poultry farm, so no poultry manure produced. This system is excluded.
17	Aerobic treatment（Anaerobic digester-Aerobic Treatment system）	Applicable	A single aerobic treatment technique is not suitable for treating low concentration organic wastewater in wastewater. This kind of wastewater contains a large amount of highly concentrated organic wastewater, which is difficult to be treated by the aerobic method and does not meet the Chinese environmental quality standards and pollutant discharge standards for discharge to water bodies. At present a combine Anaerobic Digester-Aerobic Treatment system is considered to be one of the most advanced manure management systems, but to implement such technology need high invest and the proposed project will not be invested and constructed without being registered as a VCS project.

Outcome of Step 1a: In summary, the alternatives to the baseline scenario are identified by the tool 02:” Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)”as:

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

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

Step 1b: Consistency with mandatory applicable laws and regulations

There is no legal law and regulation to mandate the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques to treat the animal manure in China. Only the manure is prohibited to discharge directly into environment without any treatment as per Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming[21] issued by the State Council in Nov. 2013.

According to "Technical specification for sanitation treatment of livestock and poultry manure[22]", in China, the uncovered anaerobic lagoon is a kind of manure treatment method recognized by the state, which need minimum financial cost and is compliance with laws and regulations. Therefore, it is the most economic, viable and reasonable for livestock farm owners. As per "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)[23]"and *Jiangsu Province's Work Plan for Promoting the Return of Livestock and Poultry Manure to Land Use and Strengthening the Supervision of Farming Pollution in accordance with the Law* issued by Department of Agriculture and Rural Affairs of Jiangsu Province, Department of Ecology and Environment of Jiangsu Province[24], anaerobic digester, aerobic treatment or other biological treatment techniques methods to dispose manure waste are encouraged by the state and not mandatory.

Therefore, the Scenario 6: "The manure is disposed in an uncovered anaerobic lagoon" and Scenario 8&17: Anaerobic Digester-Aerobic Treatment are all Consistency with mandatory laws and regulations. So, 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.

Step 3: Investment analysis

Undertake investment analysis of all the alternatives that don't face any barriers, as identified in Step II. For each alternative, all costs and economic benefits attributable to the waste management scenario should be illustrated in a transparent and complete manner. Table 3-10 shows the investment analysis results of the uncovered anaerobic lagoon.

[21] http://politics.people.com.cn/n/2013/1126/c1001-23662445.html
[22] https://oss.baigongbao.com/2020/12/14/MRyhTKQcWC.pdf
[23] http://www.moa.gov.cn/gk/tzgg_1/tfw/201801/t20180111_6134801.htm

[24] http://coa.jiangsu.gov.cn/art/2020/10/29/art_11977_9551365.html

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

Costs and benefits	1	2-15	16
Cash inflow	**0.00**	**0.00**	**0.00**
Revenues from organic fertilizers sales	0.00	0.00	0.00
Subsidy income	0.00	0.00	0.00
Fixed assets residue value	0.00	0.00	0.00
Recovered current capital	0.00	0.00	0.00
Cash outflow	**6.80**	**2.80**	**2.80**
Construction investment	4.00	0.00	0.00
Current capital	0.00	0.00	0.00
O&M cost	2.80	2.80	2.80
Sales tax and associate charge	0.00	0.00	0.00
Net cash flow	**-6.80**	**-2.80**	**-2.80**
NPV (discount rate=9%)	**¥-26.94**		

There are no potential revenues involved in the baseline scenario. There are only negative flows in the baseline scenario, so the economic comparison should be based on the Net Present Value (NPV) indicator. Table 3-11 summaries the results of financial analysis of Anaerobic Digester-Aerobic Treatment without VCU revenues.

Table 3-11 Investment analysis of the Anaerobic Digester-Aerobic Treatment without VCU revenues（10^4 RMB）

Costs and benefits	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11-15**	**16**
Cash inflow	**0.00**	**1,460.16**	**1,460.16**	**1,347.88**	**1,248.00**	**1,248.00**	**1,248.00**	**1,248.00**	**1,248.00**	**1,248.00**	**1248.00**	**1636.08**
Revenues from organic fertilizers sales	0.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00	1248.00
Subsidy income	0.00	212.16	212.16	99.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fixed assets residue value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	624.00
Recovered current capital	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	300.00
Cash outflow	**5,153.87**	**897.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**	**771.69**
Construction investment	5153.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Current capital	0.00	126.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M cost	0.00	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23
Sales tax and associate charge	0.00	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46	25.46

Adjustment of income tax	0.00	44.30	49.83	27.48	7.48	11.80	16.25	20.86	25.62	30.53	35.13	35.13
Net cash flow (after tax)	**-5,153.87**	**518.17**	**638.64**	**548.71**	**468.83**	**464.52**	**460.06**	**455.46**	**450.70**	**445.79**	**441.19**	**829.27**
NPV (discount rate=9%)	**¥-1,018.81**											

(a) Basic parameters

Table 3-12 Basic parameters used in investment analysis

item	value	source
Annual organic fertilizers sales	48,000t	Project evaluation report
Price of organic fertilizers	260 RMB/t	Project evaluation report
Total static investment	5,153.87*10^4RMB	Project evaluation report
O&M cost	746.23*10^4RMB	Project evaluation report
Operation period	15 years	Project evaluation report
Emission reduction	150,212 tCO_2e	Calculated
VCU Price	15 RMB/ton	Expected

(b) Comparison of NPV for the project activity without VCS revenues and uncovered anaerobic lagoon

Table 3-13 NPV Comparison (Uint:10^4RMB)

Item	Uncovered anaerobic lagoon	The project activity without VCS revenues
NPV	-26.94	-1,018.81

The net cash flow of uncovered anaerobic lagoon is negative. As the result, the financial analysis is based on NPV comparison. NPV of project activity without VCS revenues is much lower than the NPV of current uncovered anaerobic lagoon. Therefore, uncovered anaerobic lagoon is much more economic attractive and should be chosen as baseline scenario.

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 Para 27 of methodological tool 27" Investment Analysis" (Version 11.0), 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 organic fertilizers sales 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 organic fertilizers sales
- O&M cost

The variation range of -10%~10% is conducted and the results of sensitivity analysis of the three parameters of the project activity are shown in the Table 3-14, Table 3-15 and Table 3-16.

Table 3-14 Sensitivity analysis of NPV on total static investment（10^4 RMB）

Item	-10%	-5%	0	5%	10%
The project activity without VCS revenues	-545.98	-782.39	-1,018.81	-1,255.22	-1,491.64
Uncovered anaerobic lagoon	-26.58	-26.76	-26.94	-27.13	-27.31
Critical point that the project activity becomes more financial attractive than uncovered anaerobic lagoon			-20.98%		

Total static investment decreasing about 20.98%, the project activity becomes more financial attractive than uncovered anaerobic lagoon. 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 in the past years. Also, now, the project has been completed, as per the anaerobic tank purchase contract, electricity generators purchase contract, Turnover machine purchase contract and the project EPC Contract, the project actual investment has reached 55.859 million RMB, exceed the total static investment of 51.5387 million RMB, Therefore, the it is not likely to implement the project activity through decreasing the total static investment by 20.98%.

Table 3-15 Sensitivity analysis of NPV on annual organic fertilizers sales（10^4 RMB）

Item	-10%	-5%	0	5%	10%
The project activity without VCS revenues	-1,588.24	-1,290.30	-1,018.81	-746.78	-473.52
Uncovered anaerobic lagoon	-26.94	-26.94	-26.94	-26.94	-26.94
Critical point that the project activity becomes more financial attractive than uncovered anaerobic lagoon			18.15%		

Annual organic fertilizers sales increasing about 18.15%, the project activity becomes more financial attractive than uncovered anaerobic lagoon. the organic fertilizers are produced through the aerobic composting system, which is determined by the manure of the swine farm. Since the scale of the swine farm will stay stable in the future, at the same time, sales of organic fertilizers are only a small part of the total organic fertilizers' generation and the price of organic fertilizers is determined by the raw material, production technology, the quality of organic fertilizer and so on. the organic fertilizers produced by the project belong to semi-finished Products (or called compost), which is harmless but not reaching the Chinese organic fertilizer standard. It can be directly applied to farmland or sold to commercial organic fertilizer plants for further processing. The price of the semi-finished products is lower than the commercial organic fertilizers. And according to the sale agreement of organic fertilizer, the organic fertilizer is sold to local agricultural company and local organic fertilizer plant with the fixed price i.e., 260 RMB/ton. Therefore, it is not possible for annual organic fertilizers sales to increase 18.15%.

Table 3-16 Sensitivity analysis of NPV on O&M cost（10^4 RMB）

Item	-10%	-5%	0	5%	10%

The project activity without VCS revenues	-617.04	-818.12	-1,018.81	-1,218.60	-1,424.82
Uncovered anaerobic lagoon	-24.62	-25.78	-26.94	-28.11	-29.27
Critical point that the project activity becomes more financial attractive than uncovered anaerobic lagoon		-24.61%			

O&M cost decreasing about 24.61%, the project activity becomes more financial attractive than uncovered anaerobic lagoon. However, the decrease of it is not likely to occur. The annual O&M cost of the project includes Maintenance expense, Salary, Welfare, Labor insurance expense. Housing fund expense and insurance expense. Based on "China National Statistical Yearbook, 2021[25]", the average salary of people employed kept rising from 2018 to 2020 (from 49,575 RMB to 5,7727RMB). 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 of 24.61% in O&M cost is not realistic.

As shown in the sensitivity analysis above, it can be conclusive that uncovered anaerobic lagoon is the most economically attractive option than the project activity.

In summary, 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 VCS 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.

3.5 Additionality

Additionality for the project activity is demonstrated using Tool 02 Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0). Step 1-3 were already done in section 3.4 of this JPM.

Investment analysis has been conducted in section 3.4. As per Tool 24 Common practice (Version 03.1), Step 4 common practice analysis will be conducted as follows:

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 for power generation or flared. 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.

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

[25] http://www.stats.gov.cn/tjsj/ndsj/2021/indexch.htm

The proposed project is belonged to type (D) measure listed in the latest version of the Tool 24 "Common practice (Version 03.1)", 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 Tool 24 "Common practice (Version 03.1)", available on the UNFCCC website is applied as below:

Sub-step 4a.1: calculate applicable capacity or output range as +/-50% of the total design capacity or output of the proposed project activity.

For this project, 4 swine farms involving 99,450 heads of marketing pigs, 54,252 heads of breeding pigs in stock are included, and are estimated to produce 246,740 tons of manure every year, Therefore, the projects belong to "methane formation avoidance" and can handle manure from 123,370 tons to 370,110 tons are included.

Sub-step 4a.2: identify similar projects (both CDM and non-CDM) which fulfill 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, Jiangsu province is considered to be a geographical area with comparable investment climate and is selected for geographical boundaries of common practice analysis.

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

As described above, the project installs new AWMSs to treat the manure from 4 existing swine farms, which can avoid methane emissions generated in the baseline uncovered anaerobic lagoons. And the measure of the proposed project belongs to "Methane formation avoidance" as per Tool 24"Common practice (version03.1)".

(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 4 existing swine farms avoid methane emissions generated in the baseline uncovered anaerobic lagoons through installing new 4 set of AWMSs. The biogas captured for power generation, which is used for swine farms.

(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;

The proposed project can handle 246,740 tons of animal manure waste annually. If the similar projects can 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 ourput 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 123,370 tons to 370,110 tons annually.

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

The similar project stared commercial operation before the start date of proposed project at 10-June-2020, which is earlier date.

Based on above analysis, it can conclude that the project belongs to "Methane formation avoidance" with handle manure operated before 10-June-2020 and can handle manure from 123,370 tons to 370,110 tons annually in Jiangsu province is the similar project as the proposed project activity.

Sub-step 4a.3: within the projects identified in Step 2, identify those that are neither registered CDM project activities, project activities submitted for registration, nor project activities undergoing validation. Note their number, Nall.

Through searching UNFCC website, CDM website, China CER exchange info-platform, GS website, VCS website, local DRC of Jiangsu Province website[26] and Department of Agriculture and rural affairs of Jiangsu Province[27], there are no similar projects, therefore N_{all}=0.

Sub-step 4a.4: within similar projects identified in Step 3, identify those that apply technologies different that the technology applied in the proposed project activity. Note their number N_{diff}.

N_{diff}=0

Sub-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 analysis above, $N_{all}= N_{diff} =0$, and the factor $F=1-N_{diff}/N_{all}=1-1 =0< 0.2$. Therefore, the result of common practice assessment is: $N_{all}-N_{diff}=0 < 3$ Therefore, the proposed activity is not a common practice in the region.

Conclusion of the assessment and demonstration of additionality

To summarize, "the project activity is undertaken without being registered as a VCS project activity" is not financially attractive to investors, the project activity would not have occurred in

[26] http://fzggw.jiangsu.gov.cn/

[27] http://nynct.jiangsu.gov.cn/

the absence of the incentive provided by the carbon markets. Being registered as a VCS project, the VCUs revenues can alleviate the identified barriers, therefore the proposed project is additional.

3.6 Methodology Deviations

There is no methodology deviation for the project.

4 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

This section details the applicable formulas from the methodologies applied to the project Activity.

The baseline is the AWMS identified through the baseline selection procedure in Section 3.4 of this JPM. As per paragraph 26 of the applied methodology,

Baseline emissions are：

$$BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{elec/heat,y} \qquad \text{(Equation 1)}$$

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)
$BE_{N2O,\ y}$	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)

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

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

where:

$BE_{CH4,\ y}$	Baseline CH_4 emissions in year y (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). 0.00067t/m^3 at room temperature (20℃) and 1am pressure.
MCF_j	Annual methane conversion factor (MCF) for the baseline AWMSj. IPCC 2006 Guidelines, 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}	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%. $MS\%_{Bl,j}$ =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 ndy (number of days treatment plant was operational in year y).

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

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

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 GELT)
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:

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

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 $VS_{LT,y}$.

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

Option 1:

$$N_{LT} = N_{da,LT} * \left(\frac{N_{p,LT}}{365}\right) \qquad \text{(Equation 5)}$$

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:

$$N_{LT} = \frac{\sum_{1}^{365} N_{AA,LT}}{365} \qquad \text{(Equation 6)}$$

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)

There are two types of swine in this project, i.e., market swine and Breeding swine. For market swine, since there is no way to trace the daily stock, so the Option 1 is adopted to calculate N_{LT} for market swine. For Breeding swine, the PP can monitor the daily stock of Breeding swine in a reliable way, discounting dead Breeding swine and discarded them from the productive process from the daily stock. So, the Option 2 is adopted to calculate N_{LT} for Breeding swine.

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

According to applied methodology ACM0010(Version 08.0), this value varies by species and diet. Default values are used, and they are taken from tables 10A-4 through 10A-9 (IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter10).

The proposed project is located in Jiangsu Province, China, Asia. According to Table 10A-7 and 10A-8 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for Market swine and Breeding swine in Asia region is 0.29 m^3 CH_4/kg VS.

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

(a)The MCF_j values given in table 10.17, chapter 10, volume 4, IPCC 2006 Guidelines should be used. MCF_j values depend on the annual average temperature where the anaerobic manure treatment facility in the baseline existed. For this project, the annual average temperature is 15.3°C and the value of 74% is applied.

(b)A conservativeness factor should be applied by multiplying MCF values (estimated as per above bullet) with a value of 0.94, to account for the 20% uncertainty in the MCFj values as reported by IPCC 2006.

ii)Baseline N_2O emissions ($BE_{N2O,y}$)

$$BE_{N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (E_{N2O,D,y} + E_{N2O,ID,y}) \qquad \text{(Equation 7)}$$

where:

$BE_{N2O,y}$	Annual baseline N_2O emissions in (t CO_2e/yr)
GWP_{N2O}	Global Warming Potential (GWP) for N_2O (t CO_2e/tN_2O)
$CF_{N2O-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$E_{N2O,D,y}$	Direct N_2O emission in year *y* (kg N_2O-N/year)
$E_{N2O,ID,y}$	Indirect N_2O emission in year *y* (kg N_2O-N/year)

$$E_{N2O,D,y} = \sum_{j,LT} EF_{N2O,D,j} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,j} \qquad \text{(Equation 8)}$$

where:

$E_{N2O,D,y}$	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). (Estimated with site-specific, regional or national data if such data is available, otherwise use default EF_3 from table 10.21, chapter 10, volume 4, in 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 EF_3.

$NEX_{LT,y}$ Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr) estimated as described in appendix 2

$MS\%_{Bl,j}$ Fraction of manure handled in system *j* (fraction)

N_{LT} Annual Average number of animals of type LT for the year *y* estimated as per equation (5) or (6) (number)

$$E_{N2O,ID,y} = \sum_{j,LT} EF_{N2O,ID} * F_{gasMS,j,LT} * NEX_{LT,y} * N_{LT} * MS\%_{Bl,j} \quad \text{(Equation 9)}$$

where:

$E_{N2O,ID,y}$ Indirect N_2O emission in year *y* (kg N_2O-N/year)

$EF_{N2O,ID}$ 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 EF_4 from table 11.3, chapter 11, volume 4 of 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 EF_4.

