YANTAI XINHAO SWINE FARM MANURE MANAGEMENT SYSTEM GHG MITIGATION PROJECT

Document Prepared by

Search Co2(Shanghai) Environmental Science & Technology Co. Ltd.

Project Title	Yantai Xinhao Swine Farm Manure Management System GHG Mitigation Project
Version	1.0
Date of Issue	20-June-2022
Prepared By	Search Co2(Shanghai) Environmental Science & Technology Co. Ltd
Contact	Address: Room 302, No.2815 Longteng Avenue, Xuhui District, Shanghai, China. Tel: +86-21-64693022 Email: alg@searchco2.com Website: www.searchco2.com

CONTENTS

1 PROJECT DETAILS

1.1 Summary Description of the Project

Yantai Xinhao Swine Farm Animal Manure Management System GHG Mitigation Project (hereinafter referred to as the Project) introduce animal waste management system (AWMS) to swine farms in Yadi village, Muping District, Yantai City, Shandong Province, China, which are owned by Yantai Xinhao agriculture and animal husbandry Co., Ltd (hereinafter called" Xinhao"). The purpose of the project activity is to treat the manure and wastewater from the swine farm to avoid methane emissions generated in the baseline uncovered anaerobic lagoons.

In this project, AWMS is built to replace the traditional open anaerobic lagoons, and swine farm installed one AWMS. The manure and waster will be collected into the anaerobic digesters and then biogas generated during the anaerobic treatment process will be captured and total 1,450*10^4 m^3 biogas are expected to be generated annually. Biogas is then sent into biogas boilers for heat production. Every biogas boiler has been installed in each swine farms. All of the heat generated are used by AWMSs and the swine farms, while the rest (if any) will be burned. The sludge produced after fermentation is applied to corn fields as fertilizer, and the wastewater produced by anaerobic biogas digesters is used for agricultural irrigation.

Benefited from the "waste-biogas-fertilizer" pattern, harmlessness and ecological utilization of the swine manure can be realized. All the heat generated by the project will be used by the AWMSs and the swine farm. The heat generated will not be connected to other users or the regional heating supply system, and the baseline emissions associated with heat generation will not be claimed.

The project activity will reduce of GHG in the atmosphere through avoiding methane emissions from anaerobic treatment of swine manure and wastewater. The project is expected to achieve an annual emission reduction of 105,655 tCO_2e and a total emission reduction of 739,585 tCO_2e in the first crediting period.

The project aims to:

- The capture of methane will significantly reduce the odor nuisance in the vicinity of the facility.
- The project activity can provide job opportunities for local residents.
- The effluent and fermented sludge are ecological organic fertilizers that are partly supplied to the farmers living around for free, which can be used to yield organic products and improve the living conditions of the farmers.
- The biogas can be used for heat generation, which can contribute to the mitigation of global climate change.

1.2 Sectoral Scope and Project Type

Sectoral scope 1： Energy industries (renewable - / non-renewable sources)

Sectoral scope 13： Waste handling and disposal.

The Project is neither a grouped project nor an AFOLU project.

1.3 Project Eligibility

The scope of the VCS Program includes:

1) The six Kyoto Protocol greenhouse gases: The project is expected to avoid Methane (CH_4) emissions from the uncovered anaerobic lagoons in the baseline scenario, which will be captured and destroyed in the project scenario. Thus, the project applies to this scope.

2) Ozone-depleting substances: Not Applicable.

3) Project activities supported by a methodology approved under the VCS Program through the methodology approval process: Not Applicable.

4) Project activities supported by a methodology approved under a VCS approved GHG program unless explicitly excluded under the terms of Verra approval: The applied methodology ACM0010 (Version 8.0) of the project are methodologies approved under CDM Program, which is a VCS approved GHG program.

5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (JNR) Requirements: Not Applicable.

The biogas generated from the anaerobic digesters is recovered and utilized as an energy source within the project boundary. The project does not generate GHG emissions primarily for their subsequent reduction, removal, or destruction.

Furthermore, the project does not belong to the project activities excluded in Table 1 of VCS Standard 4.2.

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

1.4 Project Design

The project includes a single location only.

Eligibility Criteria

This is not a grouped project.

1.5 Project Proponent

Organization name	Yantai Xinhao agriculture and animal husbandry Co., Ltd.
Contact person	Qitao Sun
Title	Manager
Address	Yadi village, Muping District, Yantai City, Shandong Province, China,
Telephone	1340652847
Email	yantaixinhao@126.com

1.6 Other Entities Involved in the Project

Organization name	Search Co2(Shanghai) Environmental Science & Technology Co. Ltd
Role in the project	Consultant
Contact person	Allen Gang
Title	Business Manager
Address	Room 302, No.2815 Longteng Avenue, Xuhui District, Shanghai, China.
Telephone	+86-21-64693022
Email	alg@searchco2.com

Search CO2 (Shanghai) Environmental Science & Technology Co. Ltd (hereinafter “Search CO2”) is founded in 2018 with a registered capital of CNY 5 million and 20 full-time employees. Search CO2 has developed more than 200 offset projects in China, ranging from wind, solar and forestry, under various standards including VCS, Gold Standard and CCER.

1.7 Ownership

The project owner of the project is Yantai Xinhao agriculture and animal husbandry Co., Ltd. The project approval, approval of Environmental Impact Assessment (EIA), and the business license of the project owner are evidence for legislative right. Besides, the equipment purchasing contract and the construction contracts are the evidence for the ownership of the plant and equipment.

1.8 Project Start Date

As per VCS standard, 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 started operation on 05-March-2021 as per Monthly production records, hence the project start date is 05-March-2021.

1.9 Project Crediting Period

This project adopts a 7-year renewable crediting period, from 05-March-2021 to 04-March-2028 (both days included).

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	√
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2e)
05-March-2021 to 04-March-2022	105,655
05-March-2022 to 04-March-2023	105,655
05-March-2023 to 04-March-2024	105,655
05-March-2024 to 04-March-2025	105,655
05-March-2025 to 04-March-2026	105,655
05-March-2026 to 04-March-2027	105,655
05-March-2027 to 04-March-2028	105,655
Total estimated ERs	739,585
Total number of crediting years	7
Average annual ERs	105,655

1.11 Description of the Project Activity

In the project, one animal manure management system has been implemented in the swine farm that belongs to Yantai Xinhao agriculture and animal husbandry Co., Ltd, involving 13,650 breeding swines and 144,000 commercial swines. The project aims to build a centralized anaerobic animal manure treatment system for collecting pig manure, urine, washing water, etc as fermenting materials to generate biogas in Anaerobic tanks that adopts Upflow Anaerobic Sludge Bed Reactor (UASB). The generated biogas will be used for heat generation of biogas boiler. If there is any remaining biogas, it will be burned through flare. After the feedstock is anaerobic fermented, it carries out a solid-liquid separation. And the residual waste from the UASB digester will be used to produce organic fertilizer. After the fermentation, biogas slurry can be used as fertilizer to return to the field and make the plant area green.

To conclude, biogas through the biogas boiler would generate the heat energy used for AWMSs and the swine farm, which to some extent substitutes swine farm's baseline energy and reduces carbon emissions. Besides, the heat energy generated will not be used by others or for other regional heating system. So, the baseline emissions associated with heat generation will not be claimed in ERR, which is conservative.

The estimated lifetime of the project is 25 years. And the project is expected to avoid methane GHG emissions by recycling and burning biogas.

The key system involved in the project are as follows：

1.Livestock farms：

The project consists of one large farm of breeding swines and market swines. The Livestock population in the breeding swine farm is 13,650. And the Livestock population in the market swine farm is 144,000. The breeding cycle of market swine is 150 days.

