SHUANGBAOTAI AWMS GHG MITIGATION PROJECT IN JIANGSU PROVINCE

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

Contact Information (optional)

Project Title	*Shuangbaotai AWMS GHG Mitigation Project in Jiangsu Province*
Version	*01*
Date of Issue	*27-10-2021*
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1 PROJECT DETAILS

1.1 Summary Description of the Project

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

The project activity uses flushing system to collect the manure automatically. All the manure and wastewater are collected and then be separated first. The solid will be treated in aerobic composting system and the organic fertilizers will be produced, most of the fertilizer is distributed to local farmers for free and only a small portion will be sold on the domestic market. The liquid will be treated through anaerobic digestion and the biogas generated during the treatment process will be captured for electricity generation. The sludge produced from anaerobic digestion will be treated through aerobic composting together with the solid, the effluent will be supplied to the farmers living around 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.

It is estimated that approximately 676 tons of animal manure will be handled daily by the AWMS. The biogas released during the anaerobic digestion will be collected and used for electricity production. Total installed capacity of the project is 2.28MW and the annual electricity production is estimated to be 19,254MWh. Also, the generated electricity will be only used for daily operation of the AWMS and the 4 swine farms themselves and will not be connected to the region grid net or other users. For conservativeness, baseline emissions from power generation are neglected.

The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure and wastewater. It is estimated that 151,225 tCO_2e emission reductions will be produced annually.

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

1.2 Sectoral Scope and Project Type

Methodology ACM0010 "GHG emission reductions from manure management systems[2]" (Version 08.0) is applied for this project, the CDM Standard "applicability of sectoral scope" states that "If the recovered biogas is used for any other purposes then sectoral scopes 13 and 1 apply. The recovered biogas of this project is used for power generation, therefore, sectoral scopes 13 and 1 is applicable.

In addition, section A1.2 of Appendix 1 eligible AFOLU project categories in VCS v4.1. also states that "Project activities relating to manure management are eligible under sectoral scope 15 (livestock, enteric fermentation, and manure management), not sectoral scope 14 (AFOLU)."

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.*

1.3 Project Eligibility

As per section 2.1.1 of *VCS Standard* (version 4.1), the scope of the VCS Program include：

1) The six Kyoto Protocol greenhouse gases:
2) Ozone-depleting substances.
3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process.
4) Project activities supported by a methodology approved under a VCS approved GHG program, unless explicitly excluded under the terms of Verra approval.
5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements.

The project activity reduces methane emissions by replacing uncovered anaerobic lagoons in the baseline scenario with the new AWMS. Meanwhile, the project is not belonged to the projects excluded in Table 1 of VCS Standard 4.1. Therefore, the project is eligible under the scope of VCS program.

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

According to section 3.1 of the *VCS-Standard* (version 4.1), establishing a consistent and standardized certification process is critical to ensuring the integrity of VCS projects. Accordingly, certain high-level requirements must be met by all projects, as set out below:

Reference to VCS Standard (Version 4.1)	Requirement	Justification
3.1.1	Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.	The project meets all applicable rules and requirements as set out under the VCS Program.
3.1.2	Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.13.1. The list of methodologies and their validity periods is available on the Verra website.	The project applies CDM approved methodology ACM0010 (version 08.0) which is an eligible VCS methodology along with tool or modules as applicable. Refer to section 3.1 and 3.2 of the PD below for more details.
3.1.3	Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	Projects are in compliance with currently applicable laws. According to the approval of Environmental Impact Assessment (EIA) of the project, the project complies with all Chinese relevant laws and regulations. Refer to section 1.14 of the PD below for more details.
3.1.4	Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document *Program Definitions* for definition of model), such model shall meet with the requirements set out in the VCS Program document *VCS Methodology Requirements* and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals).	Not applicable. There are no model needs to be chosen by the project proponent as per the applied methodology ACM0010 (version 08.0).
3.1.5	Where projects apply methodologies that permit the project proponent its own choice of third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet with the requirements set out in the VCS Program document *VCS Methodology Requirements*	The default factor or standard applied in this project are all methodologically permissible, so the default factor or standard meet the requirements set out in the VCS Program document *VCS Methodology Requirements.*
3.1.6	Projects shall preferentially apply methodologies that use performance methods (see the VCS Program document	Baseline scenario and additionality have been analysed as per the applied methodology ACM0010

	VCS Methodology Requirements for further information on performance methods) where a methodology is applicable to the project that uses a performance method for determining both additionality and the crediting baseline (i.e., a project shall not apply a methodology that uses a project method where such a performance method is applicable to the project). Methodologies approved under the VCS Program that use performance methods provide a list of similar methodologies that use project methods (that were approved under the VCS Program or an approved GHG program at the time the performance method was developed). Such lists are not necessarily exhaustive but can serve as the starting point for determining whether a performance method is applicable to the project. Following the approval of a methodology that uses a performance method, projects may use any applicable pre-existing methodology that uses a project method for a six-month grace period.	(version 08.0) and tool 02 (Version 07.0). Refer to section 3.4 and 3.5 of the PD for more details.
3.1.7	Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence.	Not applicable.
3.1.8	Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document *Program Definitions* for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	Not applicable. There is no specified capacity limits and any other relevant requirements set out as per the applied methodology and tools.
3.1.9	Where Verra issues new requirements relating to projects, registered projects do not need to adhere to the new requirements for the remainder of their project crediting periods (i.e., such projects remain eligible to issue VCUs through to the end of their project crediting period without revalidation against the new requirements). The new requirements shall be adhered to at project crediting period renewal, as set out in Section 3.8.9.	This is the first crediting period of the project, and it has fallowed all the latest requirements of Verra.