$NEX_{LT,y}$ Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/yr) estimated as described in appendix 2

$MS\%_{Bl,j}$ 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) or (6) (number)

Estimation of various variables and parameters for above equations:

(A)Procedure for estimating $NEX_{LT,y}$

Option 1:

$$NEX_{LT,y} = N_{intake} * (1 - N_{retention}) * nd_y \quad \text{(Equation 10)}$$

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:

$$N_{intake} = \left(\frac{GE}{18.45}\right) * \left(\frac{CP/100}{6.25}\right) \quad \text{(Equation 11)}$$

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 "CDM-PDD", national or regional data should be used for the nitrogen excretion $NEX_{LT,y}$, if available. In the absence of such data, default values from table 10.19 of the IPCC 2006, volume 4, chapter 10 may be used and should be corrected for the animal weight at the project site in the following way:

$$NEX_{LT,y} = \frac{W_{site}}{W_{default}} * NEX_{IPCC\ default} \quad \text{(Equation 12)}$$

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)

$$NEX_{IPCC\ default} = N_{rate(T)} * \frac{TAM}{1000} * 365 \quad \text{(Equation 13)}$$[28]

where:

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

For this project, neither specific information on Portion of that N intake nor site-specific national or regional data is available. So, the Option 2 is adopted to calculate $NEX_{LT,y}$.

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

$$BE_{elec/heat,y} = BE_{EC,y} + BE_{HG,y} \quad \text{(Equation 14)}$$

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 is used, so the emission can be excluded for simplification. In addition, the biogas generated during the treatment process in this project is captured for power generation and all the electricity generated from this project is used by the daily operation of AWMS and the 4 swine farms. The electricity generated is not connected to another user or to

[28] This formula refers to the formula 10.30 in chapter 10 volume IPCC2006.

the regional power grid. So, the baseline CO_2 emission from electricity and/or heat used in the baseline is 0, which is conservative.

4.2 Project Emissions

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

Project emissions are estimated as follows:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{EC/FC,y} \qquad \text{(Equation 15)}$$

where：

PE_y	Project emissions in year y
$PE_{AD,y}$	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)
$PE_{N2O,y}$	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)

i) 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 14 "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:

$$PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y} \qquad \text{(Equation 16)}$$

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)

Since the electricity consumption of the anaerobic digestion system cannot be measured separately from the entire AWMS, so the Project emissions from electricity consumption associated with the anaerobic digester and that is not related to the anaerobic digester will be calculated together.

The project emissions from electricity consumption calculated according to the tool 05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation",

$$PE_{EC,y} = \sum_{j,LT} EC_{PJ,J,y} * EF_{EF,j,y} * (1 + TDL_{j,y}) \quad \text{(Equation 17)}$$

Where：

$PE_{EC,y}$	Project emissions from electricity consumption in year y (t CO_2e)
$EG_{PJ,J,y}$	Quantity of electricity consumed by the project electricity consumption source *j* in year *y* (MWh/yr)
$EF_{EF,j,y}$	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*

As biogas is produced during the anaerobic treatment of the project, and the biogas is collected for power generation and all the power is used for the operation of AWMS firstly and then surplus electricity is supplied to the swine farm. So, there is no outsourcing power consumption, i.e., the $PE_{EC,y} = 0$ in pre-calculation. During the monitoring period, the actual electricity consumption from the region grid of the AWMS is calculated according to the actual electricity settlement with the grid company.

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.

In case, there is residual gas stream which will be 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 either on monitored data or default values.

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

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

STEP 2: Determination of the flare efficiency;

STEP 3: Calculation of project emissions from flaring.

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

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

The following requirements apply:

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

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

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

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

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

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

Therefore, option A is adopted to calculate the mass flow of the residual biogas for flaring as per Too 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 60ºC (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 is designed as medium temperature, and the optimal temperature range is 35 ~ 38 ºC. Therefore, the gas temperature measured by the flowmeter does not exceed 60 ºC, it can be demonstrated that the gaseous stream is dry.

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

$$F_{i,t} = V_{t,db} * \upsilon_{i,t,db} * \rho_{i,t} \quad \text{(Equation 18)}$$

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

where:

$F_{i,t}$	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m³ dry gas/h)
$\upsilon_{i,t,db}$	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m³ gas *i*/m³ dry gas)
$\rho_{i,t}$	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m³ gas *i*)
P_t	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	Universal ideal gases constant (Pa.m³/kmol.K)
T_t	Temperature of the gaseous stream in time interval *t* (K)

Step 2: Determination of 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 the case of enclosed flares, in addition the monitoring requirements provided by the manufacturer’s specifications for operating conditions shall be met.

The flares 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 ($\eta_{flare,m}$) 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 in the minute, therefore, fixed value of 0% for the flare efficiency will be applied for this project, and this is for conservative.

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:

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

Where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	Global warming potential of methane valid for the commitment period (tCO_2e/tCH_4)
$F_{CH4,RG,m}$	Mass flow of methane in the residual gas in the minute *m* (kg)
$\eta_{flare,m}$	Flare efficiency in minute *m*

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

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

Where:

$V_{t,db}$	Volumetric flow of the residual gas for flaring in time interval *t* on a dry basis (m^3 dry gas/h)
$\upsilon_{i,t,db}$	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 though the same pipeline, and the temperature and pressure of gaseous stream can be stable. Therefore the $\upsilon_{i,t,db}$ *and* $\rho_{i,t}$ of residual gas will be same with the biogas produced in the anaerobic digester.

As per project evaluation report, there are 133.29*10^4 m^3 biogas which generated in the AWMS will be flared, so the flared biogas volume of 133.29*10^4 m^3 is used in the pre-calculation of emission reductions. While, in the monitoring period, the project emissions from flaring of biogas will be calculated according to the actual flaring mass flow of methane.

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

$PE_{CH4,y}$ was determined following the step 4 of the applied tool “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 side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH4,\ default}$), as follows:

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

where:

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

Estimation of various variables and parameters for above equations:

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

According to the TOOL14" 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 large scale projects defined by CDM, so $Q_{CH4,y}$ 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 anaerobic digestion process. The flowmeters are installed at the outlet of the biogas digesters and the measured on an hourly basis time interval. So 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 in an hourly basis time interval. i.e., $Q_{CH4,y} = \sum_{i=1}^{8760} F_{i,t}$.

The mass flow of greenhouse gas *i* (*Fi,t*) is determined as follows:

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

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

where:

$F_{i,t}$	Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)
$V_{t,db}$	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (m^3 dry gas/h)
$v_{i,t,db}$	Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis (m^3 gas *i*/m^3 dry gas)
$\rho_{i,t}$	Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/m^3 gas *i*)
P_t	Absolute pressure of the gaseous stream in time interval *t* (Pa)
MM_i	Molecular mass of greenhouse gas *i* (kg/kmol)
R_u	Universal ideal gases constant (Pa.m3/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) is the sum of the Project emissions of methane from the anaerobic digester in year y (t CO_2e), the project emissions from electricity consumption associated with the anaerobic digester (if any) and that is not related to the anaerobic digester and the project emission from flaring the biogas (if any). i.e., $PE_{AD,y}$= $PE_{CH4,\ y}$+ $PE_{EC,y}$+ $PE_{flare,y}$.

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

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

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

(Equation 25)

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
$B_{o,LT}$	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) or (6)
$PE_{sl,y}$	Project CH_4 emissions from sludge disposed of in storage pit prior to disposal during the year y (t CO_2e/yr)
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)

All sludge produced from the aerobic composting will be used for land application, which is calculated as leakage emission, so the $PE_{sl,y}$=0. So,

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

(Equation 26)

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
$B_{o,LT}$	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) or (6)
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)

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

$$PE_{N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * \left(E_{N2O,D,y} + E_{N2O,ID,y}\right)$$

(Equation 27)

where:

$PE_{N2O,y}$	Project N_2O emissions in year y (t CO_2/yr)
GWP_{N2O}	Global Warming Potential (GWP) for N_2O (t CO_2e/tN_2O)
$CF_{N2O-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$E_{N2O,D,y}$	Direct N_2O emission in year y (kg N_2O-N/year)
$E_{N2O,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)

Option1:

$$E_{N2O,D,y} = \sum_{j,LT} EF_{N2O,D,j} * NEX_{LT,y} * N_{LT} * MS\%_{j}$$

(Equation 28)

where：

$E_{N2O,D,y}$	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* (fraction)
N_{LT}	Annual Average number of animals of type LT for the year *y* estimated as per equation (5) or (6) (number)

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

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)

$NEX_{LT,y}$ 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* (fraction)

$F_{gasMS,j,LT}$ Default values for nitrogen loss due to volatilization 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) or (6) (number)

Option2:

$$E_{N2O,D,y} = \sum_j EF_{N2O,D,j} * \sum_{m=1}^{12}(Q_{EM,m} * [N]_{EM,m}) \quad \text{(Equation 30)}$$

$$E_{N2O,ID,y} = EF_{N2O,ID} * \sum_{j,LT} F_{gasMS,j,LT} * \sum_{m=1}^{12}(Q_{EM,m} * [N]_{EM,m}) \quad \text{(Equation 31)}$$

where:

$E_{N20,D,y}$ Direct N_2O emission in year *y* (kg N_2O-N/yr)

$E_{N20,ID,y}$ 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 volatilization 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 the Option 1 is used to calculate the Project N_2O emissions $PE_{N20,y}$.

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

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

where:

$PE_{EC,y}$ Project emissions from electricity consumption in year y. The project emissions from electricity consumption will be calculated following the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". In case, the electricity consumption is not measured then the electricity consumption shall be estimated as follows $EC_{PJ,y} = \sum_i CP_{i,y} * 8760$, where $CP_{i,y}$ is the rated capacity (in MW) of electrical equipment i used for the project activity.

$PE_{FC,y}$ Project emissions from fossil fuel combustion in process j during the year y. The project emissions from fossil fuel combustion will be calculated following the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". For this purpose, the processes j in the tool corresponds to all fossil fuel combustion in the AWMS (not including fossil fuels consumed for transportation of feed material and sludge or any other on-site transportation).

These emissions should only be considered for consumption of electricity or heat that is not related to the anaerobic digester. As described above, since the electricity consumption that is not related to the anaerobic digester cannot be separated from the total electricity consumption, therefore the emission for consumption of electricity is calculated in $PE_{FC,y}$. please refer to above $PE_{FC,y}$ calculation.
Therefore, $PE_{elec/heat}$=0

4.3 Leakage

Leakage covers the emissions from 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 net of those released under project activity and those released in the baseline scenario. Net leakage is only considered if they are positive.

$$LE_y = \left(LE_{PJ,N2O,y} - LE_{BL,N2O,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right) + LE_{AD,y} \quad \text{(Equation 33)}$$

Where:

$LE_{PJ,\ N2O,\ y}$ Leakage N_2O emissions released during project activity from land application of the treated manure in year y (t CO_2e/yr)

$LE_{BL,\ N2O,\ y}$ 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)

i) Estimation of leakage N_2O emissions released during baseline scenario from land application of the treated manure in year y, $LE_{BL,\ N2O,\ y}$

$$LE_{BL,N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (LE_{N2O,land,y} + LE_{N2O,runoff,y} + LE_{N2O,vol,y}) \quad \text{(Equation 34)}$$

$$LE_{N2O,land,y} = EF_1 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 35)}$$

$$LE_{N2O,runoff,y} = EF_5 * F_{leach} * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 36)}$$

$$LE_{N2O,vol,y} = EF_4 * \prod_{n=1}^{N}\left(1 - R_{N,n}\right) * F_{gasm} * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 37)}$$

where:

GWP_{N2O} Global Warming Potential (GWP) for N_2O (t CO_2e/tN_2O)

$CF_{N2O\text{-}N,N}$ Conversion factor N_2O-N to N_2O (44/28)

$LE_{N2O,land,y}$ Leakage N_2O emissions from application of manure waste in year y (kg N_2O-N/year)

$LE_{N2O,runoff,y}$	Leakage N_2O emissions due to leaching and run-off in year y (kg N_2O-N/year)
$LE_{N2O,vol,y}$	Leakage N_2O emissions due to volatilization 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) or (6) (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/mineralized in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (fraction)
$R_{N,n}$	Nitrogen reduction factor (fraction)

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

$$LE_{PJ,N2O} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (LE_{N2O,land,y} + LE_{N2O,runoff,y} + LE_{N2O,vol,y}) \quad \text{(Equation 38)}$$

$$LE_{N2O,land,y} = EF_1 * \prod_{n=1}^{N}(1 - R_{N,n}) * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 39)}$$

$$LE_{N2O,runoff,y} = EF_5 * F_{leach} * \prod_{n=1}^{N}(1 - R_{N,n}) * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 40)}$$

$$LE_{N2O,vol,y} = EF_4 * \prod_{n=1}^{N}(1 - R_{N,n}) * F_{gasm} * \sum_{LT} NEX_{LT,y} * N_{LT} \quad \text{(Equation 41)}$$

where:

GWP_{N2O}	Global Warming Potential (GWP) for N_2O (t CO_2e/tN_2O)
$CF_{N2O-N,N}$	Conversion factor N_2O-N to N_2O (44/28)
$LE_{N2O,land,y}$	Leakage N_2O emissions from application of manure waste in year y (kg N_2O-N/year)
$LE_{N2O,runoff,y}$	Leakage N_2O emissions due to leaching and run-off in year y (kg N_2O-N/year)
$LE_{N2O,vol,y}$	Leakage N_2O emissions due to volatilization 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) or (6) (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/mineralized 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 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, $\prod_{n=1}^{N}(1 - R_{N,n}) * \sum_{LT} NEX_{LT,y} * N_{LT}$ should be substituted by$Q_{DM} * N_{DM}$. ☐

iii) 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:

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

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

where:

$LE_{BL,CH4,y}$	Leakage CH_4 emissions released during baseline scenario from land application of the treated manure in year *y* (t CO_2e/yr)
$LE_{PJ,CH4,y}$	Leakage CH_4 emissions released during project activity from land application of the treated manure in year *y* (t CO_2e/yr)
$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method *n* of the *N* treatment steps prior to sludge being treated
GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (t CO_2e/tCH_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^3CH_4/kg dm)
N_{LT}	Annual average number of animals of type *LT* estimated as per equation (5) or (6), 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

iV) 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:

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

where:

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

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).

The anaerobic digestion process of this project is carried out in a fully enclosed system. The biogas generated during the treatment process will be captured for power generation or flared (if any). The Emissions from combustion will be calculated in project emissions (if any). After anaerobic digestion, the fermented sludge will be treated in aerobic composting system, which will be used as fertilizer. Wastewater from the new animal waste management systems will be treated aerobically and then used for agriculture irrigation. So, the Estimation of leakage emissions associated with the anaerobic digester is 0. i.e., $LE_{AD,y}$ =0.