2. Anaerobic Animal Manure Management System

An Upflow Anaerobic Sludge Bed Reactor (UASB) anaerobic digester is used in the project activities. And one set of UASB digester is installed on the project site. The project is expected to produce 1,450*10^4 m^3 of biogas per year at full capacity. The operating time of the anaerobic digester is expected to be 7,400 hours, resulting in a plant load factor of 84.47% for the project.

3. Biogas pre-treatment system

Before combustion or flaring, the biogas is pre-treated to remove impurities and moisture, etc, which is to prevent the corrosion of the biogas pipeline. In addition, biogas should be continuously in a stable condition before it flows into combustion facility or flare. The pre-treatment consists of pre-filtration, dehumidification, dewatering, cooling and fine filtration.

4. Biogas combustion facility

Biogas is combusted in the auxiliary equipment of the project's animal manure treatment system (i.e. biogas boiler). One biogas boiler has been installed to provide heat for winter heating of the anaerobic digesters and other project facilities.

1.12 Project Location

The Project is located in Yadi village, Muping District, Yantai City, Shandong Province, China. The geographical coordinates of the project is 37° 11′ 12.76″ N, 121° 12′ 3.12″ E.

The geographic location of the project is shown in Figure 1-1.

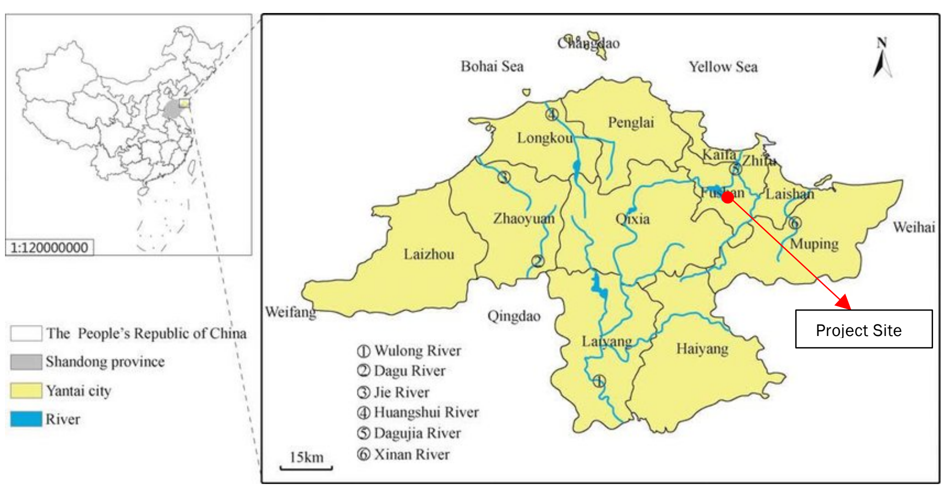


Figure 1-1 Location of the project

1.13 Conditions Prior to Project Initiation

The conditions existing prior to project initiation:

The animal manure waste was left to decay in an anaerobic manure management system (uncovered open lagoon) at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility.

The conditions existing prior to project initiation are also the baseline scenario of the project.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

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

No.	Laws and Regulations	Compliance of the project
1	Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution.	Clause 65 of the Law stipulate "Those engaged in large-scale livestock and poultry breeding shall promptly collect, store, utilize or dispose of solid waste such as livestock and poultry manure generated in the breeding process to avoid environmental pollution". The project is to build a centralized anaerobic animal manure treatment system, which fully complies with the Law.
2	Regulations on prevention and control of pollution from large scale livestock and poultry breeding	The Regulation requires effective measures such as scientific breeding methods and waste treatment techniques should be adopted to reduce the amount of waste generated from livestock and poultry breeding and the amount of pollutants emissions to the environment. The project adopts UASB digesters to treat animal manures from livestock farms, which fully complies with the Regulation.
3	Catalogue for the Guidance of Industrial Structure Adjustment (2013 revision)	The Guidance encourages the construction and operation of Large-scale biogas project using waste from livestock and poultry farms as raw materials. The project adopts UASB

		digesters to treat animal manures from livestock farms and recovers the biogas for energy use, which fully complies with the Guidance
4	Guiding opinions of Shandong animal husbandry and Veterinary Bureau on the development of pig industry	Yantai is an economic development zone in Shandong Province, and also an Agricultural Industrialization Demonstration Base. Projects adopting environmentally friendly technologies are welcomed by Shandong Yantai economic development Zone. The project adopts UASB digesters to treat animal manures from livestock farms and recovers the biogas for energy use. The implementation of the project complies with the industrial policy of Shandong Yantai economic development Zone.

Furthermore, the project has obtained the project approval and EIA approval from local government authorities: Development and Reform Commission of Yantai City and Ecological Environment Bureau of Yantai City. The two 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 is seeking registration under any other GHG programs. The project is seeking registration only under the VCS program.

1.15.2 Projects Rejected by Other GHG Programs

The project has never been seeking registration under any other GHG program; hence the project has never 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 is not included in any emissions trading program or any other mechanism that includes GHG allowance trading. Therefore, the GHG emission reductions and removals generated by the project will not be used for compliance under such programs or mechanisms.

1.16.2 Other Forms of Environmental Credit

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

1.17 Sustainable Development Contributions

The Project will contribute to sustainable development in the following ways:

1. The project will reduce CH4 emissions from animal wastes through biogas digesters with methane capture and utilization.
2. The project will enhance the quality of the water, control the odor, and improve the working environment of the workers of the livestock farms.
3. The residual waste from the digesters of the project will be used to produce organic fertilizer, which will reduce the usage of fertilizer and pesticide, improve the quality of soils, and alleviate agricultural non-point source pollution.
4. The project will apply advanced and environmentally friendly technologies in treating animal wastes and associated utilization, which can be replicated on other Confined Animal Feeding Operations livestock farms.
5. The project can provide job opportunities for local residents.

The project is contribute to the sustainable development and SDGs, included:

SDG Goal 7: Affordable and Clean Energy

The biogas generated during the treatment process will be captured for heat generation. All the energy would be used by swine farms. By recycling and burning biogas, the project can achieve the emission reduction.

SDG Goal 8: Decent Work and Economic Growth

The project activity will provide job opportunities for locals during the implementation and in monitoring activities irrespective of gender or any other status. Both men and women will enjoy equal payments.

SDG Goal 13: Climate Action

The project activity is designed to treat the manure and wastewater from the swine farm to avoid methane emissions generated in the baseline uncovered anaerobic lagoons. By using the key system mentioned above, a harmlessness and ecological utilization of the swine manure can be realized. Besides, the project will provide an opportunity for local residents to learn and raise awareness on climate change.

1.18 Additional Information Relevant to the Project

Leakage Management

Not applicable.

Commercially Sensitive Information

None of the project document will be considered as commercially sensitive information. And all the documentations are available to any stakeholders.

Further Information

Not applicable.

2 SAFEGUARDS

2.1 No Net Harm

The project has undergone the Environmental Impact Assessment (EIA), and the EIA report has been approved by Yantai Ecological Environment Bureau (registered number of approval:[2021]1) and [202]16). The EIA report has assessed all aspects of the project's environmental impact and recommended corresponding environmental protection measures. At the same time, the implementation of the project will improve the local economy by creating new jobs and paying taxes.

In conclusion, the project has no negative impacts on local environment and socio-economy. No net harm on local environment and social community has been detected for the project.

2.2 Local Stakeholder Consultation

The Project owner collected comments by local stakeholders on the project activity. Survey questionnaires were distributed to relevant personnel of the livestock farms, local villagers and government officials by the Project owner on Juanary-2020. The survey questionnaire was designed to assess the project impacts on the local environment and social economic development.

From these surveys, most of the local stakeholders believe that the project will help improve the lives of local people and boost the local economy development with no harm on the environment. Surveys also show that almost all the stakeholders support the proposed project. Also, these stakeholders believe that it will create more jobs and help the local economy.

As a result, most of the local stakeholders consider the implementation of the project to be beneficial.