1.4 Project Design

The project activity involves the construction and operation 4 animal manure management system in 4 swine farms in Jiangsu Province owned by Shuangbaotai Animal Husbandry Group Co., Ltd. with the treatment capacity of the AWMS in this project of 676 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
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
Email	yanan.zhu @profitcarbon.com

1.7 Ownership

The project owner of the project is 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 equipment 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 4.1), 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 it has been put into operation on 10/06/2020. Thus, the project start date is 10/06/2020.

1.9 Project Crediting Period

This project adopts fixed crediting periods of 10 years. The crediting period is 10 years 0 month from 10/06/2020 to 09/06/2030 (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 151,225 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 4.1), the scale of the project activity is under "project" category.

Project Scale	
Project	×
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
10/06/2020-31/12/2020	84,935
Year 2021	151,225
Year 2022	151,225
Year 2023	151,225
Year 2024	151,225
Year 2025	151,225
Year 2026	151,225

Year 2027	151,225
Year 2028	151,225
Year 2029	151,225
01/01/2030-09/06/2030	66,290
Total estimated ERs	1,512,250
Total number of crediting years	10
Average annual ERs	151,225

1.11 Description of the Project Activity

The project activity is to introduce a new animal manure management system to replace the traditional uncovered anaerobic lagoons to treat the swine manure in the swine farm owned by Shuangbaotai Animal Husbandry Group Co., Ltd. Project activities mainly include pre-treatment process, Solid-liquid separation, Anaerobic fermentation treatment process, Comprehensive utilization of biogas, Aerobic composting process. The process flow diagram of this project activity is shown in Figure 1-1.

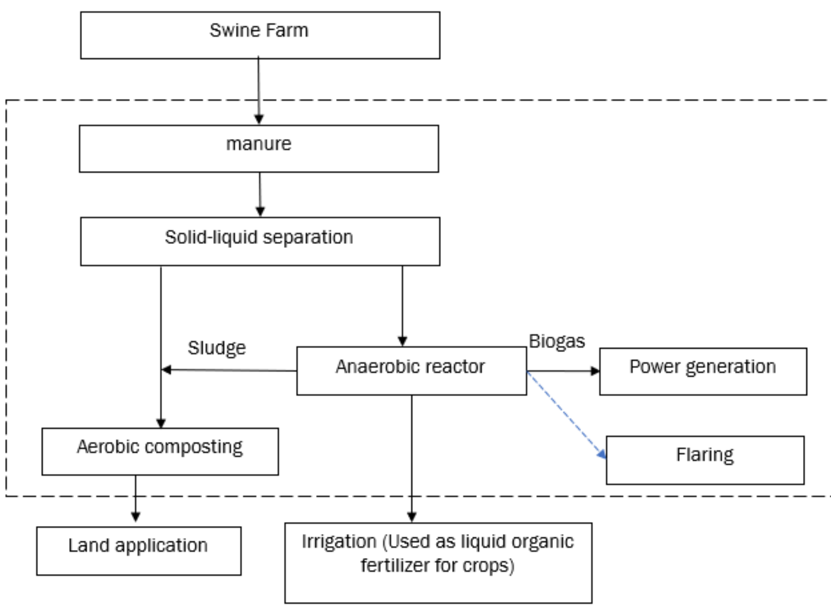

Figure 1-1 Process flow diagram of the project activity

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 will be treated in aerobic composting system and the organic fertilizers will be produced. The liquid will be treated through anaerobic digestion and the biogas generated during the treatment process will be captured for electricity generation.

Anaerobic digesters treatment process

Anaerobic digesters (AD) are one of the most important processes in animal waste treatment. The anaerobic digesters receive the animal manure and maintain a steady –state population of methanogenic bacteria for degradation. Methanogenic bacteria convert organic manure into biogas in the environment without oxygen. Captured biogas then will be used to generate electricity. In addition, AD could reduce offensive odors, pathogens from the manure slurry, and GHG emissions during the storage.

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 and other purification treatments are required. The purified biogas can enter the generator system for power generation.

Aerobic composting process

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

Table1-1 The main technical parameters of equipment involved in this project

Parameter	Value
Equipment name	Biogas generator set
Unit Type	C380D5E/C600D5E/C300D5E/C1000D5E
Electric power	380kw/600 kw/300 kw/1000 kw/
Heat output	380 kw/600 kw/300 kw/1000kw
Frequency	50Hz
Manufacturer	Cummins Generator
Units	4
Equipment technical life	No less than 15 years

1.12 Project Location

The project is located in Jiangsu Province, China. The location of the four subsidiary farms is shown in Table 1-2:

Table1-2 The location of the four 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°

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 PD 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. Environmental Protection Law of the People's Republic of China;

2. Administrative Licensing Law of the People's Republic of China;

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

4. Regulations on Environmental Protection Management of Construction Projects;

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.

1.16.2 Other Forms of Environmental Credit

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

1.17 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.

Sustainable Development

The project activity can contribute to local sustainable development in the following aspects:

-The project activity can enhance the quality of the water, control the odour, and improve the production and living conditions of the farmers.

-The project activity can provide job opportunities for local residents.

-The effluent and slurry are good organic fertilizers which are all supplied to the farmers living around free, they can be used to yield organic products and improve the income of the farmers.

-Biogas technology can capture the methane generated during the treatment process and use biogas to generate electricity which can provide clean energy to substitute some traditional energy resource, thus the project can reduce CH_4 emissions more effectively and contribute to the mitigation of global climate change.