4.4 Estimated Net GHG Emission Reductions and 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:

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

Further, in estimating emissions reduction for claiming 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 shall be compared to the ($BE_{CH4,y}$ - $PE_{AD,y}$ in the tool "Project and leakage emissions from anaerobic digesters") and if found 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:

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

Table 4-1 The calculation result of BEy

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_j	69.56%	69.56%	%
$B_{o,LT}$	0.29	0.29	m^3 CH_4 /kg_dm
N_{LT}	99,450	54,252	No of heads
W_{site}	68.5	103.6	kg
$W_{default}$	28	28	kg
$VS_{default}$	0.3	0.3	Kg-dm/animal/day
$VS_{LT,y}$	267.88	405.15	kg-dm/animal/yr

$MS\%_{Bl,j}$	100%	100%	%
nd_y	365	365	days
Sub total	100,818	83,180	tCO_2e
$BE_{CH4,y}$	**183,998**		tCO_2e

Table 4-2 the calculation result of $BE_{N20,y}$

Parameter	Value		Unit
species	**Market Swine**	**Breeding Swine**	
$EF_{N20,D,j}$	0	0	kg N_2O-N/kg N
$N_{rate(T)}$	0.42	0.24	kg N/1000kg animal mass/day
$NEX_{IPCCdefault}$	4.29	2.45	kg N/animal/year
W_{site}	68.50	103.60	kg
$W_{default}$	28	28	kg
$NEX_{LT,y}$	10.50	9.08	kg N/animal/yr
N_{LT}	99,450	54,252	No of heads
$MS\%_{Bl,j}$	100%	100%	/
$E_{N20,D,y}$	0	0	kg N_2O-N/year
$EF_{N20,ID}$	0.01	0.01	kg N_2O/kg N
$F_{gasMS,j,LT}$	40%	40%	/
GWP_{N20}	265.00	265.00	tCO_2/tN_2O
$CF_{N20-N,N}$	1.57	1.57	Conversion Factor N_2O-N to N_2O
$E_{N20,ID,y}$	4,177	1,969	tCO_2/tN_2O
$BE_{N20,y}$	**2,559**		tCO_2e

Baseline Emissions: $BE_{CH4,y}$+ $BE_{N20,y}$ =183,998 tCO_2e + 2,559 tCO_2e =186,557 tCO_2e

Calculation of the project emission

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

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

Table 4-3 the calculation result of $PE_{EC,y}$

Parameter	Value	Unit
$EC_{PJ,j,y}$	0	MWh/yr
$EF_{EF,j,y}$	0.58955	tCO_2/MWh
$TDL_{j,y}$	20%	/
$PE_{EC,y}$	**0**	tCO_2e

Table 4-4 the calculation result of $PE_{CH4,y}$

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$EF_{CH4,default}$	0.05	/
$Q_{CH4,y}$	5,953.91	tCH_4
$PE_{CH4,y}$	**8,336**	tCO_2e

Table 4-5 the calculation result of $PE_{flare,y}$

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$\eta_{flare,m}$	0%	/
$F_{CH4,RG,m}$	535.83	t CH_4
$PE_{flare,y}$	**15,004**	tCO_2e

$PE_{AD,y}$= $PE_{EC,y}$+ $PE_{CH4,y}$+$PE_{flare,y}$ =0 tCO_2e +8,336 tCO_2e +15,004 tCO_2e =23,340 tCO_2e

Table 4-6 the calculation result of $PE_{Aer,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
	0.001	0.001	/
F_{Aer}	65%	65%	/
$1-R_{vs,1}$	20%	20%	/
$B_{0,LT}$	0.29	0.29	m^3 CH_4 /kg VS
N_{LT}	99,450	54,252	No of heads
$VS_{LT,y}$	267.88	405.15	kg-dm/animal/yr
$MS\%_j$	100%	100%	/
Sub total	19	16	tCO_2e
$PE_{Aer,y}$	35		tCO_2e

Table 4-7 the calculation result of $E_{N2O,D,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N2O,D,j}$	0	0	kg N_2O-N/kg N
$NEX_{LT,y}$	10.50	9.08	kg N/animal/yr
N_{LT}	99,450	54,252	No of heads
$MS\%_j$	50%	50%	/
Sub total	**0.00**	**0.00**	kg N_2O-N/year
$EF_{N2O,D,j}$	0.006	0.006	kg N_2O-N/kg N
$NEX_{LT,y}$	10.50	9.08	kg N/animal/yr
N_{LT}	99,450	54,252	No of heads
$MS\%_j$	65%	65%	/
Sub total	**4,073**	**1,920**	kg N_2O-N/year
$E_{N2O,D,y}$	**5,993**		kg N_2O-N/year

Table 4-8 the calculation result of $E_{N2O,ID,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N2O,iD}$	0.01	0.01	kg N_2O-N/kg NH_3 and NO_x-N
$F_{gasMS,j,LT}$	40%	40%	/
$NEX_{LT,y}$	10.50	9.08	kg N/animal/yr
N_{LT}	99,450	54,252	No of heads

$MS\%_j$	50%	50%	%
GWP_{N20}	265	265	tCO_2/tN_2O
Sub total	**2,089**	**985**	kg N_2O-N/year

Table 4-9 the calculation result of $PE_{N2OD,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N20,iD}$	0.01	0.01	kg N_2O-N/kg NH_3 and NO_X-N
$F_{gasMS,j,LT}$	45%	45%	/
$NEX_{LT,y}$	10.50	9.08	kg N/animal/year
N_{LT}	99,450	54,252	No of heads
$MS\%_j$	65%	65%	%
GWP_{N20}	265	265	tCO_2/tN_2O
Sub total	**3,055**	**1,440**	kg N_2O-N/year
$PE_{N20,y}$	**5,648**		tCO_2e

Project emission: $PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y}$= 23,340 tCO_2e +35 tCO_2e +5,648 tCO_2e =29,023 tCO_2e

Calculation of leakage

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

Table 4-10 the calculation result of $LE_{BL,N2O,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
N_{LT}	99,450	54,252	No of heads
N_{rate}	0.42	0.42	kg N/1000kg animal mass/day
$NEX_{LT,y}$	10.50	9.08	kg N/animal/yr
$R_{N,n}$	80%	80%	/
EF_1	0.01	0.01	kg N_2O-N/kg N
EF_5	0.0075	0.0075	kg N_2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
GWP_{N20}	265	265	tCO_2/tN_2O
$LE_{N20,land,y}$	2,088	984	kg N_2O-N/year
	3,072		kg N_2O-N/year
$LE_{N20,runoff,y}$	470	222	kg N_2O-N/year
	692		kg N_2O-N/year
$LE_{N20,vol,y}$	418	197	kg N_2O-N/year
	615		kg N_2O-N/year
$LE_{BL,N20,y}$	**1,823**		tCO_2e

Table 4-11 the calculation result of $LE_{PJ,N2O,y}$

Parameter	Value	Unit

species	Market Swine	Breeding Swine	
N_{LT}	99,450	54,252	No of heads
NEX_{LT}	10.50	9.08	kg N/animal/yr
R_N	25%	25%	/
RN	5%	5%	-
EF_1	0.01	0.01	kg N2O-N/kg N
EF_5	0.0075	0.0075	kg N2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
GWP	265	265	/
$LE_{N2O,land,y}$	7.441	3,508	kg N_2O-N/year
	10,949		kg N_2O-N/year
$LE_{N2O,runoff,y}$	1,674	789	kg N_2O-N/year
	2,463		kg N_2O-N/year
$LE_{N2O,vol}$	1,489	702	kg N_2O-N/year
	2,191		kg N_2O-N/year
$LE_{PJ,N2O,y}$	**6,498**		tCO_2e

Table 4-12 the calculation result of $LE_{BL,CH4,y}$

Parameter	Value		Unit
species	**Market Swine**	**Breeding Swine**	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	267.88	405.15	kg-dm/animal/yr
N_{LT}	99,450	54,252	No of heads
$B_{0,LT}$	0.29	0.29	m^3 CH4/kg-VS
R_{VS}	85%	85%	/
$MS\%_j$	100%	100%	/
$LE_{BL,CH4,y}$	**21,740**	**17,937**	tCO_2e
Total	**39,677**		tCO_2e

Table 4-13 **the calculation result of LE** $LE_{PJ,CH4,y}$

Parameter	Value		Unit
species	**Market Swine**	**Breeding Swine**	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	267.88	405.15	kg-dm/animal/yr
N_{LT}	99,450	54,252	No of heads
$B_{0,LT}$	0.29	0.29	m^3 CH_4/kg-VS
R_{VS}	80%	80%	/
R_{VS}	20%	20%	/
$MS\%_j$	100%	100%	/
$LE_{PJ,CH4,y}$	**23,191**	**19,133**	tCO_2e
Total	**42,324**		tCO_2e

$LE_y = (LE_{PJ,N2O,y} - LE_{BL,N2O,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y})$= (6,498 tCO_2e- 1,823 tCO_2e) +(42,324 tCO_2e -39,677 tCO_2e) =7,322 tCO_2e

Emission Reduction: $ER_y=BE_y-PE_y-LE_y$= 186,557 tCO_2e- 29,023 tCO_2e- 7,322 tCO_2e= 150,212 tCO_2e

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
10-June-2020 to 31-December-2020	104,779[29]	16,301[30]	4,112[31]	84,366
01-January-2021 to 31-December-2021	186,557	29,023	7,322	150,212
01-January-2022 to 31-December-2022	186,557	29,023	7,322	150,212
01-January-2023 to 31-December-2023	186,557	29,023	7,322	150,212
01-January-2024 to 31-December-2024	186,557	29,023	7,322	150,212
01-January-2025 to 31-December-2025	186,557	29,023	7,322	150,212
01-January-2026 to 31-December-2026	186,557	29,023	7,322	150,212
01-January-2027 to 31-December-2027	186,557	29,023	7,322	150,212
01-January-2028 to 31-December-2028	186,557	29,023	7,322	150,212
01-January-2029 to 31-December-2029	186,557	29,023	7,322	150,212
01-January-2030 to 09-June-2030	81,778[32]	12,722[33]	3,210[34]	65,846

[29] The yearly total amount estimated baseline emission reductions is 186,557 tCO_2e, so the values estimated baseline emission reductions from 10-June-2020 to 31-December-2020 is 186,557 tCO_2e *205 days /365 days= 104,779 tCO_2e.

[30] The yearly total amount estimated project emission reductions is 29,023 tCO_2e, so the values estimated project emission reductions from 10-June-2020 to 31-December-2020 is 29,023 tCO_2e *205 days /365 days= 16,301 tCO_2e.

[31] The yearly total amount estimated leakage emission reductions is 7,322 tCO_2e, so the values estimated project emission reductions from 10-June-2020 to 31-December-2020 is 7,322 tCO_2e *205 days /365 days= 4,112 tCO_2e.

[32] The yearly total amount estimated baseline emission reductions is 186,557 tCO_2e, so the values estimated baseline emission reductions from 01-January-2030 to 09-June-2030 is 186,557 tCO_2e *160 days /365 days= 81,778 tCO_2e.

[33] The yearly total amount estimated project emission reductions is 29,023 tCO_2e, so the values estimated project emission reductions from 01-January-2030 to 09-June-2030 is 29,023 tCO_2e *160 days /365 days= 12,722 tCO_2e.

[34] The yearly total amount estimated leakage emission reductions is 7,322 tCO_2e, so the values estimated project emission reductions from 01-January-2030 to 09-June-2030 is 7,322 tCO_2e *160 days /365 days= 3,210 tCO_2e.

Total	1,865,570	290,230	73,220	1,502,120

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	GWP_{CH4}
Data unit	tCO_2/tCH_4
Description	Global Warming Potential of CH4
Source of data	IPCC Fifth Assessment Report
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	100-year values are adopted from Box 3.2, table 1, IPCC Fifth Assessment Report, 2014[35], which complies with the requirement described in Section 3.14.4 of VCS Standard (V4.2).
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	N/A

Data / Parameter	GWP_{N2O}
Data unit	tCO_2e/tN_2O
Description	Global Warming Potential of N_2O
Source of data	IPCC Fifth Assessment Report
Value applied	265
Justification of choice of data or description of measurement methods and procedures applied	100-year values are adopted from Box 3.2, table 1, IPCC Fifth Assessment Report, 2014, which complies with the requirement described in Section 3.14.4 of VCS Standard (V4.2).
Purpose of Data	Used in project emission/baseline calculations
Comments	N/A

[35] https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

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℃ and 1 atm pressure.
Purpose of Data	Used in project emission/baseline calculations
Comments	N/A

Data / Parameter	MCF_j
Data unit	-
Description	Methane conversion factor for the baseline AWMSj
Source of data	IPCC 2006 table 10.17, chapter 10, volume 4
Value applied	69.56%
Justification of choice of data or description of measurement methods and procedures applied	MCFj value for uncovered anaerobic lagoon (baseline AWMS) is chosen. A conservativeness factor has been applied by multiplying MCFj value (i.e., 74%) with a value of 0.94, to account for the 20 per cent uncertainty in the MCFj values as reported by IPCC 2006. For this project, the annual average temperature is 15.3℃[36] and the conservative value of 74% is applied. Therefore, MCFj value of 69.56% will be applied.
Purpose of Data	project/baseline emission calculations
Comments	N/A

[36] http://jiangsu.china.com.cn/html/jsnews/around/4842719_1.html

Data / Parameter	$MS\%_{Bl,j}$
Data unit	Fraction
Description	Fraction of manure handled in system j in the baseline.
Source of data	Project proponents
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 uncovered anaerobic lagoon only. The amount of manure handled by the anaerobic lagoon is 100%.
Purpose of Data	Calculation of baseline emissions
Comments	N/A

Data / Parameter	$W_{default}$
Data unit	kg
Description	Default average animal weight of a defined population
Source of data	IPCC 2006 table 10A-7 and 10A-8, chapter 10, volume 4
Value applied	$W_{default}$(Market swine)=28 kg $W_{default}$(Breeding swine)=28 kg
Justification of choice of data or description of measurement methods and procedures applied	The values in IPCC 2006 and US-EPA are compared and the lower value from IPCC 2006 is applied.
Purpose of Data	Calculation of Baseline emissions
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	IPCC 2006 table 10A-7 and 10A-8, chapter 10, volume 4
Value applied	$VS_{default}$(Market swine)=0.3 $VS_{default}$(Breeding swine)=0.3
Justification of choice of data or description of measurement methods and procedures applied	The values in IPCC 2006 and US-EPA are compared and the lower value from IPCC 2006 is applied.
Purpose of Data	Used in project emission/baseline calculations
Comments	N/A

Data / Parameter	$NEX_{IPCC\ default}$
Data unit	kg N/ animal/year
Description	Default value for the nitrogen excretion per head of a defined livestock population
Source of data	Calculated by the equation: $NEX_{IPCC\ default} = N_{rate(T)} * TAM/1000*365$
Value applied	$NEX_{IPCC\ default}$ (Market swine) =4.29 $NEX_{IPCC\ default}$ (Breeding swine) =2.45
Justification of choice of data or description of measurement methods and procedures applied	$NEX_{IPCC\ default}$ is calculated as equation 10.30 in IPCC 2006, $N_{rate(T)}$ and TAM are default value from IPCC 2006-
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	IPCC 2006 table 10.19, chapter 10, volume 4
Value applied	$N_{rate,(T)}$ (Market swine) =0.42

	$N_{rate,(T)}$(Breeding swine) =0.24
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC 2006 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	IPCC 2006 table 10A-7 and 10A-8, chapter 10, volume 4
Value applied	TAM (Market swine) =28 TAM (Breeding swine) =28
Justification of choice of data or description of measurement methods and procedures applied	Default value from IPCC 2006 is applied
Purpose of Data	$NEX_{IPCC\ default}$ calculations
Comments	N/A

Data / Parameter	$F_{gas\ MS,j,LT}$
Data unit	Fraction
Description	Default values for nitrogen loss due to volatilisation of NH_3 and NO_X from manure management
Source of data	IPCC 2006 table 10.22, chapter 10, volume 4
Value applied	$F_{gasMS,j,LT}$, (anaerobic lagoon) : 40% $F_{gasMS,j,LT}$, (solid storage) : 45%
Justification of choice of data or description of	Site specific data is unavailable therefore default values are opted for.

measurement methods and procedures 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	IPCC 2006 table 10.21, chapter 10, volume 4
Value applied	$EF_{N2O,\ D}$=0 for anaerobic lagoon and digester, $EF_{N2O,\ D}$=0.01 for aerobic lagoon
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of Data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$EF_{N2O,ID,j}$
Data unit	kgN_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	IPCC 2006 table 11.3, chapter 11, volume 4
Value applied	0.01
Justification of choice of data or description of measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of Data	Used in project/baseline emission calculations
Comments	N/A

Data / Parameter	$EF_{CH4,default}$
Data unit	t CH_4 leaked / t CH_4 produced
Description	Default emission factor for the fraction of CH_4 produced that leak from the anaerobic digester (fraction)
Source of data	Tool 14:" Project and leakage emissions from anaerobic digesters (version 02.0)"
Value applied	0.05
Justification of choice of data or description of measurement methods and procedures applied	UASB type digesters[37], floating gas holders with no external water seal
Purpose of Data	Calculation of project emissions
Comments	$PE_{CH4,y}$ for ex ante estimation adopted equation(4) of Methodological tool " Project and leakage emissions from anaerobic digesters", the amount of biogas collected at the digester will be monitored in section B.7 of JPM.

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 Annex 1 of methodology ACM0010 (version 08.0)
Value applied	$R_{VS,n}$, aerobic treatment and anaerobic digester[38]: 20%, 80% for leakage N_2O emission released during project activity

[37] As per tool 14:" project and leakage emission from anaerobic digesters (version 02.0)", the value this parameter should be determined according to the type of digester used in the project activity and the digester type shall be identified by manufacturer information. For this project, as per the purchasing contract of Anaerobic digester, the type of digester used in the project activity belongs to UASB type digester, so the Default emission factor for the fraction of CH_4 produced that leak from the anaerobic digester (fraction) is 0.05 t CH_4 leaked / t CH_4 produced.

[38] For project, Before the treated manure is applied to the land, it undergoes two stages of pre-treatment and an anaerobic-aerobic combined treatment technology, the pre-treatment belong to underfloor pit storage in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{VS,n}$ is 20% which is the most conservative value. The anaerobic-aerobic combined treatment technology belongs to covered first cell of two cell lagoon in the Appendix 1 of applied methodology ACM0010 (version 08.0), so the R_{VS} 80% which is the most conservative value.