During the stage of project implementation, communications with local stakeholders will take place regularly. The key schedule of implementation for the project had been communicated to the local authority, the residents' committee and the local residents, whose views and suggestions (if any) were collected by the local authority. And the local government agencies and competent authorities will carry out regular spot checks on project implementation.

In line with VCS requirements, all the processes have been implemented to receive comments from local stakeholders as well as communicate with them at periodic intervals.

2.3 Environmental Impact

As per the EIA report, the environmental impacts of the project in construction period and operation period are summarized as follows.

1. Construction Phase

1.1 Air pollution

Construction dust and road dust during the construction has a certain effect to the surrounding areas of construction site, these adverse effects are accidental, temporary and partial, as long as to take effective measures and strengthen management, the scope of its influence is generally limited to the surrounding area of the construction site and will disappear along with the end of construction.

The waste gas during the project construction is mainly for construction fugitive dust.

1.2 Wastewater

Wastewater during the construction period mainly includes construction wastewater and domestic sewage. The following measures are taken to prevent and control the pollution of construction wastewater: construct temporary diversion ditches on the construction site; Set up a sedimentation tank, and reuse the washing water for construction machinery as much as possible after simple treatment of equipment and vehicles;

Domestic sewage can be collected and processed by setting up mobile toilets, and regularly handed over to the sanitation department to remove garbage and excrement, which can effectively prevent the sewage generated by construction workers from polluting the water environment.

1.3 Noise

The noise generated by the project construction has a slight impact on the surrounding sensitive points, and its pollution impact is localized and short-term. After adopting a reasonable construction organization method, its impact on the surrounding area can be reduced to acceptable range.

1.4 Solid waste

During the construction period, a certain amount of construction waste and domestic waste from construction workers will be generated, of which part of the construction waste will be recycled, and the unusable waste will be handed over to the sanitation department for disposal. After the above measures are taken, the solid waste of the project will not cause pollution to the surrounding environment.

2. Operation Phase

2.1 Air pollution

During the operation period of the project, the main waste gas is the effluvium generated by pig house, dung tent, solid-liquid separation tank, temporary storage tank for biogas slurry, and the combusted waste gas of biogas boiler and biogas torch. The waste gas of biogas boiler is discharged through the exhaust funnel with no less than 8m height; after meeting the gas supply demand of biogas boiler, the remaining biogas is burned by 15m high torch and the exhaust gas is released in the air; NOx, sulfur dioxide and particulate matter in all waste gases of the project meet the second-level emission standard of Integrated emission standard of air pollutants (GB16297).

2.2 Wastewater

During the operation period of the project, the waste water mainly includes piggery flushing waste water, pig manure liquid after solid-liquid separation, pig urine, waste water of canteen and other domestic sewage. The sewage is sent into UASB digesters together for anaerobic fermentation treatment. UASB adopts the process of "mechanical grid + collection of sewage tank + solid-liquid separator +UASB digesters + solid-liquid separator". Sewage is treated to form biogas slurry, which shall meet the requirements of Technology Code for Land Application Rates of Livestock and Poultry Manure (GB/T25246-2010).

2.3 Noise

During the project operation period, the noise mainly due to fans and pumps. Therefore, adopting measures such as sound insulation, shock absorption and distance decay can bring little influence on the surrounding sound environment. The noise at boundary during the project operation shall be subject to the Emisson Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) Class-1 standard.

2.4 Solid waste

During the operation period, the solid waste mainly includes medical waste generated by daily epidemic prevention, pig manure's residue after solid-liquid separation, grid residue and biogas residue generated by UASB digesters, waste oil, waste desulfurizer, waste disinfectant packaging and household garbage generated by equipment maintenance. These solid wastes are centrally treated by qualified waste management companies regularly.

In conclusion, the project owner has taken appropriate measures to minimize adverse environmental impacts. The environmental impact during the project construction was temporary and not significant, and the environmental impact during the project operation is minor. Furthermore, the project activity can reduce greenhouse gas emissions and environmental pollution caused by methane release.

2.4 Public Comments

The public comments period will update after the project is published.

2.5 AFOLU-Specific Safeguards

Not applicable.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The methodology applied to the project is large scale CDM methodology:

ACM0010 GHG emission reductions from manure management systems（version 8.0）

This methodology also refers to the latest approved versions of the following tools:

(a) Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation. (Version 03.0).
(b) "Tool to calculate project or leakage CO2 emissions from fossil fuel combustion"; (version 03.0)
(c) "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period".
(d) "Combined tool to identify the baseline scenario and demonstrate additionality"; (version 07.0)
(e) "Project and leakage emissions from anaerobic digesters"; (version 02.0)
(f) "Tool to determine the baseline efficiency of thermal or electric energy generation systems"; (version 03.0)
(g) "Tool to determine the mass flow of a greenhouse gas in a gaseous stream". (Version 03.0)
(h) "Project emissions from flaring". (Version 03.0)

https://cdm.unfccc.int/methodologies/DB/99QRTE6N5QJEBOV2XP374B25SSIXBB

3.2 Applicability of Methodology

The project satisfies all the applicability criteria of the methodology ACM0010" GHG emission reductions from manure management systems (Version 08.0)", of which the detailed description is listed in Table 3-1 below:

Table 3-1 Applicability of ACM0010

ACM0010 (Version 08.0)" GHG emission reductions from manure management systems"		
NO.	**Applicability conditions of the methodology**	**The project**
1	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.	The project introduced a new animal manure management system to treat manure and wastewater from swine farm to avoid methane emissions in anaerobic lagoons not covered by the baseline. Biogas generated during the treatment process will be collected for biogas boilers, and the rest of the unused portion will be burned with flare.

2	This methodology applies 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 system (AWMSs) that results in less GHG emissions compared to the existing system. The methodology is also applicable to Greenfield facilities.	The project activity will replace the open anaerobic lagoon with enclosed anaerobic tank. Biogas produced during the treatment process will be collected for biogas boiler or flare combustion. After the anaerobic digestion, the fermented sludge is used as fertilizer.
3	This methodology applies to manure management projects under the following conditions:	Biogas slurry from the animal manure management system will be used for agricultural irrigation. Project activities will reduce GHG emissions in the atmosphere by avoiding methane emissions from pig manure and anaerobic treatment of wastewater.
	(a) Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions;	
	(b) Farms where manure is not discharged into natural water resources (e.g., rivers or estuaries)	The project introduced a new animal manure management system for swine farm owned by Yantai Xinhao agriculture and animal husbandry Co., Ltd. in Yantai City, Shandong Province.
	(c) In the 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 farms within the project boundary are swine farms. All swine are managed in confined conditions and can be identified during the on-site investigation period.
	(d) The annual average ambient temperature at the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C;	Swine manure is dumped into an open anaerobic lagoon near the farm, rather than into any natural water resources. This can be confirmed during the on-site investigation period.
	(e) In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is greater than one month;	The open anaerobic lagoon considered in the baseline plan has a design depth of 2-6 m.

	(f) The AWMS(s) in the project case results in no leakage of manure waste into groundwater, for example, the lagoon should have a non-permeable layer at the lagoon bottom.	The annual average ambient temperature at the site is 12.6°C[1], which is higher than 5°C

Tool 02: "Combined tool to identify the baseline scenario and demonstrate additionality(version07.0)"		
1	The tool applies 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 aims to introduce animal manure management systems to swine farm belonging to Yantai Xinhao agriculture and animal husbandry Co, Ltd. to treat manure and wastewater and to avoid methane emissions in anaerobic lagoons that are not covered by the baseline. Alternatives, Barrier analysis, investment analysis and common practices analysis will be based on tool 02.

Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version03.0)"		
1	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 emission	The project will monitor and record the amount of produced and collected biogas in the anaerobic digesters.
2	Methodologies, where CO2 is the particular and only gas of interest, should continue to adopt material balances as of the means of flow determination and may not adopt this tool as material balances are the cost-effective way of monitoring the flow of CO2	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.