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

Procedure followed to invite stakeholder comments

Public hearing for local stakeholders:

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 07/04/2020.

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.

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. some feedback and comments were received, however, these feedbacks mainly focus on the questions of project technology, project mechanism operation and the environmental impact. There were no comments on project design and monitoring methods. The minutes of stakeholder meeting was recorded by PP.

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. A short summary of the environmental impacts is presented below.

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.

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.

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

Besides, as per section 3.16.5 of the VCS Standard (Version 4.1), all projects are subject to a 30-day public comment period. The date on which the project is listed on the project pipeline marks the beginning of the project's 30-day public comment period. This project will be open for public comment on the verra website. The project shall be listed, and comments shall be incorporated later.

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)[3]".

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

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

Tool 02: "Combined tool to identify the baseline scenario and demonstrate additionality(version07.0)[4]"

Tool 05:" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 3.0)[5]"

Tool 06:" Project emissions from flaring (Version 3.0)[6]"

Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version03.0)[7]"

Tool 14: "Project and leakage emissions from anaerobic digesters (Version 02.0)[8]"

Tool 24:" Common practice (Version 03.1)[9]"

3.2 Applicability of Methodology

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

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.	This project introduces new AWMSs to treat the manure and wastewater from the 4 swine farms to avoid methane emissions generated in the baseline uncovered anaerobic lagoons and the biogas generated during the treatment process will be captured for power generation, which result in less GHG emissions.

[4] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-02-7.0.pdf/history_view
[5] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-05-3.0.pdf/history_view
[6] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-06-3.0.pdf/history_view
[7] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-08-3.0.pdf/history_view
[8] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v2.pdf/history_view
[9] https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-24-v1.pdf

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 will be treated in aerobic composting system, which will be used as fertilizer. The liquid will be treated through anaerobic digestion and the biogas generated during the treatment process will be captured for power generation, the sludge produced from anaerobic digestion will be treated through aerobic composting together with the solid, the effluent will be used for agriculture irrigation. The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure.
This methodology is applicable to manure management projects under the following conditions: Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions; Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries); 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; The annual average ambient temperature at the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C; In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is greater than one month; 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 AWMS to a group of 4 swine farms owned by Shuangbaotai Animal Husbandry Group Co., Ltd. [10] which is a large-scale private owned swine farm in which swine are managed under confined conditions. (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[11]， which is higher than 5°C. (e)The minimum retention time of manure waste in the open anaerobic lagoons is about 60days. This was discussed with the farm owners. (f) the lagoons of the AWMS in the project case have steel layer at the lagoon bottom which can ensure that no leakage of manure waste into ground water takes place.

Tool 02: "Combined tool to identify the baseline scenario and demonstrate additionality(version07.0)"

[10] http://www.sbtjt.com/gysbt.jhtml?page=0

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

The tool is applicable to all types of proposed project activities. However, in some cases, methodologies referring to this tool may require adjustments or additional explanations as per the guidance in the respective methodologies. This could include, inter alia, a listing of relevant alternative scenarios that should be considered in Step 1, any relevant types of barriers other than those presented in this tool and guidance on how common practice should be established.	The project activity is designed to introduce new AWMS to a group of 4 swine farms to treat the swine manure to avoid methane emissions generated in the baseline uncovered anaerobic lagoons. Alternative scenarios, barrier analysis, investment analysis and common practice analysis will be carried out based on Tool 02. Refer to section 3.4 and 3.5 of the PDD for more details.

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.	Partial electricity used by the project will be from East China Power Grid (ECPG)[12], 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	Tool 05 is only used to calculate project emissions of electricity consumption supplied by ECPG. For

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

provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO_2 emissions.	conservativeness, baseline emissions of captive biogas power generation system are ignored. Only CO_2 emissions will be accounted.

Tool 06: "Project emissions from flaring (version03.0)"	
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 will be captured for power generation and the residual biogas will be flared if there is any surplus biogas. Enclosed flares will be used by the project activity.
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 will be 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.

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 will be collected and monitored. Refer to section 5.2 of the PDD 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 PDD. b) The mass flow is determined in the monitoring plan of the PDD. c) The flow of the gaseous stream will be measured continuously. d) The gaseous stream is dry, equation (18) and (19) are used to calculate the mass flow of greenhouse gas.

Tool 14: "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 (d) CH_4 emissions from flaring of biogas.	Electricity will be used during the operation of the anaerobic digester, and the anaerobic digestion process of this project does not involve the use of fossil fuels. 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 will be treated in aerobic composting system and the organic fertilizers will be produced, most of the fertilizer is distributed to local farmers for free and only a small portion will be sold as fertilizer. The liquid will be treated through anaerobic digestion and the biogas generated during the treatment process will be captured for electricity generation. The sludge produced from anaerobic digestion will be treated through aerobic composting together with the solid, the effluent will be supplied to the farmers living around free for agriculture irrigation. 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.	After anaerobic digestion, the sludge produced from anaerobic digestion will be treated through aerobic composting together with the solid. In this project, there is 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.

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 waste treatment processes. The baseline situation is shown in figure 3-1 below.