	$R_{VS,n}$, one cell lagoon[39]:85% for leakage N_2O emission released during baseline scenario
Justification of choice of data or description of measurement methods and procedures applied	Estimated from Table provided in Annex 1 of ACM0010 and FSR. The most conservative value for the given technology must be used.
Purpose of Data	project emission/ leakage calculation
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 Annex 1 of methodology ACM0010 (version 08.0)
Value applied	$R_{N,n}$, aerobic treatment and anaerobic digester: 5%, 25%[40] $R_{N,n}$, uncovered anaerobic lagoon : 80%[41]
Justification of choice of data or description of measurement methods and procedures applied	Estimated from Table provided in Annex 1 of ACM0010. The most conservative value for the given technology must be used.
Purpose of Data	Calculation of leakage emission
Comments	The most conservative value for the given technology must be used

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

[39] For project, the baseline is uncovered anaerobic lagoon which belongs to the anaerobic treatment of One-cell lagoon in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{VS,n}$ is 85% which is the most conservative value.
[40] For project, Before the treated manure is applied to the land, it undergoes two stages of pre-treatment and the an anaerobic-aerobic combined treatment technology, the pre-treatment belong to underfloor pit storage in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{N,n}$ is 5% which is the most conservative value. The anaerobic-aerobic combined treatment technology belongs to covered first cell of two cell lagoon in the Appendix 1 of applied methodology ACM0010 (version 08.0), so the $R_{N,n}$ is 25% which is the most conservative value.
[41] For project, the baseline is uncovered anaerobic lagoon which similar to the anaerobic treatment of One-cell lagoon in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{N,n}$ is 80% which is the most conservative value.

Description	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	IPCC 2006 Guidelines default values are be used, since country specific or region-specific data are not available. EF_1 from table 11.1, chapter 11, volume 4. EF_4 and EF_5 from table 11.3, chapter 11, volume 4
Value applied	EF_1 = 0.010 EF_4 =0.010 EF_5 = 0.0075
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 table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines
Value applied	0.2
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 table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines
Value applied	0.3
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	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)", Methane conversion factor for leakage calculation assumed to be equal 1
Purpose of Data	Calculation of leakage emission
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 [42]
Value applied	0.58955[43]

[42] http://mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/t20201229_815386.shtml
[43] https://www.mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/t20201229_815386.shtml

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	R_u
Data unit	Pa.m³/kmol.K
Description	Universal ideal gases constant
Source of data	Tool 08:" Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)"
Value applied	8,314
Justification of choice of data or description of measurement methods and procedures applied	Value is fixed as Tool 08
Purpose of Data	Calculation of project emission
Comments	/

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

Data / Parameter	$\eta_{flare,m}$
Data unit	%
Description	Flare efficiency in minute m
Source of data	Tool 06" Project emissions from flaring (Version 04.0)"
Value applied	0%
Justification of choice of data or description of measurement methods and procedures applied	0% is the conservative value.
Purpose of Data	Calculation of project emission
Comments	/

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 proponents
Description of measurement methods and procedures to be applied	Each pig involved in this project has a unique electronic ear tag when was born, which is an electronic device dedicated to the identification and electronic management of animals, can track automatically. This electronic ear tag will be connected to the Data Collection System (DCS), which can store and read information. Therefore, the number of swine produced in the farm can be monitored through the auto tracking devices of electronic ear tag once pig slaughter monthly and obtained by the DCS. At the same time, the technicians in farms will record manually the number of swine produced in the farms monthly. Also, the number of monthly exported from the stock will also be recorded.
Frequency of monitoring/recording	Monthly
Value applied	99,450 heads of market swine used for ex-estimated which is the annual average number of swine (N_{LT}) and this value sourced from Project evaluation report. 201,663 head of commercial pigs is produced annually ($N_{p,LT}$).

Monitoring equipment	*N/A*
QA/QC procedures to be applied	The sale records will be crosschecked during the monitoring period 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 (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 proponents
Description of measurement methods and procedures to be applied	Each pig involved in this project has a unique electronic ear tag when was born, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag will be connected to the Data Collection System (DCS), which can store and read information. Therefore, the days of swine alive in the farm can be traced through the electronic ear tag by the technical staff in each farm and obtained by the DCS.
Frequency of monitoring/recording	Monitored monthly.
Value applied	180days which sourced from Project evaluation report, and this value is in line with the number of days for pigs to be slaughtered by existing large-scale breeding groups in China[44].
Monitoring equipment	*N/A*
QA/QC procedures to be applied	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 (sale records) will be crosschecked.

[44] https://zhuanlan.zhihu.com/p/38676811
http://finance.people.com.cn/n1/2017/1121/c1004-29658996.html

Data / Parameter	$N_{AA,LT}$
Data unit	Number
Description	Daily stock of animals in the farm, discounting dead and discarded animals
Source of data	Project proponents
Description of measurement methods and procedures to be applied	Each pig involved in this project has a unique electronic ear tag when was born, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag will be connected to the Data Collection System (DCS), which can store and read information. The technicians in farms monitor and record the number of breeding swine through the auto tracking devices of electronic ear tag daily, of which new imported animals are included and dead and discharge animals are excluded. The annual average number of animals ($N_{AA,LT}$) is calculated as an average of the daily stock of breeding swine in the farms without considering dead animals and discarded animals.
Frequency of monitoring/recording	Daily.
Value applied	54,252 heads of Breeding swine were used to ex-estimated, and this value sourced from Project evaluation report.
Monitoring equipment	*N/A*
QA/QC procedures to be applied	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	The project proponents monitor the population of breeding pigs through the auto tracking device, which is connected to the Data Collection System (DCS). Therefore, the data of $N_{AA,\ LT}$ can be obtained through DCS.

Data / Parameter	W_{site}
Data unit	kg

Description	Average animal weight of a defined livestock population at the project site
Source of data	Project proponents
Description of measurement methods and procedures to be applied	Measured by the weight measurer
Frequency of monitoring/recording	monthly
Value applied	68.5kg for commercial pigs and 103.6 kg for breeding pigs which sourced from Project evaluation report.
Monitoring equipment	weight measurer
QA/QC procedures to be applied	This parameter is used in equation 4 for estimating $VS_{LT,y}$ using option 3, and in equation 2 (appendix 2) for estimating $NEX_{LT,y}$ when using IPCC 2006 default values. 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 baseline scenario from land application of the treated manure in the leakage section, the lower bound of the 95% confidence interval obtained from the sampling measurements should be used; (d) When estimating project emissions and emissions released during project activity from land application of the treated manure in the leakage section, the upper bound of the 95% confidence interval obtained from the sampling measurements should be used. The weight measurer will be calibrated annually to ensure the reliability of the parameter.
Purpose of data	Used for estimating $VS_{LT,y}$
Calculation method	*N/A*
Comments	Sampling procedures and method is described in Section 5.3 of JPM.

Data / Parameter	F_{Aer}
Data unit	Fraction
Description	Fraction of volatile solids directed to aerobic treatment
Source of data	Project evaluation report
Description of measurement methods and procedures to be applied	the maximum value is applied due to not monitored in operation period.
Frequency of monitoring/recording	Annually
Value applied	*65%* for ex ante estimation, which sourced from Project evaluation report. As this parameter is not monitored in the actual operation. So, in the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is 100%.
Monitoring equipment	N/A
QA/QC procedures to be applied	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	n_{dy}
Data unit	number
Description	Number of days treatment plant was operational in year y.
Source of data	Project proponents
Description of measurement methods and procedures to be applied	The number of of days treatment plant was operational will be recorded manually by the responsible staff.
Frequency of monitoring/recording	Daily

Value applied	365 days for ex ante estimation. The actual number of days treatment plant was operational used in the monitoring periods will be monitored by project proponents
Monitoring equipment	N/A
QA/QC procedures to be applied	Production record from the DCS system can be crosscheck that the treatment plant is operational.
Purpose of data	Calculation of Baseline emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	V_f
Data unit	m^3
Description	Biogas flow
Source of data	Project proponents
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	1,481.072472*$10^4 m^3$ of biogas are expected to be generated by the project annually, of which 133.29*$10^4 m^3$ of biogas will be flared, which sourced from Project evaluation report.
Monitoring equipment	flow meters
QA/QC procedures to be applied	The calibration of flow meters, including the frequency of calibration, should be done per two years in accordance with national standards or requirements.
Purpose of data	To calculated CH_4 generated in the anaerobic digester in the project situation $Q_{CH4,y}$
Calculation method	N/A
Comments	The biogas flow will be measured at four points, as shown in the figure. But if the project participants can demonstrate that leakage in distribution pipeline is zero, it need be measured at any

	three points. The biogas flow to electricity or heat equipment in a moment can be considered destroyed, by monitoring that the equipment was working at this time. For the proposed project, the biogas generated during the treatment process will be captured for power generation, so the biogas produced from the anaerobic digestion, the amount of biogas used for electricity generation and the amount of biogas flared (if any) will be monitored through the flow meter.

Data / Parameter	$EC_{PJ,j,y}$
Data unit	MWh
Description	Quantity of electricity consumed by the proposed project in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Description of measurement methods and procedures to be applied	Measured by electricity meter installed at the electricity consumption sources.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	0 MWh for ex ante estimation. During the monitoring period, if the electricity consumption sourced from the gird company, then the value will be determined as per the electricity meters monitoring and Cross-check with the grid statement.
Monitoring equipment	electricity meter
QA/QC procedures to be applied	The value will be cross-check with the grid statement. 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	$EG_{d,y}$
Data unit	MWh

Description	Electricity generated using biogas in year y
Source of data	Project proponents
Description of measurement methods and procedures to be applied	Measured by electricity meter installed at the generator outlet.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	Electricity of 19,254MWh can be generated using biogas annually for ex ante estimation, which is sourced from project evaluation report.
Monitoring equipment	Electricity meters
QA/QC procedures to be applied	The calibration of electricity meters, including the frequency of calibration, should be done in accordance with national standards or requirements.
Purpose of data	This value is the monitored outcome of SDG7.
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"
Description of measurement methods and procedures to be applied	Default value of 20% will be applied, which is conservative. According to tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Frequency of monitoring/recording	Value will change once the tool is updated
Value applied	20%
Monitoring equipment	N/A

QA/QC procedures to be applied	N/A
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 flowmeter from project proponents
Description of measurement methods and procedures to be applied	Monitored by flowmeter and Volumetric flow measurement should always refer to the actual pressure and temperature.
Frequency of monitoring/recording	Continuous measurement
Value applied	Biogas were estimated according to the amount of manure for Ex ante estimation and will be monitored in the monitoring period.
Monitoring equipment	Flowmeters
QA/QC procedures to be applied	Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory for all projects applying large scale methodology(ies). Calibration and frequency of calibration is according to manufacturer's specifications
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$V_{i,t,db}$
Data unit	m^3 gas i/m^3 dry gas

Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis
Source of data	Measured by gas analyzer from Project proponents
Description of measurement methods and procedures to be applied	Continuous gas analyser operating in dry-basis. Volumetric flow measurement should always refer to the actual pressure and temperature
Frequency of monitoring/recording	Continuous measurement
Value applied	CH_4 fraction of biogas is 60% in pre-estimated which sourced from Project evaluation report. In monitoring period. This value will be monitored by the gas analysers.
Monitoring equipment	Gas analyzers
QA/QC procedures to be applied	Calibration should include zero verification with an inert gas (e.g., N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period.
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 signal (analogical or digital) are required. Examples include thermocouples, thermo resistance, etc
Frequency of monitoring/recording	Continuous unless differently specified in the underlying methodology
Value applied	293.15 K was used in the pre-calculation for the density of CH_4 as the applied methodology ACM0010(Version08.0), in actual

	monitoring period, the temperature of the gaseous stream is monitored by the recordable electronic signal. The temperature Tt(K) is calculated as the equation T(K)=t(°C) +273.15.
Monitoring equipment	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	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 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 metered only when performing such measurements (with same frequency)

Data / Parameter	$\rho_{i,t}$
Data unit	kg gas i/m^3 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 biogas flow meters -
Value applied	0.67 kg/m^3 for ex-estimated. In monitoring period, this parameter will be calculated based on temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t
Monitoring equipment	N/A
QA/QC procedures to be applied	Calculated value according to the pressure and temperature
Purpose of Data	Calculation of project emissions
Calculation method	Equation 19
Comments	N/A

Data / Parameter	$MS\%_j$

Data unit	Fraction
Description	Fraction of manure handled in system j in project activity
Source of data	Project proponents
Description of measurement methods and procedures to be applied	All the manure flew into AWMSs to be treated; no any manure will be discharged outside. Therefore, the value of this parameter is 100%.
Frequency of monitoring/recording	Annually
Value applied	100% for ex-estimated. Since the treatment process of this project is an anaerobic-aerobic combined treatment technology and as this parameter is not monitored in the actual operation. so, in the monitoring period, to be conservative, the value of this parameter applied in the emission reduction calculation in the two phases are both 100%.
Monitoring equipment	N/A
QA/QC procedures to be applied	100% is the maximum value and conservative.
Purpose of Data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$B_{0, LT}$
Data unit	m^3CH_4/kg -dm
Description	Maximum methane producing potential of the volatile solid generated by animal type *LT*
Source of data	IPCC 2006 table 10A-7 and 10A-8, chapter 10, volume 4
Description of measurement methods and procedures to be applied	$B_{0, LT}$ can be measured as per ISO 11734:1995. As this parameter is not monitored in the actual operation. so, in the monitoring period 0.29 m^3CH_4/kg -dm is still applied. While the actual methane producing potential of the volatile solid generated by swine manure is 479.4ml/g VS according to the public

	literature[45],which is higher. Therefore 0.29 m^3CH_4/kg -dm applied in monitoring period is conservative.
Frequency of monitoring/recording	Annually
Value applied	$B_{0, LT}$ (Market swine) =0.29[46] $B_{0, LT}$ (Breeding swine) =0.29
Monitoring equipment	N/A
QA/QC procedures to be applied	The value is taken from published sources. The parameter value should be updated on latest available public data source.
Purpose of Data	Used in project emission/baseline calculations
Calculation method	N/A
Comments	N/A

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

[45] http://www.doc88.com/p-9902182440715.html

[46] The proposed project is located in Jiangsu Province, China, Asia. According to Table 10A-7 and 10A-8 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for Market swine and Breeding swine in Asia region is 0.29 m^3 CH_4/kg VS.

Calculation method	N/A
Comments	N/A

Data / Parameter	T
Data unit	°C
Description	Annual average ambient temperature at project site
Source of data	Official publicly available information
Description of measurement methods and procedures to be applied	Data sourced from Official public information.
Frequency of monitoring/recording	monthly
Value applied	15.3°C for ex-ante estimated. During the monitoring period, the vintage average ambient temperature at project site can be obtained from the Official publicly available information.
Monitoring equipment	N/A
QA/QC procedures to be applied	Cross-Check with the value of ex-ante estimated, i.e., 15.3°C
Purpose of Data	Used to select the annual MCFj from IPCC 2006 Guidelines
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

The monitoring plan presented in this JPM assures 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

The project owner will be responsible for the whole monitoring work. The VCS Monitoring Team will be established to collect and record monitoring data within the project boundary. The VCS monitoring team will be responsible for the normal operation of the manure treatment system and the collection and record of all the monitoring data. All the data will be reviewed by the project developer and VVB. Each member of the VCS monitoring team will be trained by the project owner at least once a year. The overall monitoring system structure of the project shows as below:

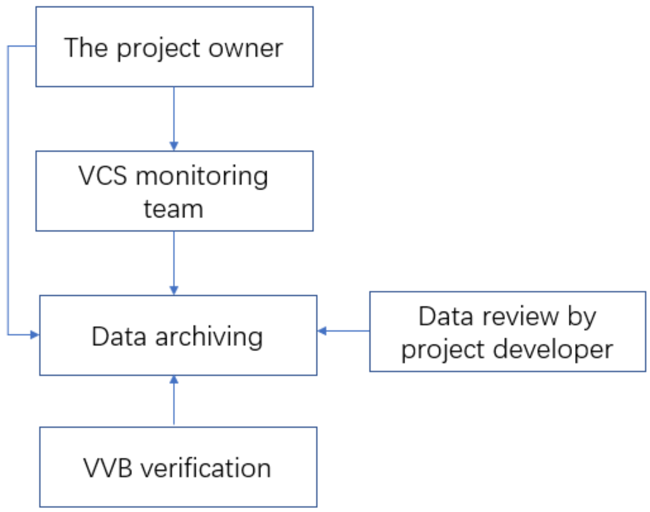


Figure 5-1 The Organization Structure of the Monitoring Team

2. Monitoring equipment and installation

Installation and configuration of meters are shown as Figure 5-2. In order to ensure measurements with a low degree of uncertainty, the data metering equipment will be calibrated and checked by an appropriately qualified third party according to an appropriate national standard. The calibration records will be appropriately maintained and made available for review by VVB.