[1] http://www.weather.com.cn/cityintro/101120501.shtml

3	The underlying methodology should specify: (a) The gaseous stream the tool should be applied to; (b) For which greenhouse gases the mass flow should be determined; (c) In which time intervals the flow of the gaseous stream should be measured; and (d) Situations where the simplification offered for calculating the molecular mass of the gaseous stream (equations (3) or (17) is not valid (such as the gaseous stream is predominantly composed of a gas other than N_2).	a) Methodological tool" Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied in the PD. b) The mass flow is determined in the monitoring plan of the PD. c) The flow of the gaseous stream will be measured continuously. d) The gaseous stream is dry, equation (5) and (6) are used to calculate the mass flow of greenhouse gas

Tool 14: "Project and leakage emissions from anaerobic digesters (Version 02.0)"		
1	The following sources of project emissions are accounted for in this tool: (a) CO2 emissions from the consumption of electricity are associated with the operation of the anaerobic digester. (b) CO2 emissions from the consumption of fossil fuels are associated with the operation of the anaerobic digester. (c) CH4 emissions from the digester (emissions during maintenance of the digester, physical leaks through the roof and sidewalls, and release through safety valves due to excess pressure in the digester). (d) CH4 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, meanwhile the project activity will replace the current open anaerobic lagoons with new closed anaerobic digester. So, the project meets the (a) and (c)
2	The following sources of leakage emissions are accounted for in this tool: (a) CH4 and N2O emission from composting of digestate. (b) CH4 emissions from the anaerobic decay of digestate disposed in an SWDS	The project activity will replace the open anaerobic lagoon with enclosed anaerobic digester. The biogas generated during the treatment process will be collected and used for biogas boiler combustion to produce heat. After the anaerobic digestion, the

	or subjected to anaerobic storage, such as in a stabilization pond.	fermented sludge is used as fertilizer. As a result, the proposed project meets this criterion.
3	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, the 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.

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 AMMS, including the GHG emissions from waste treatment processes. The baseline situation is shown as follows.

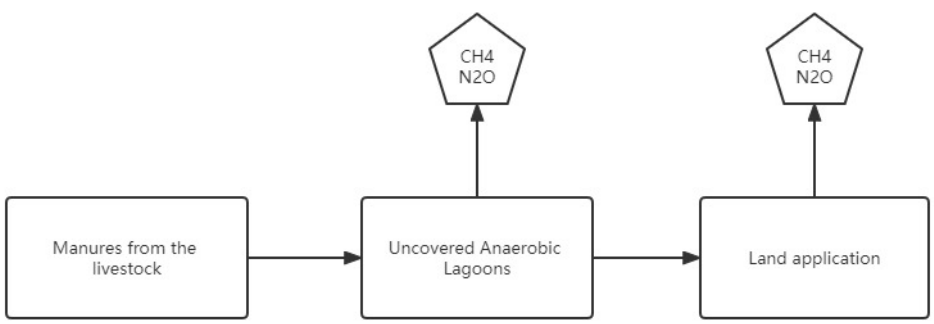


Figure 3-1 The Baseline Scenario of the Project

And the project boundary is shown in Figure 3-2 below.

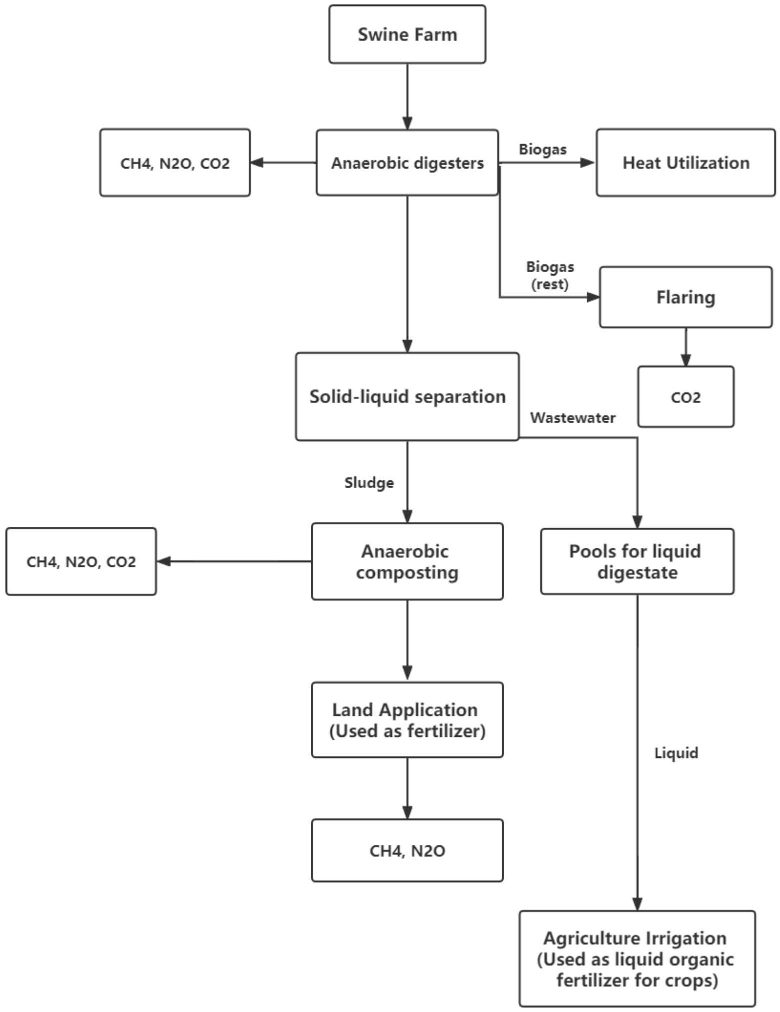


Figure 3-2 The project boundary of the project

The greenhouse gases included or excluded from the project boundary are summarized in the following table.

Table 3-4 Emission Sources Included in or Excluded from the Project Boundary

Source		Gas	Included?	Justification/Explanation
Baseline scenario	Emissions from the waste treatment processes	CO_2	No	CO2 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 N2O emissions are accounted

Source		Gas	Included?	Justification/Explanation
	Emissions from electricity consumption/ generation	CO_2	No	The anaerobic lagoon does not consume electricity.
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from thermal energy generation	CO_2	No	The anaerobic lagoon does not consume thermal energy.
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project scenario	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 treatment processes	CO_2	No	CO_2 emissions from the decomposition of organic waste are not accounted
		CH_4	Yes	The emission from anaerobic digesters and aerobic treatment
		N_2O	Yes	Direct and indirect N_2O emissions are accounted

3.4 Baseline Scenario

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

Step1: Identification of alternative to the project activity consistent with current laws and regulations

Step 1a: Define alternative scenarios to the project activity

Without this project, all manure waste produced from the existing swine farm will be left to decay in uncovered anaerobic lagoons at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. With the implementation of the project, one set of AWMS in these swine farm was enabled. Therefore, it belongs to the existing facilities.

The baseline and available alternatives for 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 labour-intensive to remove the manure and apply it daily. Therefore, this manure management system is not an economically attractive prospect. So, the exclusion of this potential baseline scenario can be justified.
3	Solid Storage: The manure is disposed of by solid storage.	Not Applicable	This involves the storage of manure, typically for 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 that 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 does not apply to the conditions of the farm in the project. The proposed project is a non-free captive mode. This method is only a storage method of manure, not a disposal method. So, this system is excluded.