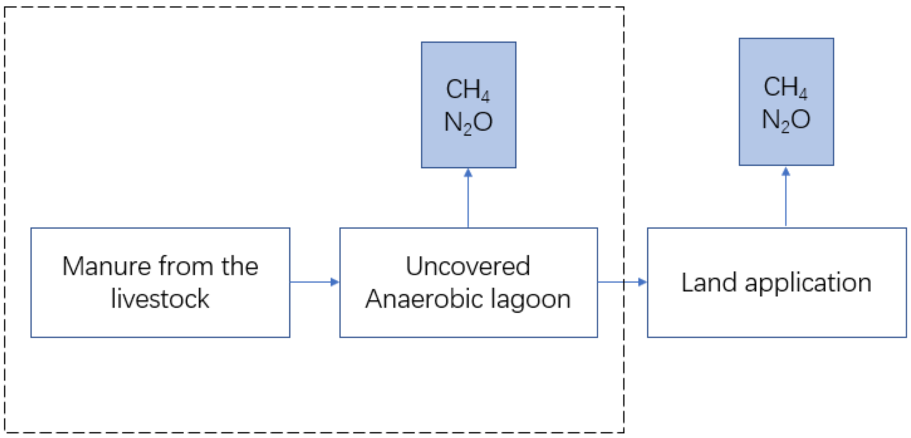

Figure 3-1 The baseline situation in the swine farms

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

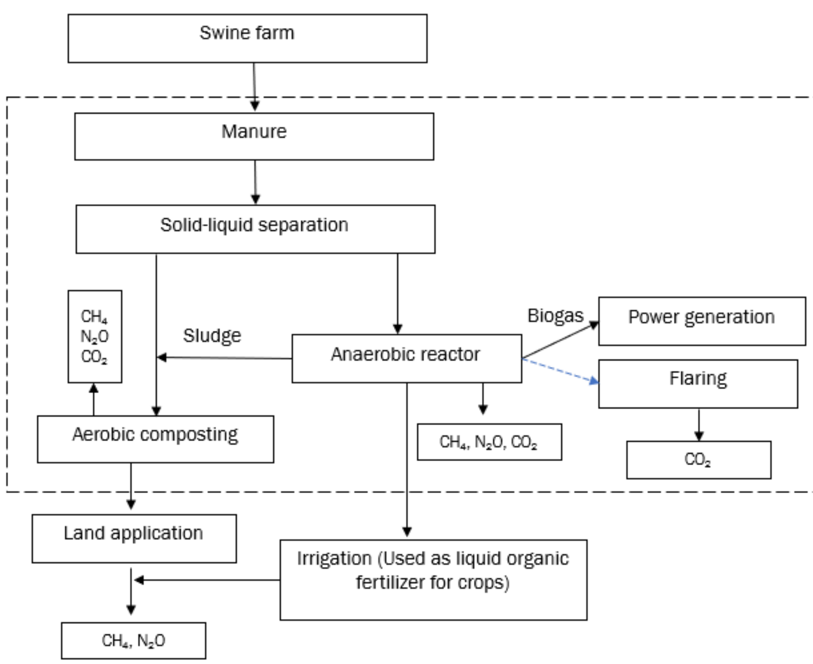

Figure 3-2 The project boundary of the project

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

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

Source		Gas	Included?	Justification/Explanation
Baseline	Emissions from the waste treatment processes	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Yes	The major source of emissions in the baseline
		N_2O	Yes	Direct and indirect N_2O emissions are accounted
	Emissions from electricity consumption/ generation	CO_2	No	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.
	Emissions from the waste	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

Source		Gas	Included?	Justification/Explanation
	treatment processes	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 analyze this step.

Step1: Identification of alternative scenarios

Step 1a: Define alternative scenarios to the project activity

The baseline and available alternatives for the manure management are:

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 laws and regulations

According to "Technical specification for sanitation treatment of livestock and poultry manure[13]" and the "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)[14]", the Scenario 6: "The manure is disposed in an uncovered anaerobic lagoon" and Scenario 8&17: Anaerobic Digester-Aerobic

[13] https://oss.baigongbao.com/2020/12/14/MRyhTKQcWC.pdf
[14] http://www.moa.gov.cn/gk/tzgg_1/tfw/201801/t20180111_6134801.htm

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 3-4 shows the investment analysis results of the uncovered anaerobic lagoon.

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

Coats 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	2.00	2.00	2.00
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**		
IRR	**undefined**		

There are no potential revenues involved in the baseline scenario. There are only negative flows in the baseline scenario, so the Internal Rate of Return (IRR) cannot be calculated, and the economic comparison should be based on the Net Present Value (NPV) indicator. Table 3-5 summaries the results of financial analysis of Anaerobic Digester-Aerobic Treatment without VCU revenues.

Table 3-5 Investment analysis of the Anaerobic Digester-Aerobic Treatment without VCU revenues（10^4 RMB）

Coats 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											
IRR	5.09%											

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

The technology to be used in the proposed project represents a state-of-the-art manure treatment system. In China, the enterprise would not take the initiative to use the technology, as the investment for biogas-based power generation is very high even though a law concerning renewable energy has been formulated and subsidy for biogas power generation is considered. As a result, even commercial banks are not willing to support such projects without promises from the government or other incentives. Apart from that, manure treatment falls under the category of a public good service, beyond the production scope previously defined for the animal enterprise. Therefore, most livestock producers do not have the capacity for investment in a project activity without VCU revenue.

Total investment of the project activity is 51.5387 million Yuan, of which 15.3468 million is equity fund and the rest is loans from the domestic commercial banks. The lifetime of the project activity is 15 years. Its operation costs mainly include maintenance costs, Insurance costs, other costs, labour costs and loan interest expenses. Part organic fertilizers produced will be sold annually, which can bring revenue for PP. Table 3-6 and Table 3-7 show the investment analysis results of the project activity

Table 3–6 Investment analysis of the project activity without revenues from sale of VCUs

Coats 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	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00
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**											
IRR	**5.09%**											

From Table 3-2, the Internal Rate of Return (IRR) without income from selling VCUs is 5.09% which is lower than the benchmark IRR of 9.5% for the animal industry, making the proposed project financially unacceptable.