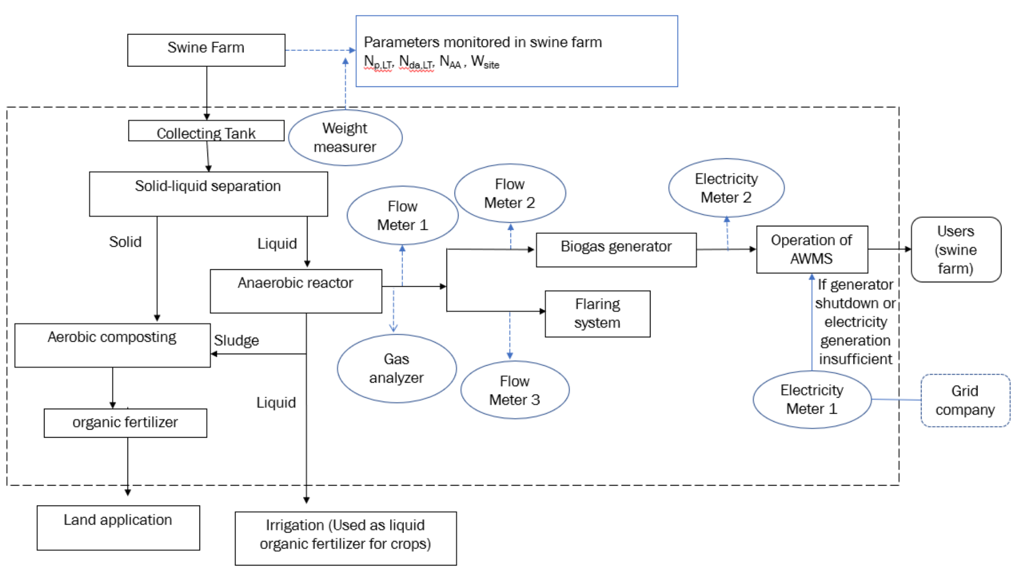


Figure 5-2 Installation and Configuration of Meters

3. Principle of Monitoring

Every swine farm should monitor all the data mentioned description in section 5.2 in this JPM.

The installation of relevant monitoring instruments and meters shall be carried out in accordance with industry requirements and manufacturer specifications and shall be calibrated regularly as required.

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

4. Parameters to be monitored

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

For this project, the parameters that need to be monitored as the description of section 5.2 are as follows:

a) Number of animals of type LT produced annually for the year y, $N_{p,LT}$;

b) Number of days animal of type LT is alive in the farm in the year y, $N_{da,LT}$;

c) Daily stock of animals in the farm, discounting dead and discarded animals, $N_{AA,LT}$;

d) Average animal weight of a defined livestock population at the project site, W_{site};

e) Number of days treatment plant was operational in year y, n_{dy};

f) Quantity of electricity consumed by the proposed project in year y, $EC_{PJ,j,y}$;

g) Electricity generated using biogas in year y, $EG_{d,y}$

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

i) Biogas flow, V_f;

j) Volumetric flow of the gaseous stream in time interval t on a dry basis, $V_{t,db}$;

k) Volumetric fraction of greenhouse gas i in a time interval t on a dry basis, m^3 gas i/m^3 dry gas, $V_{i,t,db}$

l) Temperature of the gaseous stream in time interval t, T_t;

m) Pressure of the gaseous stream in time interval t, P_t.

n) Density of greenhouse gas i in the gaseous stream in time interval t, $\rho_{i,t}$

o) Fraction of volatile solids directed to aerobic treatment, F_{Aer} ;

p) Fraction of manure handled in system j in project activity, $MS\%_j$;

q) Maximum methane producing potential of the volatile solid generated by animal type *LT,* $B_{0,\ LT}$

r) Type of barn and AWMS, Type

s) Annual average ambient temperature at project site, T

For the number of animals of type LT produced annually for the year y and the daily stock of animals in the farm, discounting dead and discarded animals are sourced from the monthly statistics of the number of exported from stock of market swine and the monthly number of the breeding in stock.

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 usually 180 days.

The monitoring activities of the average animal weight of a defined livestock population at the project site will be conducted by sampling in the three age groups of Nursery phase, Growing phase and Mature phase in each swine farm at least one monthly. The monthly data is recorded by the PP and then average animal weight of a defined livestock population at the project site was calculated based on these data.

The number of days treatment plant was operational is determined according to the actual operating days of the manure treatment system during the monitoring period. The data can be obtained from the production record from the DCS system.

For Electricity generated using biogas in year y can be obtained from the monthly summary table of electricity generated.The quantity of electricity consumed from the grid company by the proposed project is sourced from the summary table of monthly power consumption and cross-checked by the grid statement issued by the power company.

Average technical transmission and distribution losses for providing electricity to source j is sourced from the tool" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" and will be updated once the tool is updated.

Biogas flow, Volumetric flow of the gaseous stream in time interval t on a dry basis and the volumetric fraction of greenhouse gas i in a time interval t on a dry basis can be monitored by the flowmeters and gas analysers, the data are sourced from the production record from the DCS system.

The temperature and pressure of the gaseous stream in time interval t is measured by the instruments with recordable electronic signal, the monitoring is continuous, and the change is very small. so, the data can be obtained from the the production record from the DCS system. And the Density of greenhouse gas i in the gaseous stream in time interval t should be calculated based on the temperature and pressure of the gaseous stream in time interval t.

For Fraction of volatile solids directed to aerobic treatment, F_{Aer} and Fraction of manure handled in system j in project activity, MS%j, since there is no monitoring equipment to monitor in the actual operation. So, in the monitoring period, to be conservative, the value of the two parameters in the emission reduction calculation is 100%.

For $B_{0, LT}$, a default value from IPCC 2006 is applied, therefore it is not monitored during the operation period.

For Type of barn and AWMS, the swine barn and AWMS layout and configuration are collected, which can be prove the Type of barn and AWMS, and only changes in the type of barn and AWMS will be reported after the first verification.

For annual average ambient temperature at project site, the monthly data can be sourced from publicly available information and can be cross-checked with the value of ex-ante estimated, i.e., 15.3℃.

5. Quality control and quality assurance procedures

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. Besides, the project owner should ensure that only skilled employees are allowed to undertake the monitoring work. The training contents should be regard to the general and technical aspects of the project to the extent appropriate, as well as basic understandings of VCS Standard and climate change.

Data management

All data collected as part of monitoring plan should be saved with at least 1 backup copy until the end of the crediting period. After the crediting period ends, the data should be archived electronically on hard disks and be kept at least 2 years after the end of the last crediting period.

Corrective actions

The project signs an agreement that it is not participate in other environment credits, other GHG programs and has not been rejected by any other GHG Programs. The whole VCS monitoring team follow recognized standard data evaluation methods to guarantee that the data is reliable and accurate. 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 should 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 non-conformity and its causes to prevent its recurrence.

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

- Relative information should be included in the monitoring report and reported to VVB during the verification.

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

-The general principle is that Conservative value is used for the missing or damaged data. This is most conservative approach. The monitoring personnel are trained before the starting 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 are required to strictly abide by the above conservative principle in data recording, i.e., use Conservative value for all the missing or damaged data.

-If this is due to the working error of the monitoring personnel, further train the person until he or she can perform the job properly. And in the meantime, use Conservative value for the missing or damaged data;

-If this is due to the inability or attitude of a particular worker in monitoring team, dismiss such worker and re-hire those with proper ability and attitude. And in the meantime, use Conservative value for the missing or damaged data;

-If some data recorded are 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, Conservative value is used for that day's data. And 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 is accepted for the monitoring report.

6. Sample plan

The sampling objective

To determining the average animal weight of a defined livestock population at the project site during the crediting period with a 95/10 confidence/precision.

According to "Sampling and surveys for CDM project activities and programmes of activities (Version 09.0)[47]", the sampling plan is as follows:

Table 5-1 Sampling plan of the project

Parameter	Wsite
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 "Sampling and surveys for CDM project activities and programmes of activities (Version 09.0)", PP shall use 95/10

47 https://cdm.unfccc.int/filestorage/e/x/t/extfile-20210531160756474-Meth_Stan05.pdf/Meth_Stan05.pdf?t=T2x8cjBuZjFpfDDpBcoW32Nj3OQgIkN4PmUs

	confidence/precision as the criteria for the reliability of sampling efforts for large-scale project. 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; The three age categories of marketing swine are classified according to the age in days, i.e. Nursery phase with 30-60days, Growing phase with 60-130days and Mature phase with 130-180days. The three age categories of breeding swine are classified according to the age in days, i.e. Nursery phase with 30-70days, Growing phase with 70-220days and Mature phase with 220-310days. 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 Nursery phase, Growing phase and Mature phase in each swine farm at least one monthly.
Target population and sampling frame	For the ex-calculation, A total of 99,450 Market swine and 54,252 Breeding swine included in this project and the data of the average animal weight of a defined livestock population at the project site is from the Project technical evaluation report. As the applied value of 99,450 Market swine and 54,252 Breeding swine is the design scale, 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 in the monitoring period and it is conservative.
Sampling method	For this project, Siyang Aiyuan farm, Dongtai Jianggang Farm and Sheyang Linhai farm has breeding swine and market swine in stock, Siyang Nanliuji farm belongs to fatting farm which only have market swine. As this project involved 4 swine farms and two types of swine i.e., Market swine and Breeding swine, and as per applied methodology, each defined livestock population should be classified into a minimum of three age categories, so the sampling method is Stratified random sampling. The specific sampling methods are as follows: For the sampling, PP should calculate the overall sample size based on the population of pigs in stock firstly. As the project involved 4 swine farms, so the sample size in each swine farm should be determined based on the proportion of the number of each farm in the total number of 4 farms. Similarly, the sample size of each age group of Market swine and Breeding swine in a farm were also calculated based on the proportion of the number of each age group of Market swine and Breeding swine to the total number of swine in the farm. After the sample size in each age group of Market swine and Breeding swine of each swine farm determined, the sample can be conducted in every swine farm. Since swine in different age are kept in the different pig houses, samples can be randomly selected from pig houses of this age group. After the samples are selected, the weight is measured by weight measurers and recorded in the weight record table.

The sampling sizes

According to the standard of the “Sampling and surveys for CDM project activities and programmes of activities (Version 09.0)”, PP shall use 95/10 confidence/precision as the criteria for the reliability of sampling efforts for large-scale project.

According to statistical principles and sampling survey method, the sample size should be determined as follows[48]:

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

$n_2 = n_1N/(N+n_1)$

$n_3 = Bn_2$

$n_4 = n_3/r$

$n = n_4\ (110\%)$

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 153,702;

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, 10% contingency was added to* n_4 *to produce n in this sampling.*

For pre-calculation, since the total number of involved swine is 153,702, N in the calculation of sample size is 153,702, and the calculation result is as follows:

Table 5-2 the calculation result of overall sample size

Z	V	e	N	B	r
1.96	1	10%	153,702	1	100%
n_1	Z^2V^2/e^2	384			
n_2	$n_1N/(N+n_1)$	383			
n_3	Bn_2	383			
n_4	n_3/r	383			

48 https://www.doc88.com/p-73947158230.html

n	*n_4 (110%)*	422

The calculation result of n is 422. Therefore, 422 samples should be sufficient to satisfy the desired confidence and precision.

As the applied value of 99,450 Market swine and 54,252 Breeding swine is the design scale, 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 in monitoring period and it is conservative.

Stratified sampling (with samples of 422) was used for the monitoring of the W_{site}. The specific sampling methods are as follows: For the sampling, PP should calculate the overall sample size based on the population of pigs in stock firstly. As the project involved 4 swine farms, so the sample size in each swine farm should be determined based on the proportion of the number of each farm in the total number of 4 farms. Similarly, the sample size of each age group of Market swine and Breeding swine in a farm were also calculated based on the proportion of the number of each age group of Market swine and Breeding swine to the total number of swine in the farm. The distribution of the samples in each age category in each farm shows as follow:

Table 5-3 The distribution of the samples in each age category in each farm

NO.	Swine farm	Swine type	age catagory	Sample size
1	Siyang Aiyuan Farm	Market	Nursery phase with 30-60days	9
			Growing phase with 60-130days	9
			Mature phase with 130-180days	9
		Breeding	Nursery phase with 30-70days	16
			Growing phase with 70-220days	16
			Mature phase with 220-310days	16
2	Dongtai Jianggang Farm	Market	Nursery phase with 30-60days	10
			Growing phase with 60-130days	10
			Mature phase with 130-180days	10
		Breeding	Nursery phase with 30-70days	29
			Growing phase with 70-220days	29
			Mature phase with 220-310days	29
3	Sheyang Linhai Farm	Market	Nursery phase with 30-60days	12
			Growing phase with 60-130days	12
			Mature phase with 130-180days	12
		Breeding	Nursery phase with 30-70days	7
			Growing phase with 70-220days	7
			Mature phase with 220-310days	7
4	Siyang Nanliuji Farm	Market	Nursery phase with 30-60days	63
			Growing phase with 60-130days	62
			Mature phase with 130-180days	62
Total				436

Implementation and Monitoring frequency

The Sampling process will start as soon as the target population is determined, and the sampling should be done once a month.

The one monthly monitoring activity of the samples will be completed in the 4 swine farms during each monitoring periods.

Because the sampling activity is once a month, all the samples will be changed in the next month. The monitoring data will be collected and recorded throughout the entire crediting period. All archived data and documentation will be kept for at least 2 years after the end of the last crediting period.

Procedures for Administering Data Collection and Minimizing Non-sampling Errors

During the monthly monitoring activities, the weight of the month's sample was recorded in the weight record table by the monitoring team member in the 4 swine farms. Then average animal weight of a defined livestock population at the project site was calculated based on these data by the monitoring team member. The data will be reviewed by the project developer and VVB.

If the recorded raw data on the monitoring form are reasonable and basically consistent with the actual growth state, the raw data is archived.

If the data record is missing or damaged or the target animal was dead during the monitoring periods, the following makeup process should be conducted:

1) The general principle is that zero value is used for the missing or damaged data. This is most conservative approach. The monitoring personnel are trained before the starting 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 are required to strictly abide by the above conservative principle in data recording, i.e., use zero values for all the missing or damaged data.

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

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

4) If some data recorded 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, zero value is used for that day's data. And need to calibrate and maintain the weighing scale or replace 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 is accepted for the monitoring report.

QA/QC Procedures

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

If the data reported by the team member significantly deviates from the normal range, the monitoring personnel should write down the reasons and report to the team leader, any action is forbidden before the permission. The monitoring team arrange research according to the attached form. At the same time, when the verification group has any doubt with the right result, they can arrange related research.

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

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

6.1 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
Value applied:	(see table below)
Comments	$N_{p,LT}$ has been crosschecked through the sale records of Market swine in 4 swine farms during this monitoring period.

Time	$N_{p,LT}$
10-June-2020 to 30-June-2020	11,126 heads of Market swine
01-July-2020 to 31-July-2020	16,043 heads of Market swine
01-August-2020 to 31-August-2020	15,970 heads of Market swine
01-September-2020 to 30-September-2020	16,048 heads of Market swine
01-October-2020 to 31-October-2020	15,991 heads of Market swine
01-November-2020 to 30-November-2020	15,998 heads of Market swine
01-December-2020 to 31-December-2020	16,010 heads of Market swine
01-January-2021 to 31-January-2021	15,982 heads of Market swine
01-February-2021 to 28-February-2021	16,023 heads of Market swine
01-March-2021 to 31-March-2021	16,031 heads of Market swine
01-April-2021 to 30-April-2021	15,943 heads of Market swine
01-May-2021 to 31-May-2021	15,959 heads of Market swine
01-June-2021 to 30-June-2021	16,036 heads of Market swine
01-July-2021 to 31-July-2021	16,026 heads of Market swine
01-August-2021 to 31-August-2021	16,000 heads of Market swine
01-September-2021 to 30-September-2021	16,043 heads of Market swine
01-October-2021 to 31-October-2021	16,036 heads of Market swine
01-November-2021 to 30-November-2021	16,036 heads of Market swine
01-December-2021 to 31-December-2021	15,975 heads of Market swine
Total	299,276 heads of Market swine

	And according to the Equation 5, the calculated N_{LT} is 94,708 (299,276heads *180 days /365days *12month/18.7month) heads. Also, according to the number of market pigs produced annually of each farm, the N_{LT} calculated by Equation 5 is rounded to an integer as 94,708 heads. Therefore, the 94,708 heads were applied in the calculations of emission reductions in MR.