5	The manure is disposed of as liquid/slurry.	Not Applicable	This method is only a storage method of manure, not a disposal method. Manure is stored as excreted or with some minimal addition of water in either tanks or earthen ponds outside the animal housing, usually for periods less than one year. Since the amount of discharged manure is very large even on a daily basis, storing the liquid manure in the tank to distribute them to the farmland requires a lot of labor work. Therefore, it is unrealistic to implement such a task for the farms under the competition of the market. Therefore, this option faces a 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[2]", the uncovered anaerobic lagoon is a kind of harmless treatment of manure. After being treated in the uncovered anaerobic pond, the manure can be used for agricultural irrigation, Prior to the implementation of the project, the animal manure waste was left to decay in uncovered anaerobic lagoons. Therefore, animal waste that has been treated by uncovered anaerobic lagoon can satisfy the above regulations. Since there is no legal regulation to mandate the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques and to capture and/or utilize methane generated at these lagoons. So, the uncovered anaerobic lagoon is an alternatives baseline scenario.
7	Pit storage below animal confinements, <1month	Not Applicable	This method is only a storage method of manure, not a disposal method. The farms involved in this project are large-scale livestock farms and the manure quantity produced is too large to implement a pit storage structure under the barns. In addition, the manure stored in below animal confinements were removed within 1 month requires a lot of labor work. so, this scenario is excluded.

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

	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 farms and the manure quantity produced is too large to implement a pit storage structure under the barns. In addition, the excreted volume accumulated under the barns produces enteric fermentation gas, if it is not discharged out of the barns in time, the pigs will be quickly killed by the accumulation of toxic fumes.
8	Anaerobic digester	Applicable	A single Anaerobic digester is suitable for treating manure, but to implement such technology needs high investment compared to an Uncovered anaerobic lagoon, which is the most common and economic method. However, a single anaerobic process is not yet able to meet the requirements for the use of the waste and must be followed up with disposal, which requires the use of a combination of aerobic and anaerobic processes together.
9	Burned for fuel	Not Applicable	The farms involved in this project are large scale swine farms, the manure is flushed to the anaerobic digester, the dung and urine generated from the farm are too large even daily, so it is unlikely to dry the dung before using it 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 of 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	Manure in this project is collected by using a scraping and flushing system. Manure in this

			project is in liquid with a 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 a 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 farms, not the Poultry farm, so no poultry manure is produced. This system is excluded.
16	Poultry manure without litter	Not Applicable	The farms involved in this project are large-scale swine farms, not the Poultry farm, so no poultry manure is 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.

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

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

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

3.5 Additionality

Step 1b: Consistency with mandatory laws and regulations

According to "Technical specification for sanitation treatment of livestock and poultry manure[3]" and the "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)[4]", Scenario 6: "The manure is disposed in an uncovered anaerobic lagoon" and Scenario 8 & 17: Anaerobic Digester 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

The anaerobic digester system is considered to be one of the most advanced manure management systems in the world. High costs involved in the investment compared to other available systems are required to implement such technology. Additionally, the investment required to generate heat from biogas is still too high and the cost is much higher than electricity prices in the market, so the IRR of the project activity is lower than the average level and it is difficult for the project proponents to get loans from the banks. Only the project proponents can prove that they can get revenues from VCS Standard certification, it can attract the banks to

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

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

provide loans for this project. For these reasons, without the revenues, PP is willing to adopt other manure management systems of lower costs which will lead to more GHG emissions.

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

Sub-step 2a. Determine appropriate analysis method

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

The investment comparison analysis method (option II) applies to projects whose alternatives are also investment projects. Only on such a basis, comparison analysis can be conducted. The alternative baseline scenario of the proposed project doesn't belong to investment projects. Therefore, option II is not an appropriate method.

The proposed project will use the benchmark analysis method (option III) based on the consideration that benchmark, Project IRR is available.

Sub-step 2b. Benchmark Analysis Method (Option III)

According to the "Financial benchmark rate of return of construction projects" issued by NDRC, the financial benchmark of the animal industry for Project IRR (after tax) is 9.5% for the total investment.

Sub-step 2c: Calculation and comparison of financial indicators

(a) Basic parameters

Item	Value	Source
Total static investment	13,310.04*10^4 RMB	FSR
O&M cost	13,892.07*10^4 RMB	FSR
Operation period	21 years	FSR
Emission reduction	105,656 tCO_2e	Calculated
VCU Price	CNY 25/ton	Expected

(b) Comparison of the project IRR for the proposed project and the benchmark following table.

Without income from selling VCUs, the IRR of the proposed project is 7.05%, lower than the benchmark IRR 9.5% and the proposed project is financially unacceptable because of its low profitability. While considering such income, the IRR of the proposed project is 10.05%, higher than the benchmark, and the proposed project is financially acceptable.

Item	Without income from VERs	Benchmark IRR	With income from VERs
The Project IRR	7.05%	9.5%	10.05%

Sub-step 2d: Sensitivity analysis:

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

According to Guidance on the Assessment of Investment Analysis, the “variables, including the initial investment cost, that constitute more than 20% of either total project costs or total project revenues should be subjected to reasonable variation”. Therefore, the total static investment, and organic fertilizers sales were taken as uncertain factors for sensitive analysis. Furthermore, the O&M cost which was widely included in the sensitivity analysis for projects in China was also examined in the analysis. As a result, the following parameters are selected for the analysis:

*Total static investment

*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 following table and figure:

item	-10%	-5%	0	5%	10%
Total static investment	8.49%	7.74%	7.05%	6.41%	5.82%
O&M cost	7.58%	7.32%	7.05%	6.78%	6.50%
organic fertilizers sales	5.29%	6.18%	7.05%	7.89%	8.72%

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 16.00%;

Organic fertilizers sales: increase 14.80%;

O&M cost: decrease 47.00%

Since all the data used for the investment analysis was sourced from the FSR, which was completed by an authorized entity. 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 16.00%: But the change of this extent is unlikely to happen. 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 14.80%: The organic fertilizers is determined by the manure of the swine farm. Since the scale of the swine farm will stay stable in the future, therefore the increase of annual organic fertilizers generation to threshold is impossible to achieve, at the same time, sales of organic fertilizers are only part of the total organic fertilizers' generation.

O&M cost decreasing 47.00%: 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 Shandong 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 47.00% 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.

Ongoing Financial Need

According to the results of investment analysis described in section B.4, IRR without carbon revenue of the project is 7.05%, which is lower than 9.5% benchmark of construction project for animal industry. The project can apply for carbon credits under VCS project, the IRR can reach to 10.05% with carbon revenue. Therefore, the revenue from Gold Standard certification is material to the ongoing sustainability of the project.

Conclusion of the assessment and demonstration of additionality

To summarize, "the Project is undertaken without being registered as a VCS project activity" is not financially attractive to investors, thus it is not feasible. Being registered as a VCS project, the VCUs revenues can alleviate the identified barriers, therefore the proposed project is additional.

3.6 Methodology Deviations

Not Applicable

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

As per paragraph 26 of the applied methodology,

Baseline emissions are:

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

where:

BE_y Baseline emissions in year y (t CO_2/yr)

$BE_{CH4,\,y}$ Baseline CH_4 emissions in year y (t CO_2/yr)

$BE_{N2O,\,y}$ 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)

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

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

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_j) for the baseline *AWMSj*. IPCC 2006, 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:

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

where:

$VS_{LT,y}$	Annual volatile solid excretions for livestock *LT* entering all AWMS on a dry matter weight basis (kg -dm/animal/yr)
GE_{LT}	Daily average gross energy intake (MJ/animal/day)
DE_{LT}	Digestible energy of the feed (per cent)
UE	Urinary energy (fraction of 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 VSdefault to adjust for a site-specific average animal weight as shown in equation below:

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

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 ndy (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.

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

(c) 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:

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

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 (NLT) may be calculated as follows:

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

where:

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

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

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

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

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

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

(a)The MCF values are 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 12.6℃ and the value of 70% 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.