Table 3-7 Investment analysis of the project activity with revenues from sale of VCUs

Coats and benefits	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11-15**	**16**
Cash inflow	**0.00**	**1,687.00**	**1,687.00**	**1,574.71**	**1,474.84**	**1,474.84**	**1,474.84**	**1,474.84**	**1,474.84**	**1,474.84**	**1,248.00**	**1,636.08**
Revenues from organic fertilizers sales	0.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00	1,248.00
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	262.08
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	126.00

Revenues from sale of VCUs	0.00	687.76	687.76	687.76	687.76	687.76	687.76	687.76	687.76	687.76	687.76	
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	300.00	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	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84	1,446.84
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	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23	746.23
Net cash flow (after tax)	**-5,153.87**	**745.01**	**865.48**	**775.55**	**695.67**	**691.35**	**686.90**	**682.29**	**677.54**	**672.62**	**441.19**	**829.27**
NPV (discount rate=9%)	**316.76**											
IRR	**10.22%**											

If the project activity can get the revenue from the sales of VCUs revenues (assuming that the VCUs price is 15RMB/tCO_{2e} and the crediting period is 10 years), IRR increases to 10.22% which is above the benchmark. As a result, VCU revenues are making the proposed project activity more attractive and more viable for the investor. Thus, the proposed project activity is additional

In order to further illustrate the proposed project activity without VCS is unlikely to be financial attractive, sensitivity analysis was conducted with reasonable variations in the critical assumptions.

Sensitivity analysis

The total static investment and annual 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:

- Investment
- Annual organic fertilizers sales
- O&M cost

The variation range of -10%~10% which was employed in the Project Evaluation Report and prevailing in China was used. The results of sensitivity analysis of the three parameters of the proposed project are shown in the table 3-8 and figure:

Table 3-8 Sensitivity analysis

Item	-10%	-5%	0	5%	10%
Total static investment	6.62%	5.82%	5.09%	4.41%	3.78%
Annual organic fertilizers *sales*	2.73%	3.98%	5.09%	6.18%	7.23%
O&M cost	6.69%	5.90%	5.09%	4.27%	3.42%

The sensitivity analysis was further conducted and the project IRR (after tax) could reach the benchmark of 9.5% if one of the following conditions can be achieved:

- Total static investment: decrease about 25.2%.
- Annual organic fertilizers sales: increase about 21.1%.
- O&M cost: decrease about 28.6%

Since all the data used for the investment analysis was sourced from the Project Evaluation Report. Therefore, the data used in the investment analysis are believed to be reliable and credible and none of above conditions can be achieved:

Total static investment decreasing about 25.2%: But the change of this extent is unlikely to happen. the total static investment cost derived from the Project Evaluation Report. 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, and this trend seems unlikely to be changed before the project construction is completed. As a result, the IRR cannot increase through the change of equipment cost.

Annual organic fertilizers sales increasing about 21.1%: the organic fertilizers is 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, therefore the increase of annual organic fertilizers sales to threshold is impossible to achieve.

O&M cost decreasing about 28.6%: However, the decrease of it is not likely to occur. Based on Chinese Statistic Yearbook, the fluctuations of indices of purchasing price of raw material, power and fuel are insignificant over last ten years and the annual average wages in Jiangsu Province have been constantly growing during over last ten years. 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 28.6% in O&M cost is not realistic.

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

3.5 Additionality

Section 3.13 in VCS v4.1. states that "A project activity is additional if it can be demonstrated that the activity results in emission reductions or removals that are in excess of what would be achieved under a 'business as usual' scenario and the activity would not have occurred in the absence of the incentive provided by the carbon markets" (2019:33). Moreover, Section 3.13.1 clearly mandates that "Additionality shall be demonstrated and assessed in accordance with the requirements set out in the methodology applied to the project"

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 PD.

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 for the demonstration and assessment of additionality" (version 07.0.0), 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.

The proposed project is belonged to type (D) measure listed in the latest version of the "Guidelines on common practice, i.e., Methane formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation). As per additionality tool, the "Guidelines on common practice" available on the UNFCCC website is applied as below:

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

The output of the proposed project is power generation, therefore all projects that capturing methane generated from AWMSs for power generation will be 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;

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

(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;

(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;

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

(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 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). Therefore, only the activities in the same province could be regarded as sharing the same "comparable environment".

The starting date of the proposed project is 10/06/2020, Thus, the project that capturing methane generated from AWMSs for power generation and operated before 10/06/2020 in Jiangsu Province is included.

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 and other public information, 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}.

Ndiff=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 $F=1-N_{diff}/N_{all}$=1-0 =1. Therefore, the result of common practice assessment is: $N_{all}-N_{diff}$=1 < 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 is undertaken without being registered as a VCS project activity" is not financially attractive to investors, thus it is not feasible. 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 QUANTIFICATION OF 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 PDD. 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:

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

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($B_{0,LT}$)

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).

Developed countries $B_{0,LT}$ values is 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 uses 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.).

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

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

(a)The MCF values given in table 10.17, chapter 10, volume 4, IPCC 2006 Guidelines should be used. MCF 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 18°C and the value of 77% 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 MCF values as reported by IPCC 2006.

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

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

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)

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

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(a)) or (5(b)) (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(a)) or (5(b)) (number)

Estimation of various variables and parameters for above equations:

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

Option 1:

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

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:

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

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:

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

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)

$$NEX_{IPCC\ default} = N_{rate(T)} * \frac{TAM}{1000} * 365^{15} \qquad \text{(Equation 13)}$$

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

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

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

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 ($PE_{AD,y}$)

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

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",

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

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 will be produced during the anaerobic treatment of the project, and the biogas will be collected for power generation and all the power will be used for the operation of AWMS firstly and then surplus electricity will be 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 will be 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 03.0).