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
Value applied:	see table below
Comments	During this monitoring period, a certain number of market swine are slaughtered in each farm every month and the number of days market swine alive in the farm is 180days as per Export record

Time	$N_{da,LT}$
10-June-2020 to 30-June-2020	180 days[49]
01-July-2020 to 31-July-2020	180 days
01-August-2020 to 31-August-2020	180 days
01-September-2020 to 30-September-2020	180 days
01-October-2020 to 31-October-2020	180 days
01-November-2020 to 30-November-2020	180 days
01-December-2020 to 31-December-2020	180 days
01-January-2021 to 31-January-2021	180 days
01-February-2021 to 28-February-2021	180 days
01-March-2021 to 31-March-2021	180 days
01-April-2021 to 30-April-2021	180 days
01-May-2021 to 31-May-2021	180 days
01-June-2021 to 30-June-2021	180 days
01-July-2021 to 31-July-2021	180 days
01-August-2021 to 31-August-2021	180 days
01-September-2021 to 30-September-2021	180 days
01-October-2021 to 31-October-2021	180 days
01-November-2021 to 30-November-2021	180 days
01-December-2021 to 31-December-2021	180 days

[49] During this monitoring period, a certain number of market swine are exported from the stock every month, as per export record form of Market swine, the number of days Market swine alive in the farm is 180days, also this parameter needs to be monitored every month, therefore, the number of days of the market swine which exported from the stockin every month is 180 day.

	form of market swine. Also, this parameter needs to be monitored every month, therefore, the number of days of the market swine alive in the farm is 180 days. The number of days the animal alive in the farm is crosschecked through the sale records of 4 swine farms during this monitoring period. and it can be concluded that the data is consistent. In addition, this value is in line with the number of days for pigs to be slaughtered by existing large-scale breeding groups in China[50].

Data / Parameter	$N_{AA,LT}$
Data unit	Number
Description	Daily stock of animals in the farm, discounting dead and discarded animals
Value applied:	see table below

Time	$N_{AA,LT}$
10-June-2020 to 30-June-2020	51,811 heads of Breeding swine
01-July-2020 to 31-July-2020	51,845 heads of Breeding swine
01-August-2020 to 31-August-2020	51,842 heads of Breeding swine
01-September-2020 to 30-September-2020	51,855 heads of Breeding swine
01-October-2020 to 31-October-2020	51,808 heads of Breeding swine
01-November-2020 to 30-November-2020	51,858 heads of Breeding swine
01-December-2020 to 31-December-2020	51,872 heads of Breeding swine
01-January-2021 to 31-January-2021	51,865 heads of Breeding swine
01-February-2021 to 28-February-2021	51,889 heads of Breeding swine
01-March-2021 to 31-March-2021	51,838 heads of Breeding swine
01-April-2021 to 30-April-2021	51,829 heads of Breeding swine
01-May-2021 to 31-May-2021	51,836 heads of Breeding swine
01-June-2021 to 30-June-2021	51,849 heads of Breeding swine
01-July-2021 to 31-July-2021	51,854 heads of Breeding swine
01-August-2021 to 31-August-2021	51,815 heads of Breeding swine
01-September-2021 to 30-September-2021	51,900 heads of Breeding swine
01-October-2021 to 31-October-2021	51,859 heads of Breeding swine
01-November-2021 to 30-November-2021	51,827 heads of Breeding swine
01-December-2021 to 31-December-2021	51,854 heads of Breeding swine

[50] https://zhuanlan.zhihu.com/p/38676811
http://finance.people.com.cn/n1/2017/1121/c1004-29658996.html

Comments	Monitored daily through the auto tracking devices of electronic ear tag and the data can be obtained from Breeding pig Daily stock record.

Data / Parameter	W_{site}
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Value applied:	(see table below)

Time	Market pigs	Breeding Pigs
10-June-2020 to 30-June-2020	58.0	72.1
01-July-2020 to 31-July-2020	57.7	71.4
01-August-2020 to 31-August-2020	57.4	73.1
01-September-2020 to 30-September-2020	59.0	72.2
01-October-2020 to 31-October-2020	58.7	71.7
01-November-2020 to 30-November-2020	58.7	73.2
01-December-2020 to 31-December-2020	57.8	74.2
01-January-2021 to 31-January-2021	59.1	72.0
01-February-2021 to 28-February-2021	58.9	72.6
01-March-2021 to 31-March-2021	57.7	72.7
01-April-2021 to 30-April-2021	56.7	73.6
01-May-2021 to 31-May-2021	57.9	73.3
01-June-2021 to 30-June-2021	57.5	71.6
01-July-2021 to 31-July-2021	57.8	72.0
01-August-2021 to 31-August-2021	58.1	72.1
01-September-2021 to 30-September-2021	59.1	72.3
01-October-2021 to 31-October-2021	58.4	73.3
01-November-2021 to 30-November-2021	57.8	72.5
01-December-2021 to 31-December-2021	58.1	72.0

Comments

Measured by the weight measurers and record by the technical staff in each farm monthly.

Weight measurers were calibrated on 16-May-2020 and 13-May-2021 by Jiangsu Institute of Metrology in compliance with JJG539-2016 “Verification Regulation of Digital Indicating Weighting Instruments” in China.

Swine farm	Type/Accuracy	Series number	Calibration date	Validity

Siyang Aiyuan	XK3190-A12+（E）/3 level	2020010125	16-May-2020 13-May-2021	1 year
Dongtai Jianggang		2020020114		
Sheyang Linhai		2020030108		
Siyang Nanliuji		2020040095		

Data / Parameter	F_{Aer}
Data unit	Fraction
Description	Fraction of volatile solids directed to aerobic treatment
Value applied:	100%
Comments	During this monitoring period, there is no equip install in the project activity to monitor the influent into anaerobic digestion and aerobic system, therefore the value of F_{Aer} is applied as 100%, which is conservative.

Data / Parameter	n_{dy}
Data unit	number
Description	Number of days treatment plant was operational in year y.
Value applied:	The actual number of days 4 treatment plants that was operational are 570 days during this monitoring periods.

Time	n_{dy} (days)
10-June-2020 to 30-June-2020	21
01-July-2020 to 31-July-2020	31
01-August-2020 to 31-August-2020	31
01-September-2020 to 30-September-2020	30
01-October-2020 to 31-October-2020	31
01-November-2020 to 30-November-2020	30
01-December-2020 to 31-December-2020	31
01-January-2021 to 31-January-2021	31
01-February-2021 to 28-February-2021	28
01-March-2021 to 31-March-2021	31
01-April-2021 to 30-April-2021	30
01-May-2021 to 31-May-2021	31
01-June-2021 to 30-June-2021	30
01-July-2021 to 31-July-2021	31
01-August-2021 to 31-August-2021	31
01-September-2021 to 30-September-2021	30
01-October-2021 to 31-October-2021	31
01-November-2021 to 30-November-2021	30
01-December-2021 to 31-December-2021	31

	Total in this monitoring period	570
Comments	The production record from DCS system can be demonstrated that the AWMSs are actually running on a daily basis.	

Data / Parameter	Vf
Data unit	m^3
Description	Biogas flow
Value applied:	see table below

Monitoring Period	Vf1- at outlet of the anaerobic digestion (m3)	Vf2- at the inlet of generator (m3)	Vf3- in inlet of flare system (m3)
10-June-2020 to 30-June-2020	746,776.20	732,654.95	0.00
01-July-2020 to 31-July-2020	1,102,662.24	1,083,377.93	0.00
01-August-2020 to 31-August-2020	1,102,637.70	1,084,195.74	0.00
01-September-2020 to 30-September-2020	1,067,171.76	1,049,185.33	0.00
01-October-2020 to 31-October-2020	1,102,359.48	1,081,540.63	0.00
01-November-2020 to 30-November-2020	1,067,195.52	1,047,032.17	0.00
01-December-2020 to 31-December-2020	1,102,883.22	1,085,617.84	0.00
01-January-2021 to 31-January-2021	1,102,825.86	1,082,869.33	0.00
01-February-2021 to 28-February-2021	996,278.22	982,217.58	0.00
01-March-2021 to 31-March-2021	1,102,604.88	1,083,294.11	0.00
01-April-2021 to 30-April-2021	1,066,965.84	1,050,052.85	0.00
01-May-2021 to 31-May-2021	1,102,588.56	1,086,546.39	0.00
01-June-2021 to 30-June-2021	1,067,124.24	1,048,553.27	0.00
01-July-2021 to 31-July-2021	1,102,735.86	1,087,112.83	0.00

01-August-2021 to 31-August-2021	1,102,416.78	1,083,284.28	0.00
01-September-2021 to 30-September-2021	1,067,528.16	1,052,486.76	0.00
01-October-2021 to 31-October-2021	1,102,776.84	1,084,973.34	0.00
01-November-2021 to 30-November-2021	1,066,950.00	1,048,518.30	0.00
01-December-2021 to 31-December-2021	1,102,735.92	1,085,791.25	0.00
10-June-2020 to 31-December-2021	20,275,217.28	19,939,304.88	0.00

Comments

Monitored continuously by flow meter 1, flowmeter 2 and flowmeter 3. Flow meter 1 was installed at the outlet of the anaerobic tank to monitor the volumetric flow of biogas produced. Flow meter 2 was installed at the inlet of the biogas generator set to monitor the volumetric flow of biogas entering the biogas generator. Flow meter 3 was installed at the inlet of the flare system to monitor the volumetric flow of biogas destroyed by the flare. The monitored data can be recorded hourly and saved automatically in the Data Collection System (DCS). The data can be obtained from this system.

Flow meters were calibrated on 13-May-2020 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China.

For this monitoring period, all the biogas produced is used for power generation, no surplus biogas for the flaring system.

The calibration information for flow meter 1 is as follows:

Swine farm	Type/Accuracy	Series number	Calibration date	Validity
Siyang Aiyuan	HD-LU/1.5 Level	202001003478	13-May-2020	2 years
Dongtai Jianggang		202002005859		
Dongtai Linhai		202003003867		
Siyang Nanliuji		202004004231		

The calibration information for flow meter 2 is as follows:

Swine farm	Type/Accuracy	Series number	Calibration date	Validity
Siyang Aiyuan	HD-LU/1.5 Level	202001003479	13-May-2020	2 years
Dongtai Jianggang		202002005860		
Dongtai Linhai		202003003868		
Siyang Nanliuji		202004004232		

	The calibration information for flow meter 3 is as follows:

Swine farm	Type/Accuracy	Series number	Calibration date	Validity
Siyang Aiyuan	HD-LU/1.5 Level	202001003480	13-May-2020	2 years
Dongtai Jianggang		202002005861		
Dongtai Linhai		202003003869		
Siyang Nanliuji		202004004233		

Data / Parameter	$EC_{PJ,j,y}$[51]
Data unit	MWh
Description	Quantity of electricity consumed by the proposed project in year y
Value applied:	(see table below)
Comments	Monitored continuously by electricity meter 1 installed in the 4 manure treatment plants. Power consumption data is recorded

Period	Electricity supplied by the grid company (MWh)
10-June-2020 to 30-June-2020	32.01
01-July-2020 to 31-July-2020	33.90
01-August-2020 to 31-August-2020	30.45
01-September-2020 to 30-September-2020	31.07
01-October-2020 to 31-October-2020	35.15
01-November-2020 to 30-November-2020	34.21
01-December-2020 to 31-December-2020	33.58
01-January-2021 to 31-January-2021	32.64
01-February-2021 to 28-February-2021	33.90
01-March-2021 to 31-March-2021	35.47
01-April-2021 to 30-April-2021	33.90
01-May-2021 to 31-May-2021	30.13
01-June-2021 to 30-June-2021	30.13
01-July-2021 to 31-July-2021	32.96
01-August-2021 to 31-August-2021	32.96
01-September-2021 to 30-September-2021	32.96
01-October-2021 to 31-October-2021	31.39
01-November-2021 to 30-November-2021	35.78
01-December-2021 to 31-December-2021	33.27
Total in this monitoring period	625.86

[51] In this monitoring period, all the biogas generated by the anaerobic fermentation process is used for power generation. While, the amount of biogas generated in Siyang Nanliuji farm cannot reach the biogas required for the full-load operation of the generator set. When the generator does not generate electricity, the system runs electricity must be purchased from the grid. In other three farm, the amount of biogas produced can meet the full load operation of the generators, so there is no need to purchase electricity from power grid. So, in this monitoring period, the electricity consumed from power grid company only happened in Siyang Naliuji swine farm.

	daily and summarized monthly and cross-checked with Grid Company Electricity Statement. Electricity meters were calibrated on 18-May-2020 by an officially accredited entity in compliance with JJG 596-2012: Electrical Meters for Measuring Alternating-current Electrical Energy. And during this monitoring period, most of the electricity consumed by the project came from the electricity generated by the biogas generated from the anaerobic fermentation process of the project, which is belongs to self-generated and self-consumed. The electricity consumption of AWMSs were sourced from the grid company when the biogas generators were not operation.

Swine farm	Type/Accuracy	Series number	Calibration date	Validity
Siyang Aiyuan	DTSD341/0.2S	01000009330210	18-May-2020	5 years
Dongtai Jianggang		1311198937000001		
Dongtai Linhai		010000085605372		
Siyang Nanliuji		010000078304212		

Data / Parameter	$EG_{d,y}$
Data unit	MWh
Description	electricity generated using biogas in year y
Value applied:	

Period	Electricity generated by the project (MWh)
10-June-2020 to 30-June-2020	988.31
01-July-2020 to 31-July-2020	1,460.97
01-August-2020 to 31-August-2020	1,462.24
01-September-2020 to 30-September-2020	1,415.03
01-October-2020 to 31-October-2020	1,458.22
01-November-2020 to 30-November-2020	1,411.99
01-December-2020 to 31-December-2020	1,464.24
01-January-2021 to 31-January-2021	1,460.10
01-February-2021 to 28-February-2021	1,324.61
01-March-2021 to 31-March-2021	1,460.58
01-April-2021 to 30-April-2021	1,416.66
01-May-2021 to 31-May-2021	1,464.93
01-June-2021 to 30-June-2021	1,414.22
01-July-2021 to 31-July-2021	1,465.92
01-August-2021 to 31-August-2021	1,461.13
01-September-2021 to 30-September-2021	1,419.38
01-October-2021 to 31-October-2021	1,462.57
01-November-2021 to 30-November-2021	1,414.15
01-December-2021 to 31-December-2021	1,464.18
total	26,889.44

Comments	Monitored continuously by electricity meter 2 installed in the outlet of biogas generators. The quantity of electricity generation can be obtained from the monthly summary table of electricity generated. Electricity meters were calibrated on 18-March-2020 by an officially accredited entity in compliance with JJG 596-2012: Electrical Meters for Measuring Alternating-current Electrical Energy.

Swine farm	Type/Accuracy	Series number	Calibration date	Validity
Siyang Aiyuan	DTSD341/ 0.2S	01000009330211	18-March-2020	5 years
Dongtai Jianggang		1311198937000002		
Dongtai Linhai		010000085605373		
Siyang Nanliuji		010000078304213		

Data / Parameter	$TDL_{j,y}$
Data unit	%
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*
Value applied:	20
Comments	The value of this parameter sourced from Tool 05 “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (version 03.0) and this tool is not updated in this monitoring period.

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
Value applied:	

Period	$V_{t,db}$ (m^3 dry gas/h) monitored by flow meter 1	$V_{t,db}$ (m^3 dry gas/h) monitored by flow meter 3
10-June-2020 to 30-June-2020	1,481.70	0
01-July-2020 to 31-July-2020	1,482.07	0
01-August-2020 to 31-August-2020	1,482.04	0
01-September-2020 to 30-September-2020	1,482.18	0
01-October-2020 to 31-October-2020	1,481.67	0
01-November-2020 to 30-November-2020	1,482.22	0

01-December-2020 to 31-December-2020	1,482.37	0
01-January-2021 to 31-January-2021	1,482.29	0
01-February-2021 to 28-February-2021	1,482.56	0
01-March-2021 to 31-March-2021	1,482.00	0
01-April-2021 to 30-April-2021	1,481.90	0
01-May-2021 to 31-May-2021	1,481.97	0
01-June-2021 to 30-June-2021	1,482.12	0
01-July-2021 to 31-July-2021	1,482.17	0
01-August-2021 to 31-August-2021	1,481.74	0
01-September-2021 to 30-September-2021	1,482.68	0
01-October-2021 to 31-October-2021	1,482.23	0
01-November-2021 to 30-November-2021	1,481.88	0
01-December-2021 to 31-December-2021	1,482.17	0

Comments

Monitored continuously by flow meter 1 and 3. The flow meters 1 was installed at the outlet of the anaerobic tank to monitor the volumetric flow of biogas produced. Flow meter 3 was installed at the entrance of the flare system to monitor the volumetric flow of biogas destroyed by the flare. The monitored data can be recorded hourly and saved automatically in the Data Collection System (DCS). The data can be obtained from this system.

Flow meters were calibrated on 13-May-2020 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China.
The calibration specifics information is listed in above table of monitored parameter "v_f".