(2) Baseline NO_2 emissions ($BE_{NO2,y}$)

$$E_{N20,D,y} = GWP_{N20} * CF_{N20-N,N} * \frac{1}{1000} * (E_{N20,D,y} + E_{N20,ID,y}) \qquad \text{Equation (7)}$$

where:

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

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

where:

$E_{N20,D,y}$	Direct N_2O emission in year *y* (kg N_2O-N/yr)
$EF_{N20,D,j}$	Direct N_2O emission factor for the treatment system *j* of the manure management system (kg N_2O-N/kg N).(Estimated with site-specific, regional or national data if such data is available, otherwise use default 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)

$$E_{N20,I,D,y} = \sum_{j,LT} EF_{N20,ID} \times F_{gasMS,j,LT} \times NEX_{LT,y} \times N_{LT} \times MS\%_{Bl,j} \qquad \text{Equation (9)}$$

where:

$E_{N20,ID,y}$	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 volatilization of NH3 and NOX 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:

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

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

Nintake may be calculated using:

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

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 atthe project site in the following way:

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

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)

$$NEX_{IPCCdefault} = Nrate(T) * \frac{TAM}{1000} * 365 \qquad \text{Equation (13)}$$

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 $NEX_{LT,y}$.

(3) 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 an uncovered anaerobic lagoon, and no electricity and/or heat is used in the baseline. So, the baseline CO_2 emission from electricity and/or heat used in the baseline is 0.

4.2 Project Emissions

One stage is involved in the manure treatment for the project activity, which is anaerobic digester. Project emissions are estimated as follows:n factors and default values).

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

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)

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

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

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

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

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)

The anaerobic digestion process of this project does not involve the use of fossil fuels, so the project emissions from fossil fuel consumption associated with the anaerobic digester is 0, i.e., $PE_{FC,y} = 0$.

The biogas generated in this project will be directly heated by the anaerobic fermenting equipment after being burned by the boiler, and the rest will be burned by torch.

In summary, the Project emissions associated with the anaerobic digester in year y (t CO2e) are as follows i.e., $PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$.

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

As the electricity consumption of the anaerobic digestion system cannot be measured separately from the entire AMMS, the Project emissions from electricity consumption is 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 Tool 05 "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (Version 03.0)"

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

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*

During the monitoring period, the project emissions from electricity consumption will be calculated as Tool 05 in the case of the electricity consumed from the regional power grid. And the electricity consumption sourced from the grid company will be determined through the electricity meters measurement and cross-check with the grid statement.

In case, there is the residual gas stream that 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:

(d) The gaseous stream to which the tool is applied is the residual biogas for flaring.
(e) The flow of the gaseous stream shall be measured continuously.
(f) CH_4 is the greenhouse gas i for which the mass flow should be determined.
(g) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 and 17 in the tool); and
(h) The time interval t for which mass flow should be calculated is every minute m.

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

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

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

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

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

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

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 flare in this project belongs to open flares. According to tool 06 paragraph 18: in the case of open flares, the flare efficiency in the minute m ($\eta_{flare,m}$) is 50% when the flame is detected in the minute m ($Flame_m$), otherwise $\eta_{flare,m}$ is 0%.

Since the flame is not detected in the minute, therefore, fixed value of 0% for the flare efficiency will be applied for this project, and this is for conservative.

Step 3: Calculation of project emissions from flaring

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

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

where:

$PE_{flare,y}$	Project emissions from flaring of the residual gas in year *y* (tCO_2e)
GWP_{CH4}	Global warming potential of methane is 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:

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

Where:

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

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

According to the Project evaluation report, nearly all the biogas generated in the AWMS will be collected for heat generation, only a small fraction of biogas will be flared in pre-calculation. In the monitoring period, the project emissions from the flaring of biogas will be calculated according to the actual situation.

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

$PE_{CH4,y}$ was determined following 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:

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

where:

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

Option 1: 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(version03.0)”. 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 for which the mass flow should be determined.
(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

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

The mass flow of greenhouse gas *i* ($F_{i,t}$) 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 (m³ 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 (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)

In summary, the Project emissions associated with the anaerobic digester in year y (t CO_2e) is the sum of Project emissions from electricity consumption, project emissions from flaring of biogas (if any), and Project emissions of methane from the anaerobic digester in year y (t CO_2e). i.e., $PE_{AD,y} = PE_{EC,y} + PE_{flare,y} + PE_{CH4,y}$.

(2) Project CH4 emissions from aerobic AWMS treatment ($PE_{Aer,y}$)

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

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

(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)
NLT	Annual average number of animals of type LT for the year y (number) as estimated in equation (5(a)) or (5(b))
PEsl,y	Project CH4 emissions from sludge disposed of in storage pit prior to disposal during the year y (t CO2e/yr)
MS%j	Fraction of manure handled in system j in the project activity (fraction)

No oxygen waste management system is involved in this project, so **$PE_{Aer,y}$=0.**

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

$$PE_{N20,y} = GWP_{N20} * CF_{N20-N,N} * \frac{1}{1000} * (E_{N20,D,y} + E_{N20,ID,y}) \qquad \text{(Equation 26)}$$

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 N2O (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:

$$E_{N2O,,y} = \sum_{j,LT} EF_{N2O,D,j} * NEX_{LT,y} * N_{LT} * MS\%_j \qquad \text{(Equation 27)}$$

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)

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

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:

$$E_{N20,D,y} = \sum_j EF_{N20,D,j} \times \sum_{m=1}^{12} (Q_{EM,m} \times [N]_{EM,m}) \qquad \text{(Equation 29)}$$

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

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 Option 1 is used to calculate the Project N_2O emissions $PE_{N2O,y}$.

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

$$PE_{EC/FC,y} = PE_{EC,y} + \sum_j PE_{FC,j,y} \qquad \text{(Equation 31)}$$

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

the same for the $PE_{FC,y}$, please refer to $PE_{FC,y}$ calculation.

Therefore, $PE_{elec/heat} = 0$

4.3 Leakage

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

$$LE_y = (LE_{PJ,N20,y} - LE_{BL,N20,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y}) + LE_{AD,y} \quad \text{(Equation 32)}$$

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)

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

$$LE_{BL,N20,y} = GWP_{N20} * CF_{N20-N,N} * \frac{1}{1000} * (LE_{N20,runoff,y} + LE_{N20,vol,y}) \quad \text{(Equation 33)}$$

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \quad \text{(Equation 34)}$$

$$LE_{N20,runoff,y} = EF_5 \times F_{teach} \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT}$$ (Equation 35)

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT}$$ (Equation 36)

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

(2) Estimation of leakage N_2O emissions released during project activity from land application of the treated manure in year y, $LE_{PJ,\ N20}$

$$LE_{PJ,N20} = GWP_{N20-N,N} * \frac{1}{1000} * (LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y})$$ (Equation 37)

$$LE_{N20,land,y} = EF_1 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times \sum_{LT} NEX_{LT,y} \times N_{LT}$$ (Equation 38)

$$LE_{N20,runoff,y} = EF_5 \times F_{leach} \times \prod_{n=1}^{N}(1 - R_{N,N}) \times \sum_{LT} NEX_{LT,y} \times N_{LT} \qquad \text{(Equation 39)}$$

$$LE_{N20,vol,y} = EF_4 \times \prod_{n=1}^{N}(1 - R_{N,n}) \times F_{gasm} \times \sum_{LT} NEX_{LT,y} \times N_{LT} \qquad \text{(Equation 40)}$$

where:

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

(3) Estimation of leakage CH4 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:

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

(Equation 41)

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

(Equation 42)

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

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

$LE_{AD,y}$ is determined using the methodological tool "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:

$$LE_{AD,y} = LE_{storage,y} + LE_{comp,y} \qquad \text{(Equation 43)}$$

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 RN 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 TN).

Because this project does not involve anaerobic storage of biogas residue and composting treatment of biogas residue, so $LE_{AD,y} = 0$.

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:

$$ER = BE_y - PE_y - LE_y \qquad \text{(Equation 44)}$$

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 CH4 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 $Q_{CH4,y}$.