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"

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

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

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

where:

$F_{i,t}$ Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h)

$V_{t,db}$	Volumetric flow of the gaseous stream in time interval *t* on a dry basis (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 proposed project will adopt enclosed flare.

Enclosed flare

In the case of enclosed flares, project participants may choose between the following two options to determine the flare efficiency for minute m ($\eta_{flare,m}$) and shall document in the CDM-PDD which option is selected:

Option A: Apply a default value for flare efficiency.

Option B: Measure the flare efficiency.

For this project, the Option A is selected.

Option A: Default value

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

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

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

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

Since the flame is not detected in minute, therefore the flare efficiency $\eta_{flare,m}$ is 0%

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:

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

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:

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

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 all the biogas generated in the AWMS will be collected for power generation, so no biogas will be flared in pre-calculation. In the monitoring period, the project emissions from flaring of biogas will be calculated according to the actual situation.

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

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:

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

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 leaks 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 only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2. The proposed project belongs to large scale projects, 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 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)

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.

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

(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(a)) or (5(b))
$PE_{sl,y}$	Project CH_4 emissions from sludge disposed of in storage pit prior to disposal during the year y (t CO_2e/yr)
$MS\%_j$	Fraction of manure handled in system j in the project activity (fraction)

All sludge produced from the aerobic composting will be 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(a)) or (5(b))

$MS\%_j$ Fraction of manure handled in system j in the project activity (fraction)

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

$$PE_{N2O,y} = GWP_{N2O} * CF_{N2O-N,N} * \frac{1}{1000} * (E_{N2O,D,y} + E_{N2O,ID,y}) \quad \text{(Equation 27)}$$

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:

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

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(a)) or (5(b)) (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:

$E_{N2O,ID,y}$ 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)

$NEX_{LT,y}$ 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 volatilisation of NH_3 and NO_X from manure management (fraction)

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

Option2:

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

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

where:

$E_{N2O,D,y}$	Direct N_2O emission in year *y* (kg N_2O-N/yr)
$E_{N2O,ID,y}$	Indirect N_2O emission in year y (kg N_2O-N/year)
$EF_{N2O,D,j}$	Direct N_2O emission factor for the treatment system j of the manure management system (kg N_2O-N/kg N)
$Q_{EM,m}$	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)
$EF_{N2O,ID}$	Indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces (kg N_2O-N/kg NH_3-N and NO_X-N)
$F_{gasMS,j,LT}$	Default values for nitrogen loss due to volatilisation of NH_3 and NO_X from manure management (fraction)

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

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

$$PE_{EC/FC,y} = PE_{EC,y} + \sum_j PE_{FC,j,y}$$ (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.

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)
$CF_{N2O-N,N}$	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 volatilisation in year y (kg N_2O-N/year)
F_{gasm}	Fraction of N lost due to volatilization (fraction)
N_{LT}	Annual average number of animals of type LT estimated as per equation (5(a)) or (5(b)) (number)
$NEX_{LT,y}$	Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/year) estimated as described in appendix 2
EF_1	Emission factor for N_2O emissions from N inputs (kg N_2O-N/kg N input)
EF_5	Emission factor for N_2O emissions from N leaching and runoff in (kg N_2O-N/kg N leached and runoff)
EF_4	Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N_2O/ (kg NH_3-N + NO_X-N volatilized)]
F_{leach}	Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff (fraction)
$R_{N,n}$	Nitrogen reduction factor (fraction)

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

It is 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(a)) or (5(b)), expressed (number)
$VS_{LT,y}$	Annual volatile solid excretions for livestock *LT* entering all AWMS on a dry matter weight basis (kg - dm/animal/yr)
$MS\%_j$	Fraction of manure handled in system *j* in the project activity (fraction)
MCF_d	Methane conversion factor (MCF) assumed to be equal to 1

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

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 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 $Q_{CH4,y}$.

In the Pre-estimation, the CH_4 baseline emissions is 183,999 tCO_2e, the biogas captured is 1,481.07*10^4m^3, which equals to 166,709 tCO_2e. The project emissions associated with the anaerobic digester $PE_{AD,y}$ is 23,340 tCO_2e. Estimated methane captured from anaerobic digesters is higher than the difference of $BE_{CH4,y}$ and $PE_{AD,y}$, so in the Pre-estimation, the equation 42 can be used to calculate emission reduction.

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)
10/06/2020-31/12/2020	104,780	15,734	4,111	84,935
Year 2021	186,559	28,014	7,320	151,225
Year 2022	186,559	28,014	7,320	151,225
Year 2023	186,559	28,014	7,320	151,225
Year 2024	186,559	28,014	7,320	151,225
Year 2025	186,559	28,014	7,320	151,225
Year 2026	186,559	28,014	7,320	151,225
Year 2027	186,559	28,014	7,320	151,225
Year 2028	186,559	28,014	7,320	151,225
Year 2029	186,559	28,014	7,320	151,225
01/01/2030-09/06/2030	81,779	12,280	3,209	66,290

Total	1,865,590	280,140	73,200	1,512,250

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	Climate Change 2014 Synthesis 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[16]
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	Climate Change 2014 Synthesis 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
Purpose of Data	Used in project emission/baseline calculations
Comments	N/A