Data / Parameter	$V_{i,t,db}$
Data unit	m^3 gas i/m^3 dry gas
Description	Volumetric fraction of greenhouse gas i in a time interval t on a dry basis

Value applied:

Period	Average $V_{i,t,db}$ (m^3 gas i/m^3 dry gas)
10-June-2020 to 30-June-2020	60.00
01-July-2020 to 31-July-2020	59.88
01-August-2020 to 31-August-2020	61.02
01-September-2020 to 30-September-2020	59.00
01-October-2020 to 31-October-2020	60.16
01-November-2020 to 30-November-2020	60.78
01-December-2020 to 31-December-2020	60.76
01-January-2021 to 31-January-2021	60.83
01-February-2021 to 28-February-2021	59.30
01-March-2021 to 31-March-2021	60.71
01-April-2021 to 30-April-2021	59.85
01-May-2021 to 31-May-2021	59.76
01-June-2021 to 30-June-2021	59.31
01-July-2021 to 31-July-2021	61.20
01-August-2021 to 31-August-2021	59.76

	01-September-2021 to 30-September-2021	59.84
	01-October-2021 to 31-October-2021	60.39
	01-November-2021 to 30-November-2021	61.37
	01-December-2021 to 31-December-2021	62.18

Comments

Measured continuously and record hourly by online gas analysers installed at the outlet of the anaerobic digesters and saved automatically in the DCS (Data Collection System). The data can be obtained from this system. Daily and Monthly CH_4 concentration was calculated based on the 24-hour average and daily average CH_4 concentration.

All the gas analysers were calibrated on 13-May-2020 and 10-May-2021 by an officially accredited entity in compliance with JJG693-2011" Verification Regulation of Alarmer Detectors of Combustible Gas" in China. And the zero verification with an inert gas (N_2) and one reading verification with a standard gas (single calibration gas) are implemented in the process of calibration, which is in accordance with JJG693-2011. All calibration gases are from Nanjing Changyuan Industrial Gas Co.Ltd, which is a qualified reference materials manufacturer issued by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China on 06-Septemner-2017.

Swine farm	Type	Series number	Calibration date	Validity
Siyang Aiyuan	Gasboard-9060	2020010034781	13-May-2020 and 10-May-2021	1 years
Dongtai Jianggang		2020020058591		
Dongtai Linhai		2020030038671		
Siyang Nanliuji		2020040042311		

Data / Parameter	T_t
Data unit	K
Description	Temperature of the gaseous stream in time interval t
Value applied:	

Period	Average Tt (K)
10-June-2020 to 30-June-2020	310.05
01-July-2020 to 31-July-2020	309.85
01-August-2020 to 31-August-2020	309.45
01-September-2020 to 30-September-2020	309.75
01-October-2020 to 31-October-2020	310.15
01-November-2020 to 30-November-2020	309.65
01-December-2020 to 31-December-2020	309.25
01-January-2021 to 31-January-2021	310.05
01-February-2021 to 28-February-2021	308.85
01-March-2021 to 31-March-2021	310.35
01-April-2021 to 30-April-2021	309.95
01-May-2021 to 31-May-2021	310.15
01-June-2021 to 30-June-2021	310.05
01-July-2021 to 31-July-2021	309.05
01-August-2021 to 31-August-2021	309.75

	01-September-2021 to 30-September-2021	310.05
	01-October-2021 to 31-October-2021	310.05
	01-November-2021 to 30-November-2021	309.85
	01-December-2021 to 31-December-2021	310.65
Comments	Measured continuously by the biogas flow meters, since the flowmeters can monitor other parameter such as $V_{t,db}$, T_t and P_t simultaneously. And record hourly and saved automatically in the DCS system. The readout of flowmeter was indicated degrees Celsius (°C). Therefore, the temperature T_t(K) is calculated as the equation T(K)=t(°C) +273.15. The data can be obtained from DCS system. Daily and Monthly temperature was calculated based on the 24-hour average and daily average temperature. Flow meters were calibrated on 13-May-2020 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China. The calibration specifics information is listed in above table of monitored parameter "v_f".	

Data / Parameter	P_t
Data unit	Pa
Description	Pressure of the gaseous stream in time interval t
Value applied:	(see table below)

Period	Average P_t (Pa)
10-June-2020 to 30-June-2020	101325
01-July-2020 to 31-July-2020	101325
01-August-2020 to 31-August-2020	101325
01-September-2020 to 30-September-2020	101325
01-October-2020 to 31-October-2020	101325
01-November-2020 to 30-November-2020	101325
01-December-2020 to 31-December-2020	101325
01-January-2021 to 31-January-2021	101325
01-February-2021 to 28-February-2021	101325
01-March-2021 to 31-March-2021	101325
01-April-2021 to 30-April-2021	101325
01-May-2021 to 31-May-2021	101325
01-June-2021 to 30-June-2021	101325
01-July-2021 to 31-July-2021	101325
01-August-2021 to 31-August-2021	101325
01-September-2021 to 30-September-2021	101325
01-October-2021 to 31-October-2021	101325
01-November-2021 to 30-November-2021	101325
01-December-2021 to 31-December-2021	101325

Comments	Measured continuously by the biogas flow meters, since the flowmeters can monitor other parameter such as $V_{t,db}$, T_t and P_t simultaneously. The data can be obtained from DCS system. Daily and Monthly pressure was calculated based on the 24-hour average and daily average pressure.

	Flow meters were calibrated on 13-May-2020 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China. The calibration specifics information is listed in above table of monitored parameter "v_f".

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
Value applied:	see table below
Comments	Calculated based on temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t using Equations (19) and (24). The monitoring result of Pressure and temperature are listed in the above two tables.

Period	$\rho_{i,t}$ (kg gas i/m³ gas i)
10-June-2020 to 30-June-2020	0.00063
01-July-2020 to 31-July-2020	0.00063
01-August-2020 to 31-August-2020	0.00063
01-September-2020 to 30-September-2020	0.00063
01-October-2020 to 31-October-2020	0.00063
01-November-2020 to 30-November-2020	0.00063
01-December-2020 to 31-December-2020	0.00063
01-January-2021 to 31-January-2021	0.00063
01-February-2021 to 28-February-2021	0.00063
01-March-2021 to 31-March-2021	0.00063
01-April-2021 to 30-April-2021	0.00063
01-May-2021 to 31-May-2021	0.00063
01-June-2021 to 30-June-2021	0.00063
01-July-2021 to 31-July-2021	0.00063
01-August-2021 to 31-August-2021	0.00063
01-September-2021 to 30-September-2021	0.00063
01-October-2021 to 31-October-2021	0.00063
01-November-2021 to 30-November-2021	0.00063
01-December-2021 to 31-December-2021	0.00063

Data / Parameter	MS%$_j$
Data unit	Fraction
Description	Fraction of manure handled in system j in project activity
Value applied:	100%. As this parameter is not monitored during this monitoring period. so, to be conservative, the value of this parameter in the emission reduction calculation is 100%.

Comments	All the manure flew into AWMSs to be treated; no any manure was discharged outside. Therefore, the value of this parameter is 100%

Data / Parameter	$B_{0, LT}$
Data unit	m^3CH_4/kg -dm
Description	Maximum methane producing potential of the volatile solid generated by animal type *LT*
Value applied:	$B_{0, LT}$ (Market swine) =0.29[52] $B_{0, LT}$ (Breeding swine) =0.29
Comments	$B_{0, LT}$ can be measured as per ISO 11734:1995. As this parameter is not monitored in the actual operation. so, in the monitoring period 0.29 m^3CH_4/kg -dm is still applied. While the actual methane producing potential of the volatile solid generated by swine manure is 479.4ml/gVS according to the public literature[53],which is higher. Therefore 0.29 m^3CH_4/kg -dm applied in monitoring period is conservative.

Data / Parameter	Type
Data unit	/
Description	Type of barn and AWMS
Value applied:	N/A
Comments	After the first verification, only changes in the type of barn and AWMS will be reported. This monitoring is the first monitoring period and in this monitoring period, the swine barn and AWMS layout and configuration are consistent with the design which is approved by the official government.

Data / Parameter	T
Data unit	°C

[52] The proposed project is located in Jiangsu Province, China, Asia. According to Table 10A-7 and 10A-8 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for Market swine and Breeding swine in Asia region is 0.29 m^3 CH_4/kg VS.

[53] http://www.doc88.com/p-9902182440715.html

<table>
<tr><td>Description</td><td>Annual average ambient temperature at project site</td></tr>
<tr><td>Value applied:</td><td><table><tr><th>Time</th><th>T (°C)</th></tr><tr><td>10-June-2020 to 31-December-2020</td><td>16.4[54]</td></tr><tr><td>01-January-2021 to 31-December-2021</td><td>16.8[55]</td></tr></table></td></tr>
<tr><td>Comments</td><td>Cross-Check with the value of ex-ante estimated, i.e., 15.3˚C[56]. After compared the actual temperature in 2020 and 2021 and the temperature of ex-ante estimated, So, in this monitoring period, MCFj value is 74% with the lower temperature of 15.3°C as per Appendix 3 of ACM0010(Version 08.0). Then multiplying MCF values with a value of 0.94, so 69.56% of MCF_j is used for calculation during in this monitoring period.</td></tr>
</table>

6.2 Baseline Emissions

As per paragraph 26 of the applied methodology, Baseline emissions are: $BE_y = BE_{CH4,y} + BE_{N2O,y} + BE_{elec/heat,y}$

As described in section 4.1, 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 was captured for power generation and all the electricity generated from this project is used by the daily operation of AWMSs and the 4 swine farms. The electricity generated is not connected to another user or to the regional power grid. So, the baseline CO_2 emission from electricity and/or heat used in the baseline is 0, which is conservative. So, $BE_y = BE_{CH4,y} + BE_{N2O,y}$.

During this monitoring period, the basic monitoring data values used in the calculation of baseline emissions and the calculation results are shown in the table 6-1 and table 6-2.

[54] http://js.weather.com.cn/ssstq/01/3429706.shtml
[55] https://baijiahao.baidu.com/s?id=1726325028712251976&wfr=spider&for=pc
[56] http://jiangsu.china.com.cn/html/jsnews/around/4842719_1.html

Table 6-1 the basic monitoring data values used in the calculation of baseline emissions

Time	N_{LT}	$N_{AA,LT}$	W_{site} (kg)		n_{dy}(day)	$VS_{LT,y}$ (kg-dm/ animal/year)		NEX_{IPCC} (kg N/animal/year)		$NEX_{LT,y}$ (kg N/animal/year)	
	Market swine	Breeding swine	Market swine	Breeding swine		Market swine	Breeding swine	Market swine	Breeding swine	Market swine	Breeding swine
10-June-2020 to 30-June-2020	94,708	51,811	58.0	72.1	21	18.64	23.18	0.35	0.35	0.73	0.91
01-July-2020 to 31-July-2020	94,708	51,845	57.7	71.4	31	19.16	23.72	0.36	0.36	0.75	0.93
01-August-2020 to 31-August-2020	94,708	51,842	57.4	73.1	31	19.07	24.28	0.36	0.36	0.75	0.95
01-September-2020 to 30-September-2020	94,708	51,855	59.0	72.2	30	18.96	23.21	0.35	0.35	0.74	0.91
01-October-2020 to 31-October-2020	94,708	51,808	58.7	71.7	31	19.50	23.81	0.36	0.36	0.76	0.93
01-November-2020 to 30-November-2020	94,708	51,858	58.7	73.2	30	18.87	23.53	0.35	0.35	0.74	0.92
01-December-2020 to 31-December-2020	94,708	51,872	57.8	74.2	31	19.20	24.65	0.36	0.36	0.75	0.97
01-January-2021 to 31-January-2021	94,708	51,865	59.1	72.0	31	19.63	23.91	0.36	0.36	0.77	0.94
01-February-2021 to 28-February-2021	94,708	51,889	58.9	72.6	28	17.67	21.78	0.33	0.33	0.69	0.85
01-March-2021 to 31-March-2021	94,708	51,838	57.7	72.7	31	19.16	24.15	0.36	0.36	0.75	0.95

01-April-2021 to 30-April-2021	94,708	51,829	56.7	73.6	30	18.23	23.66	0.35	0.35	0.71	0.93
01-May-2021 to 31-May-2021	94,708	51,836	57.9	73.3	31	19.23	24.35	0.36	0.36	0.75	0.95
01-June-2021 to 30-June-2021	94,708	51,849	57.5	71.6	30	18.48	23.01	0.35	0.35	0.72	0.90
01-July-2021 to 31-July-2021	94,708	51,854	57.8	72.0	31	19.20	23.91	0.36	0.36	0.75	0.94
01-August-2021 to 31-August-2021	94,708	51,815	58.1	72.1	31	19.30	23.95	0.36	0.36	0.76	0.94
01-September-2021 to 30-September-2021	94,708	51,900	59.1	72.3	30	19.00	23.24	0.35	0.35	0.74	0.91
01-October-2021 to 31-October-2021	94,708	51,859	58.4	73.3	31	19.40	24.35	0.36	0.36	0.76	0.95
01-November-2021 to 30-November-2021	94,708	51,827	57.8	72.5	30	18.58	23.30	0.35	0.35	0.73	0.91
01-December-2021 to 31-December-2021	94,708	51,854	58.1	72.0	31	19.30	23.91	0.36	0.36	0.76	0.94

Table 6-2 The calculation result of BE_y

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_j	74%	74%	%
Conservative Factor	0.94	0.94	/
MCF with cons. Factor	0.6956	0.6956	/
$B_{0,LT}$	0.29	0.29	m^3 CH_4 /kg_dm
N_{LT}	Refer to Table 6-1		
W_{site}	Refer to Table 6-1		
$W_{default}$	28	28	kg
$VS_{default}$	0.3	0.3	Kg-dm/animal/day
$VS_{LT,y}$	Refer to Table 6-1		
$MS\%_{Bl,j}$	100%	100%	%
n_{dy}	Refer to Table 6-1		
$BE_{CH4,y}$ from 10-June-2020 to 31-December-2020	**80,442**		**tCO_2e**
$BE_{CH4,y}$ from 01-January-2021 to 31-December-2021	**137,038**		**tCO_2e**
$BE_{CH4,y}$ in this monitoring period	**217,480**		**tCO_2e**
$EF_{N2O,D,j}$	0	0	kg N_2O-N/kg N
$EF_{N2O,ID,j}$	0.01	0.01	kg N_2O-N/kg N
$N_{rate(T)}$	0.42	0.24	kg N/1000kg animal mass/day
$NEX_{IPCC\ default}$	Refer to Table 6-1		
$NEX_{LT,y}$	Refer to Table 6-1		
TAM	28.00	28.00	kg
$F_{gasMS,j,LT}$	40%	40%	/
GWP_{N2O}	265	265	tCO_2/t N_2O
$CF_{N2O,N-N}$	1.57	1.57	Conversion Factor N_2O-N to N_2O
$BE_{N2O,y}$ from 10-June-2020 to 31-December-2020	**1,388**		**tCO_2e**
$BE_{N2O,y}$ from 01-January-2021 to 31-December-2021	**2,364**		**tCO_2e**
$BE_{N2O,y}$ in this monitoring period	**3,752**		**tCO_2e**
BE_y from 10-June-2020 to 31-December-2020	**81,830**		**tCO_2e**
BE_y from 01-January-2021 to 31-December-2021	**139,402**		**tCO_2e**
BE_y in this monitoring period	**221,232**		**tCO_2e**

6.3 Project Emissions

As described in section 4.2, project emissions can be calculated by Equation 15.

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

For $PE_{AD,y}$, 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 by $PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y}$

The biogas generated during the treatment process in this project was captured for power generation and all the electricity generated from this project was used by the AWMSs and 4 swine farms. The electricity generated was not connected to another user or the regional power grid. As the electricity consumption of the anaerobic digestion system cannot be measured separately from the entire AWMSs, so the Project emissions from electricity consumption associated with the anaerobic digester and that is not related to the anaerobic digester is calculated together. During this monitoring period, most of the electricity consumed by the project came from the electricity generated by the biogas generated from the anaerobic fermentation process of the project, which is belongs to self-generated and self-consumed. The electricity consumption of AWMSs were sourced from the grid company when the biogas generators were not operation.

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

The residual gas is sent to flare system (if any) and project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the tool "Project emissions from flaring". In this monitoring period, there is no residual gas to be flared, so $PE_{flare,y}$=0.

In summary, the Project emissions associated with the anaerobic digester in year y (t CO_2e) is the Project emissions of methane from the anaerobic digester in year y (t CO_2e). i.e., $PE_{AD,y}$= $PE_{CH4,y}$+$PE_{EC,y}$.

The basic monitored parameter used in the and the calculation result of $PE_{EC,y}$,$PE_{CH4,y}$ and $PE_{AD,y}$ are shown in the Table 6-3 Table 6-4 and Table 6-5.