Calculation of the baseline emission:

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

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4

D_{CH4}	0.00067	0.00067	t/m^3
MCF_j	70%	70%	%
Conservative Factor	0.94	0.94	/
MCF_j with cons. Factor	0.658	0.658	/
$B_{o,LT}$	0.29	0.29	m^3 CH_4 /kg_dm
N_{LT}	144,000	13,650	No of heads
W_{site}	85.5	95.5	kg
$W_{default}$	28	28	kg
$VS_{default}$	0.3	0.3	Kg-dm/animal/day
$VS_{LT,y}$	334.37	373.47	kg-dm/animal/yr
$MS\%_{Bl,j}$	100%	100%	%
nd_y	365	365	days
Sub total	172,362	18,249	tCO_2e
BE_{CH4}	**190,611**		

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N20,D,j}$	0	0	kg N_2O-N/kg N
$EF_{N20,ID}$	0.01	0.01	kg N_2O-N/kg N
$N_{rate(T)}$	0.42	0.24	kg N/1000kg animal mass/day
$NEX_{IPCCdefault}$	4.29	2.45	kg N/animal/year)
W_{site}	85.5	95.5	kg
TAM	28.00	28.00	kg
$W_{default}$	28	28	kg
$NEX_{LT,y}$	13.11	8.37	kg N/animal/yr
N_{LT}	144,000	13,650	No of heads
$MS\%_{Bl,j}$	100%	100%	/
$F_{gasMS,j,LT}$	40%	40%	/
GWP_{N20}	265	265	tCO_2/tN_2O
$CF_{N20,N-N}$	1.57	1.57	Conversion Factor N_2O-N to N_2O
$E_{N20,ID,y}$	7,550	457	tCO_2/tN_2O
	8,006		tCO_2/tN_2O
$BE_{N20,y}$	**3,334**		tCO_2e

Baseline Emissions: $BE_{CH4,y}$ + $BE_{N20,y}$ = 190,611 tCO_2e +3,334 tCO_2e =193,945 tCO_2e

Calculation of the project emission:

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

Parameter	Value	Unit
$EC_{PJ,j,y}$	4,800	MWh/yr
$EF_{EF,j,y}$	0.7119	tCO_2/MWh
$TDL_{j,y}$	20%	/
$PE_{EC,y}$	**4,101**	tCO_2e
$PE_{FC,y}$	**0**	tCO_2e

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$EF_{CH4,default}$	0.05	/
$Q_{CH4,y}$	6,800.5	t CH_4
$PE_{CH4,y}$	**9,520**	tCO_2e

Parameter	Value	Unit
GWP_{CH4}	28	tCO_2/tCH_4
$\eta_{flare,m}$	0	/
$Q_{CH4,y}$	150	t CH_4
$PE_{flare,y}$	**4,200**	tCO_2e

$PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$ = 4,100 tCO_2e +9,520 tCO_2e +4,200 tCO_2e =17,820 tCO_2e

Parameter	Value		Unit
species	**Market Swine**	**Breeding Swine**	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
	0.001	0.001	/
F_{Aer}	46%	46%	/
$1-R_{VS,1}$	54%	54%	/
$B_{0,LT}$	0.29	0.29	m^3 CH_4 /kg VS
N_{LT}	144,000	13,650	No of heads
$VS_{LT,y}$	334.37	373.47	kg-dm/animal/yr
$MS\%_j$	100%	100%	/
Sub total	65	7	tCO_2e
$PE_{Aer,y}$	72		

Parameter	Value		Unit
species	**Market Swine**	**Breeding Swine**	
$EF_{N2O,D,j}$	0	0	kg N_2O-N/kg N
$NEX_{LT,y}$	13.11	8.37	kg N/animal/yr

N_{LT}	144,000	13,650	No of heads
$MS\%_j$	46%	46%	/
Sub total	**5,209.31**	**315.17**	kg N_2O-N/year
$E_{N2O,D,y}$	**5,524.48**		

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N2O,iD}$	0.01	0.01	kg N_2O-N/kg NH_3 and NO_x-N
$F_{gasMS,j,LT}$	0.4	0.4	/
$NEX_{LT,y}$	13.11	8.37	kg N/animal/yr
N_{LT}	144,000	13,650	No of heads
$MS\%_j$	54%	54%	%
GWP_{N2O}	265	265	tCO_2/tN_2O
Sub total	**4,076.85**	**246.66**	kg N_2O-N/year
$E_{N2O,ID,j}$	**4,324**		kg N_2O-N/year
Parameter	Value		Unit
species	Market Swine	Breeding Swine	
$EF_{N2O,iD,j}$	0.01	0.01	kg N_2O-N/kg NH_3 and NO_x-N
$F_{gasMS,j,LT}$	0.45	0.45	/
$NEX_{LT,y}$	13.11	8.37	kg N/animal/yr
N_{LT}	144,000	13,650	No of heads
$MS\%_j$	46%	46%	%
GWP_{N2O}	265	265	tCO_2/tN_2O
Sub total	**3,906.98**	**236.38**	kg N_2O-N/year
$E_{N2O,ID,y}$	**4,143**		kg N_2O-N/year

$$PE_{N2O,y} = 310 * (44/28) * 1/1000 * (E_{N2O,D,y} + E_{N2O,ID,y}) = 5{,}826 \text{ tCO}_2\text{e}$$

Project emission: $PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} =$ 17,821 tCO_2e +72 tCO_2e +5,826tCO_2e =23,719 tCO_2e

Calculation of leakage

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

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
N_{LT}	144,000	13,650	No of heads
$NEX_{LT,y}$	13.11	8.37	kg N/animal/yr
$R_{N,n}$	80%	80%	/

EF_1	0.01	0.01	kg N_2O-N/kg N
EF_5	0.0075	0.0075	kg N_2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
GWP_{N2O}	265	265	tCO_2/tN_2O
$LE_{N2O,land,y}$	3,774.86	228.39	kg N_2O-N/year
	4,003.25		
$LE_{N2O,runoff,y}$	849.34	51.39	kg N_2O-N/year
	900.73		
$LE_{N2O,vol,y}$	754.97	45.68	kg N_2O-N/year
	800.65		
$LE_{BL,N2O,y}$	**2,376**		

Parameter	**Value**		**Unit**
species	**Market Swine**	**Breeding Swine**	
N_{LT}	144,000	13,650	No of heads
NEX_{LT}	13.11	8.37	kg N/animal/yr
R_N	25%	25%	-
EF_1	0.01	0.01	kg N2O-N/kg N
EF_5	0.0075	0.0075	kg N2O-N/kg N
EF_4	0.01	0.01	KgN-N_2O-N/kg NH_3-N+NO_X-N
F_{leach}	0.3	0.3	/
F_{gasm}	0.2	0.2	/
$LE_{N2O,land,y}$	14,155.72	856.45	kg N_2O-N/year
	15,012.17		
$LE_{N2O,runoff,y}$	3,185.04	192.70	kg N_2O-N/year
	3,377.74		
$LE_{N2O,vol}$	2,831.14	171.29	kg N_2O-N/year
	3,002.43		
$LE_{PJ,N2O}$	**8,908**		

Parameter	**Value**		**Unit**
species	**Market Swine**	**Breeding Swine**	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	334.374	373.47	kg-dm/animal/yr
N_{LT}	144,000	13,650	No of heads

$B_{0,LT}$	0.29	0.29	m^3 CH4/kg-VS
R_{VS}	85%	85%	/
$MS\%_j$	100%	100%	/
$LE_{BL,CH4,y}$	**39,292.24**	**4,160.20**	tCO_2e
Total	**43,452**		