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

Data / Parameter	D_{CH4}
Data unit	t/m³
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/m³ 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	MCF value for uncovered anaerobic lagoon (baseline AWMS) is chosen. A conservativeness factor has been applied by multiplying MCF value (i.e., 77%) with a value of 0.94, to account for the 20 per cent uncertainty in the MCF values as reported by IPCC 2006. For this project, the annual average temperature is 15.3℃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

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
Value applied	$B_{0, LT}$ (Market swine) =0.29 $B_{0, LT}$ (Breeding swine) =0.29
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Used in project emission/baseline calculations
Comments	N/A

Data / Parameter	$MS\%_{Bl,j}$
Data unit	Fraction
Description	Fraction of manure handled in system j in the baseline.
Source of data	Project 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	-
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	-
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	-
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	-
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	-
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	40%
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	$EF_{N20,D,j}$
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	$EF_{N20,\ D}$=0 for anaerobic lagoon and digester, $EF_{N20,\ D}$=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	$EF_{N20,ID,j}$
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 leaks from the anaerobic digester (fraction)
Source of data	IPCC (2006)
Value applied	0.05
Justification of choice of data or description of measurement methods and procedures applied	UASB type digesters, 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 PDD.

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: 20%, 80% for leakage N_2O emission released during project activity $R_{VS,n}$, one cell lagoon: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% $R_{N,n}$, uncovered anaerobic lagoon : 80%
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
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/mineralised 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	Site specific data is unavailable therefore default values are opted for.

measurement methods and procedures applied	
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 (version08.0)", 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[17]
Value applied	0.58955
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

[17] http://mee.gov.cn/ywgz/ydqhbh/wsqtkz/202012/t20201229_815386.shtml

Data / Parameter	R_u
Data unit	Pa.m³/kmol.K
Description	Universal ideal gases constant
Source of data	/
Value applied	8,314
Justification of choice of data or description of measurement methods and procedures applied	/
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	/
Value applied	16.04 kg/mol for methane
Justification of choice of data or description of measurement methods and procedures applied	/
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	Number of animals of type LT produced annually will be recorded manually by responsible staff.
Frequency of monitoring/recording	Monthly
Value applied	99,450 heads of market swine
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 (Daily running statistics and sale records) will be crosschecked.

Data / Parameter	$N_{da,LT}$
Data unit	Number
Description	Number of days animal of type LT is alive in the farm in the year y
Source of data	Project proponents
Description of measurement methods and procedures to be applied	The days of market swine in the farm will be recorded manually by the responsible staff.
Frequency of monitoring/recording	Monitored monthly.
Value applied	180 days
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 (Daily running statistics and sale records) will be crosschecked.

Data / Parameter	N_{AA}
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	The number of Breeding swine in the farm, discounting dead and discarded animals will be recorded manually by the responsible staff.
Frequency of monitoring/recording	Daily.
Value applied	54,252 heads of Breeding swine
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	*N/A*

Data / Parameter	W_{site}
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Source of data	Project proponents
Description of measurement methods	Measured by the weight measurer

and procedures to be applied	
Frequency of monitoring/recording	monthly
Value applied	68.5kg for commercial pigs and 103.6kg for breeding pigs
Monitoring equipment	weight measurer
QA/QC procedures to be applied	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	
Comments	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 can 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.
	Used for the calculation of N_{LT}, which used in the calculation of the baseline emission. Project emission and leakages emission.

Data / Parameter	F_{Aer}
Data unit	Fraction

Description	Fraction of volatile solids directed to aerobic treatment
Source of data	Project proponents
Description of measurement methods and procedures to be applied	Archive electronically during project plus 5 years Fraction of volatile solids directed to aerobic digesters will be calculated based on the VS concentration and quantity of influent of aerobic treatment. VS concentration will be measured by taking sample of influent. Quantity of influent will be measured by flow meter
Frequency of monitoring/recording	Annually
Value applied	*100%* for ex ante estimation. The actual number of fraction of volatile solids directed to aerobic treatment will be monitored by project proponents
Monitoring equipment	flow meter
QA/QC procedures to be applied	Flow meter will be calibrated according to technical specification by an officially accredited entity. VS concentration of collected samples will be sent for analysis at qualified labs or testing centers.
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	N/A
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 meter.
Frequency of monitoring/recording	Continuously by flow meter and reported cumulatively on weekly basis
Value applied	1,481.07*10^4m^3 of biogas are expected to be generated by the project and 133.29*10^4m^3 of biogas will be flared annually
Monitoring equipment	flow meters
QA/QC procedures to be applied	The calibration of flow meters, including the frequency of calibration, should be done in accordance with national standards or requirements.
Purpose of data	Calculation of project emissions and leakage
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.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	0 MWh for ex ante estimation since the electricity generated by the project will be used firstly for the operation of AWMSs.
Monitoring equipment	electricity meter
QA/QC procedures to be applied	The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements.
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$TDL_{j,y}$
Data unit	/
Description	Average technical transmission and distribution losses for providing electricity to source *j* in year *y*

Source of data	Tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Description of measurement methods and procedures to be applied	According to tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Frequency of monitoring/recording	N/A
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	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	Flowmeter
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.
Monitoring equipment	Gas analyzer
QA/QC procedures to be applied	Calibration should include zero verification with an inert gas (e.g. N_2) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be 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	Density of CH_4 of 0.00067t/m^3 is applied in the PDD, actual temperature will be monitored.
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	Density of CH_4 of 0.00067t/m^3 is applied in the PDD, actual pressure will be monitored.