Table 6-3 the calculation result of $PE_{EC,y}$

Time	$EC_{PJ,j,y}$ (MWh)	$EF_{EF,j,y}$ (tCO_2/MWh)	$TDL_{j,y}$	**$PE_{EC,y}$(tCO_2e)**
10-June-2020 to 30-June-2020	32.01475	0.58955	20%	**22.65**
01-July-2020 to 31-July-2020	33.89797	0.58955	20%	**23.99**
01-August-2020 to 31-August-2020	30.4454	0.58955	20%	**21.54**
01-September-2020 to 30-September-2020	31.07314	0.58955	20%	**21.99**
01-October-2020 to 31-October-2020	35.15345	0.58955	20%	**24.87**
01-November-2020 to 30-November-2020	34.21184	0.58955	20%	**24.21**
01-December-2020 to 31-December-2020	33.5841	0.58955	20%	**23.76**
01-January-2021 to 31-January-2021	32.64249	0.58955	20%	**23.10**
01-February-2021 to 28-February-2021	33.89797	0.58955	20%	**23.99**
01-March-2021 to 31-March-2021	35.46732	0.58955	20%	**25.10**
01-April-2021 to 30-April-2021	33.89797	0.58955	20%	**23.99**

01-May-2021 to 31-May-2021	30.13153	0.58955	20%	**21.32**
01-June-2021 to 30-June-2021	30.13153	0.58955	20%	**21.32**
01-July-2021 to 31-July-2021	32.95636	0.58955	20%	**23.32**
01-August-2021 to 31-August-2021	32.95636	0.58955	20%	**23.32**
01-September-2021 to 30-September-2021	32.95636	0.58955	20%	**23.32**
01-October-2021 to 31-October-2021	31.38701	0.58955	20%	**22.21**
01-November-2021 to 30-November-2021	35.78119	0.58955	20%	**25.32**
01-December-2021 to 31-December-2021	33.27023	0.58955	20%	**23.54**

Table 6-4 the calculation result of $PE_{CH4,y}$

Time	GWP_{CH4} (tCO_2/tCH_4)	$EF_{CH4,default}$ (tCH_4 leaked / tCH_4 produced)	$Q_{CH4,y}$ (tCH_4)	**$PE_{CH4,y}$(tCO_2e)**
10-June-2020 to 30-June-2020	28	0.05	282.28	**395.20**
01-July-2020 to 31-July-2020	28	0.05	415.97	**582.37**
01-August-2020 to 31-August-2020	28	0.05	423.88	**593.44**
01-September-2020 to 30-September-2020	28	0.05	396.67	**555.34**
01-October-2020 to 31-October-2020	28	0.05	417.80	**584.93**
01-November-2020 to 30-November-2020	28	0.05	408.64	**572.11**
01-December-2020 to 31-December-2020	28	0.05	422.17	**591.04**
01-January-2021 to 31-January-2021	28	0.05	422.63	**591.69**
01-February-2021 to 28-February-2021	28	0.05	372.20	**521.08**
01-March-2021 to 31-March-2021	28	0.05	421.72	**590.41**
01-April-2021 to 30-April-2021	28	0.05	402.30	**563.23**
01-May-2021 to 31-May-2021	28	0.05	415.11	**581.16**
01-June-2021 to 30-June-2021	28	0.05	398.73	**558.23**
01-July-2021 to 31-July-2021	28	0.05	425.17	**595.24**
01-August-2021 to 31-August-2021	28	0.05	415.05	**581.07**
01-September-2021 to 30-September-2021	28	0.05	402.45	**563.43**
01-October-2021 to 31-October-2021	28	0.05	419.56	**587.39**
01-November-2021 to 30-November-2021	28	0.05	412.52	**577.53**
01-December-2021 to 31-December-2021	28	0.05	431.98	**604.78**

Table 6-5 the calculation result of $PE_{AD,y}$

Period	**$PE_{EC,y}$** (tCO_2e)	**$PE_{CH4,y}$** (tCO_2e)	**$PE_{AD,y}$** (tCO_2e)
10-June-2020 to 31-December-2020	164	3,875	4,039
01-January-2021 to 31-December-2021	280	6,916	7,196
1st monitoring period	**444**	**10,791**	**11,235**

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

The Project CH_4 emissions from aerobic AWMS treatment is calculated using Equation 26 described in above section 4.2. The specific calculation results are shown in Table 6-6.

Table 6-6 the calculation result of $PE_{Aer,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
	0.001	0.001	kg N/1000kg animal mass/day
F_{Aer}	100%	100%	/
$1\text{-}R_{vs,1}$	20	20%	/
$B_{0,LT}$	0.29	0.29	$m^3CH_4/kg\text{-}dm$
N_{LT}	Refer to Table 6-1		
$VS_{LT,y}$	Refer to Table 6-1		
$MS\%_j$	100%	100%	
$PE_{Aer,y}$ from 10-June-2020 to 31-December-2020	**24**		**tCO_2e**
$PE_{Aer,y}$ from 01-January-2021 to 31-December-2021	**40**		**tCO_2e**
$PE_{Aer,y}$ in this monitoring period	**64**		**tCO_2e**

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

The Project N_2O emissions in year y can be calculated using Equation 27-29 described in above section 4.2. The specific calculation result is shown in Table 6-7.

Table 6-7 the calculation result of $PE_{N2O,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N2O,D,j}$	0	0	kg N_2O-N/kg N
$NEX_{LT,y}$	Refer to Table 6-1		
N_{LT}	Refer to Table 6-1		
$MS\%_j$	100%	100%	/
$E_{N2O,D,y}$ from 10-June-2020 to 31-December-2020	**0**		**kg N_2O-N/year**
$E_{N2O,D,y}$ from 01-January-2021 to 31-December-2021	**0**		**kg N_2O-N/year**
$E_{N2O,D,y}$ in this monitoring period	**0**		**kg N_2O-N/year**
$EF_{N2O,D,j}$	0.006	0.006	kg N_2O-N/kg N
$NEX_{LT,y}$	Refer to Table 6-1		
N_{LT}	Refer to Table 6-1		
$MS\%_j$	100%	100%	/
$E_{N2O,D,y}$ from 10-June-2020 to 31-December-2020	**5,008**		**kg N_2O-N/year**
$E_{N2O,D,y}$ from 01-January-2021 to 31-December-2021	**8,527**		**kg N_2O-N/year**
$E_{N2O,D,y}$ in this monitoring period	**13,535**		**kg N_2O-N/year**
$EF_{N2O,iD,j}$	0.01	0.01	kg N_2O-N/kg NH_3 and NO_X-N

$F_{gasMS,j,LT}$	0.4	0.4	/
$NEX_{LT,y}$	Refer to Table 6-1		
N_{LT}	Refer to Table 6-1		
$MS\%_j$	100%	100%	%
GWP_{N2O}	265	265	tCO_2/tN_2O
$E_{N2O,ID,y}$ from 10-June-2020 to 31-December-2020	**3,341**		**kg N_2O-N/year**
$E_{N2O,ID,y}$ from 01-January-2021 to 31-December-2021	**5,692**		**kg N_2O-N/year**
$E_{N2O,ID,y}$ in this monitoring period	**9,033**		**kg N_2O-N/year**
$EF_{N2O,iD,j}$	0.01	0.01	kg N_2O/kg N
$F_{gasMS,j,LT}$	0.45	0.45	/
$NEX_{LT,y}$	Refer to Table 6-1		
N_{LT}	Refer to Table 6-1		
$MS\%_j$	100%	100%	%
GWP_{N2O}	265	265	tCO_2/t N_2O
$E_{N2O,ID,y}$ from 10-June-2020 to 31-December-2020	**3,757**		**kg N_2O-N/year**
$E_{N2O,ID,y}$ from 01-January-2021 to 31-December-2021	**6,400**		**kg N_2O-N/year**
$E_{N2O,ID,y}$ in this monitoring period	**10,157**		**kg N_2O-N/year**
$PE_{N2O,y}$ from 10-June-2020 to 31-December-2020	**5,042**		**tCO_2e**
$PE_{N2O,y}$ from 01-January-2021 to 31-December-2021	**8,587**		**tCO_2e**
$PE_{N2O,y}$ in this monitoring period	**13,629**		**tCO_2e**

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

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

No fossil fuel was consumed in process that is not related to the anaerobic digester, so $PE_{FC,y}$=0

Therefore, $PE_{elec/heat}$ that is not related to the anaerobic digester =0.

In summary, the project emission of the proposed project in this monitoring period are summarized in Table 6-8.

Table 6-8 the calculation result of project emissions in this monitoring period

Period	**$PE_{AD,y}$** (tCO_2e)	**$PE_{Aer,y}$** (tCO_2e)	**$PE_{N2O,y}$** (tCO_2e)	**PE_y** (tCO_2e)
10-June-2020 to 31-December-2020	4,039	24	5,042	9,015
01-January-2021 to 31-December-2021	7,196	40	8,587	15,823
1st monitoring period	**11,235**	**64**	**13,629**	**24,928**

6.4 Leakage

As described in section 4.3, Leakage emissions can be calculated by Equation 33: $LE_y = (LE_{PJ,N2O,y} - LE_{BL,N2O,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y}) + LE_{AD,y}$.

Also, as described in section 4.3, The leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. For this project, the anaerobic digestion process of this project is carried out in a fully enclosed system. The biogas generated during the treatment process will be captured for power generation or flared (if any). The Emissions from combustion will be calculated in project emissions (if any). After anaerobic digestion, the fermented sludge will be treated in aerobic composting system, which will be used as fertilizer. Wastewater from the new animal waste management systems will be treated aerobically and then used for agriculture irrigation. So, the Estimation of leakage emissions associated with the anaerobic digester is 0. i.e., $LE_{AD,y}$ =0. Therefore, the

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

The $LE_{BL,N2O,y}$, $LE_{PJ,N2O,y}$, $LE_{BL,CH4,y}$ *and* $LE_{PJ,CH4,y}$ can be calculated by Equation 34-43 described in section 4.3 and the specific calculation and the result are shown in Table 6-9. The calculation result of leakage emission is shown in Table 6-10.

Table 6-9 the calculation result of $LE_{BL,N2O,y}$, $LE_{PJ,N2O,y}$, $LE_{BL,CH4,y}$ *and* $LE_{PJ,CH4,y}$

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
N_{LT}	Refer to Table 6-1		
$NEX_{LT,y}$	Refer to Table 6-1		
$R_{N,n}$	80%	80%	/
EF_1	0.01	0.01	kg N_2O-N/kg N
EF_5	0.0075	0.0075	kg N_2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
GWP_{N2O}	265	265	tCO_2/t N_2O
$LE_{N2O,land,y}$ from 10-June-2020 to 31-December-2020	1,660		kg N_2O-N/year
$LE_{N2O,land,y}$ from 01-January-2021 to 31-December-2021	2,829		kg N_2O-N/year
$LE_{N2O,land,y}$ in the 1st monitoring period	4,489		kg N_2O-N/year
$LE_{N2O,runoff,y}$ from 10-June-2020 to 31-December-2020	369		kg N_2O-N/year
$LE_{N2O,runoff,y}$ from 01-January-2021 to 31-December-2021	628		kg N_2O-N/year
$LE_{N2O,runoff,y}$ in the 1st monitoring period	997		kg N_2O-N/year

$LE_{N2O,vol,y}$ from 10-June-2020 to 31-December-2020	327		kg N_2O-N/year
$LE_{N2O,vol,y}$ from 01-January-2021 to 31-December-2021	555		kg N_2O-N/year
$LE_{N2O,vol,y}$ in the 1st monitoring period	882		kg N_2O-N/year
$LE_{BJ,N2O,y}$ from 10-June-2020 to 31-December-2020	**981**		**tCO_2e**
$LE_{BJ,N2O,y}$ from 01-January-2021 to 31-December-2021	**1,670**		**tCO_2e**
$LE_{BJ,N2O,y}$ in the 1st monitoring period	**2,651**		**tCO_2e**
N_{LT}	Refer to Table 6-1		
NEX_{LT}	Refer to Table 6-1		
R_N	25%	25%	/
R_N	5%	5%	/
EF_1	0.01	0.01	kg N_2O-N/kg N
EF_5	0.0075	0.0075	kg N_2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
$LE_{N2O,land,y}$ from 10-June-2020 to 31-December-2020	5,945		kg N_2O-N/year
$LE_{N2O,land,y}$ from 01-January-2021 to 31-December-2021	10,127		kg N_2O-N/year
$LE_{N2O,land,y}$ in the 1st monitoring period	16,072		kg N_2O-N/year
$LE_{N2O,runoff,y}$ from 10-June-2020 to 31-December-2020	1,344		kg N_2O-N/year
$LE_{N2O,runoff,y}$ from 01-January-2021 to 31-December-2021	2,286		kg N_2O-N/year
$LE_{N2O,runoff,y}$ in the 1st monitoring period	3,630		kg N_2O-N/year
$LE_{N2O,vol,y}$ from 10-June-2020 to 31-December-2020	1,195		kg N_2O-N/year
$LE_{N2O,vol,y}$ from 01-January-2021 to 31-December-2021	2,036		kg N_2O-N/year
$LE_{N2O,vol,y}$ in the 1st monitoring period	3,231		kg N_2O-N/year
$LE_{PJ,N2O}$ from 10-June-2020 to 31-December-2020	**3,533**		**tCO_2e**
$LE_{PJ,N2O}$ from 01-January-2021 to 31-December-2021	**6,017**		**tCO_2e**
$LE_{PJ,N2O}$ in the 1st monitoring period	**9,550**		**tCO_2e**
GWP_{CH4}	28	28	tCO_2e/t CH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	Refer to Table 6-1		
N_{LT}	Refer to Table 6-1		
$B_{0,LT}$	0.29	0.29	m^3 CH_4/kg-VS
R_{VS}	85%	85%	/
$MS\%_j$	100%	100%	/

$LE_{B,CH4,y}$ from 10-June-2020 to 31-December-2020	**17,341**		**tCO_2e**
$LE_{B,CH4,y}$ from 01-January-2021 to 31-December-2021	**29,542**		**tCO_2e**
$LE_{B,CH4,y}$ in this monitoring period	**46,883**		**tCO_2e**
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	Refer to Table 6-1		
NLT	Refer to Table 6-1		
B_0	0.29	0.29	m^3 CH_4/kg-VS
R_{VS}	80%	80%	/
R_{VS}	20%	20%	/
$MS\%_j$	100%	100%	/
$LE_{pJ,CH4}$ from 10-June-2020 to 31-December-2020	**18,511**		**tCO_2e**
$LE_{pJ,CH4}$ from 01-January-2021 to 31-December-2021	**31,536**		**tCO_2e**
$LE_{pJ,CH4}$ in this monitoring period	**50,047**		**tCO_2e**

Table 6-10 The calculation result of leakage emission

Period	**$LE_{PJ,CH4,y}$** (tCO_2e)	**$LE_{BL,CH4,y}$** (tCO_2e)	**$LE_{BL,N20,y}$** (tCO_2e)	**$LE_{PJ,N20,y}$** (tCO_2e)	**LE_y** (tCO_2e/yr)
10-June-2020 to 31-December-2020	18,511	17,341	981	3,533	**3,722**
01-January-2021 to 31-December-2021	31,536	29,542	1,670	6,017	**6,341**
1st monitoring period	**50,047**	**46,883**	**2,651**	**9,550**	**10,063**

6.5 Net GHG Emission Reductions and Removals

As per paragraph 54 in applied methodology ACM0010 (Version08.0): Furthermore, if the actual methane captured from anaerobic digesters in project activity is lower than ($BE_{CH4,y}$ - $PE_{AD,y}$), then($BE_{CH4,y}$ - $PE_{AD,y}$) is replaced by actual methane captured $Q_{CH4,y}$.

Biogas captured during monitoring period is 20,275,217.28 m^3, which equals to 215,741 tCO_2e[57]. Baseline methane emission ($BE_{CH4,y}$) in this monitoring period is 217,480 tCO_2e. project emissions associated with anaerobic digester in this monitoring period ($PE_{AD,y}$) is 11,235 tCO_2e. Actual methane captured from anaerobic digesters is higher than the difference of $BE_{CH4,y}$ and $PE_{AD,y}$ (206,245 tCO_2e =217,480 tCO_2e -11,235tCO_2e). Therefore, the equation ($BE_{CH4,y}$-$PE_{AD,y}$) can be used to calculate emission reduction. So, the Net GHG Emission Reductions and Removals can be calculated using Equation 45 in section 4.4. The Net GHG Emission Reductions and Removals in this monitoring period is shown in following table.

[57] 215,741 tCO_2e= 20,275,217.28m^3*0.00063t/m^3*60. 3211%*28tCO_2/tCH_4

Year	Baseline emissions or removals (tCO_2e)	Project emissions or removals (tCO_2e)	Leakage emissions (tCO_2e)	Net GHG emission reductions or removals (tCO_2e)
10-June-2020 to 31-December-2020	81,830	9,105	3,722	**69,003**
01-January-2021 to 31-December-2021	139,402	15,823	6,341	**117,238**
Total	221,232	24,928	10,063	**186,241**