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)

5.3 Monitoring Plan

The monitoring plan presented in this PD 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:

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:

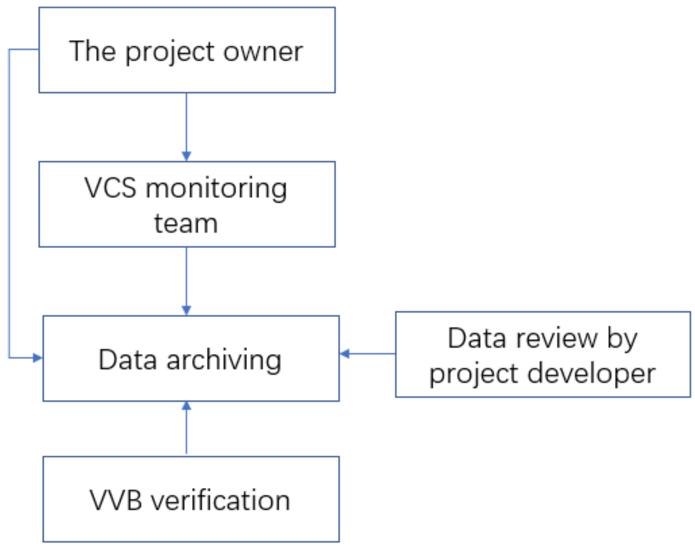

Figure 5-1 The Organization Structure of the Monitoring Team

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.

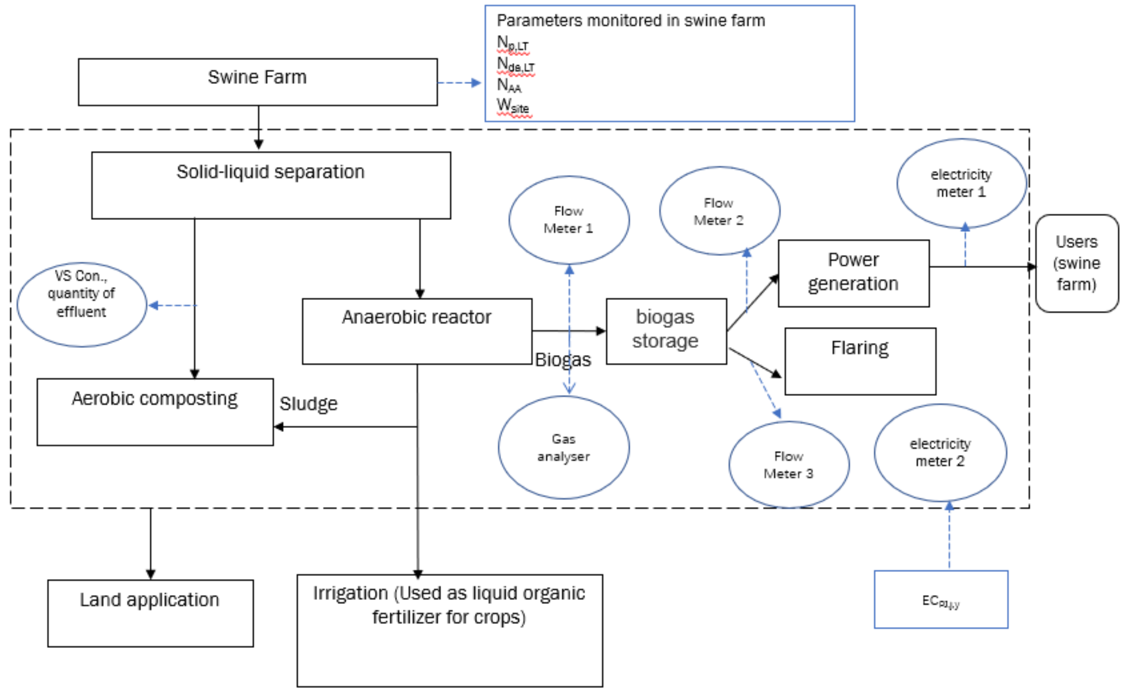

Figure 5-2 Installation and Configuration of Meters

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 will sign an agreement that it will not participate in other environment credits, other GHG programs and has not been rejected by any other GHG Programs. The whole VCS monitoring team will 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 will be carried out immediately by the project owner, with the help of external experts if necessary.

- A corrective action plan should then be developed to eliminate the non-conformity and its causes to prevent its recurrence.

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

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

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

-The general principle is that Conservative value will be used for the missing or damaged data. This is most conservative approach. The monitoring personnel will be 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 will be 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 will be 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 will be accepted for the monitoring report.

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)[18]", the sampling plan is as follows:

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 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; For each defined livestock population, a minimum of one monthly sample per age category should be taken. In this project, the monitoring activities of the Average animal weight of a defined livestock population at the project site will be conducted in the three age groups of Market swine and Breeding swine respectively.
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 Evaluation Report. During the monitoring periods, the target population will be changed as the actual situation.
Sampling method	Stratified random sampling will be used[19]. The sampling tool is Microsoft Excel, a reliable and widely accepted tool for random sampling.

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. The sampling size will be calculated as the Appendix 6 of the guideline of the "Sampling and surveys for CDM project activities and programmes of activities (Version 04.0)".

Implementation and Monitoring frequency

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

[18] https://cdm.unfccc.int/filestorage/e/x/t/extfile-20210531160756474-Meth_Stan05.pdf/Meth_Stan05.pdf?t=T2x8cjBuZjFpfDDpBcoW32Nj3OQglkN4PmUs

[19] The project is implemented in 9 swine farms owned by Fujian Aonong Biotechnology Group Co., Ltd. Since there are two types of swine in this project, i.e., Market swine and Breeding swine and it is necessary to divide the swine into at least 3 age groups according to the methodology ACM0010(version08.0), so the Stratified random sampling methods can be used.

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.