Parameter	Value		Unit
species	Market Swine	Breeding Swine	
GWP_{CH4}	28	28	tCO_2/tCH_4
D_{CH4}	0.00067	0.00067	t/m^3
MCF_d	1	1	/
$VS_{LT,y}$	334.37	373.47	kg-dm/animal/yr
N_{LT}	144,000	13,650	No of heads
$B_{0,LT}$	0.29	0.29	m^3 CH_4/kg-VS
R_{VS}	2%	2%	/
R_{VS}	45%	45%	/
R_{VS}	35%	35%	
$MS\%_j$	100%	100%	/
$LE_{PJ,CH4,y}$	**91,773.57**	**9,716.84**	tCO_2e
Total	**101,490**		tCO_2e

$LE_y = \left(LE_{PJ,N2O,y} - LE_{BL,N2O,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right) =$ (8,908 tCO_2e – 2,376 tCO_2e) + (101,490 tCO_2e–43,452 tCO_2e) =64,571 tCO_2e

Emission Reduction: $ER_y = BE_y - PE_y - LE_y$ = 193,945 tCO_2e - 23,718 tCO_2e - 64,571 tCO_2e = 105,656 tCO_2e

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project emissions or removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission reductions or removals (tCO_2e)
05-March-2021 to 04-March-2022	193,945	23,719	64,571	105,655
05-March-2022 to 04-March-2023	193,945	23,719	64,571	105,655
05-March-2023 to 04-March-2024	193,945	23,719	64,571	105,655

05-March-2024 to 04-March-2025	193,945	23,719	64,571	105,655
05-March-2025 to 04-March-2026	193,945	23,719	64,571	105,655
05-March-2026 to 04-March-2027	193,945	23,719	64,571	105,655
05-March-2027 to 04-March-2028	193,945	23,719	64,571	105,655
Total	**1,357,615**	**166,033**	**451,997**	**739,585**

5 MONITORING

5.1 Data and Parameters Available at Validation

Data / Parameter	GWP_{CH4}
Data unit	t CO_2e/tCH_4
Description	Global Warming Potential of CH_4
Source of data	IPCC 2014
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
Purpose of Data	Used in project emission/baseline calculations
Comments	*N/A*

Data / Parameter	GWP_{N2O}
Data unit	t CO_2e/TN_2O
Description	Global Warming Potential of N_2O

Source of data	IPCC 2014
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*

Data / Parameter	D_{CH4}
Data unit	t/m^3
Description	Density of CH_4
Source of data	ACM0010 Version 08.0
Value applied	0.00067 t/m^3 at room temperature 20℃ and 1 atm pressure.
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*

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	65.8%
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. 70%) 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 12.6℃ and the value of 70 % is applied. Therefore, MCFj value of 65.8% will be applied.
Purpose of Data	Used in project emission/baseline 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) = 28kg $W_{default}$ (Breeding swine) = 28kg
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 NH3 and NOX 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 N20 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	Site specific data is unavailable therefore default values are opted for.

measurement methods and procedures applied	
Purpose of Data	Used in project/baseline emission calculations
Comments	*N/A*

Data / Parameter	$EF_{N2O,ID,j}$
Data unit	kgN_2O-N/kg NH_3-N and NO_X-N
Description	Indirect N2O 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 CH4 produced that leaks from the anaerobic digester (fraction)
Source of data	IPCC 2006; The tool ”Project and leakage emissions from anaerobic digesters”
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.

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 and FSR
Value applied	$R_{VS,n}$, 2%, 45% and 35% for leakage CH_4 emission released during project activity $R_{VS,n}$, 85% for leakage CH_4 emission released during baseline scenario
Justification of choice of data or description of measurement methods and procedures applied	Estimated from Table provided in 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	N/A

Data / Parameter	$R_{N,n}$
Data unit	Fraction
Description	Nitrogen reduction factor
Source of data	Refer to Annex 1 of methodology ACM0010
Value applied	$R_{N,n}$, anaerobic digester: 0.25 $R_{N,n}$, uncovered anaerobic lagoon: 0.80
Justification of choice of data or description of measurement methods and procedures applied	The anaerobic digester has been assumed as a covered first cell of a two-cell lagoon. An uncovered anaerobic lagoon has been assumed as one cell lagoon.
Purpose of Data	project emission/ leakage calculation
Comments	N/A

Data / Parameter	EF_1, EF_4, EF_5
Data unit	kg N_2O-N/kg N for EF1, EF5 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 being 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=0.01 EF_4=0.01 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 measurement methods and procedures applied	Site specific data is unavailable therefore default values are opted for.
Purpose of Data	Calculation of leakage emission
Comments	N/A

Data / Parameter	MCF_d
Data unit	-
Description	The 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	Site specific data is unavailable therefore default values are opted for.
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 NDRC
Value applied	0.7119
Justification of choice of data or description of measurement methods and procedures applied	According to the tool" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
Purpose of Data	Calculation of project emission
Comments	N/A

Data / Parameter	Ru
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	N/A

Data / Parameter	MMi
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	N/A

5.2 Data and Parameters Monitored

Complete the table below for all data and parameters that will be monitored during the project crediting period (copy the table as necessary for each data/parameter). Data and parameters determined or available at validation are included in Section 5.1 (Data and Parameters Available at Validation) above.

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	To be collected for each swine population in all of the pig barns. The number of swine produced on the farm will be recorded manually by the responsible staff.
Frequency of monitoring/recording	Monitored monthly.
Value applied	144,000 heads of commercial pigs
Monitoring equipment	N/A
QA/QC procedures to be applied	Archive electronically during project plus 5 years.
Purpose of data	Use for the calculation of NLT
Calculation method	
Comments	Indirect information (food purchase records and sale records) will be cross-checked.

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 swine alive on the farm will be recorded manually by the responsible staff.
Frequency of monitoring/recording	Monitored monthly.
Value applied	150 days
Monitoring equipment	N/A
QA/QC procedures to be applied	Archive electronically during project plus 5 years.
Purpose of data	Use for the calculation of N_{LT}
Calculation method	
Comments	Indirect information (food purchase records and sale records) will be cross-checked.

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	Monitored daily. Archive electronically during project plus 5 years
Frequency of monitoring/recording	daily
Value applied	13,650 heads of breeding pigs
Monitoring equipment	N/A
QA/QC procedures to be applied	The PD should describe the system for monitoring the number of livestock populations.
Purpose of data	Use for the calculation of N_{LT}
Calculation method	

Comments	N/A

Data / Parameter	Wsite
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Source of data	Project proponents
Description of measurement methods and procedures to be applied	Measured by the weight measurer
Frequency of monitoring/recording	monthly
Value applied	85.5kg for commercial pigs and 95.5 kg for breeding pigs
Monitoring equipment	N/A
QA/QC procedures to be applied	This parameter is used in equation 4 for estimating $VS_{LT,y}$ using option 3, and in equation 2 (appendix 2) for estimating $NEX_{LT,y}$ when using IPCC 2006 default values. Sampling procedures 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.
Purpose of data	Used for estimating $VS_{LT,y}$
Calculation method	
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	-
Frequency of monitoring/recording	daily
Value applied	365 days for ex-ante estimation. The actual number of days the treatment plant was operationally used in the monitoring periods will be monitored by Project proponents
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of Baseline emissions
Calculation method	
Comments	N/A

Data / Parameter	F_{Aer}
Data unit	Fraction
Description	Fraction of volatile solids directed to aerobic treatment
Source of data	Project evaluation report
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annually
Value applied	46% was used in the pre-calculation,

Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emission
Calculation method	N/A
Comments	N/A

Data / Parameter	v_f[5]
Data unit	m^3
Description	Biogas flow
Source of data	Project proponents
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Continuously monitored by flow meters and reported cumulatively on a weekly basis
Value applied	In pre-calculation, $1450*10^4$ m^3 of biogas can be generated by the project annually, which is sourced from the Project evaluation report.
Monitoring equipment	N/A
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	N/A

[5] this parameter is not used in the calculation of emission reductions, but according to applied methodology ACM0010 (version08.0), this parameter needs to be monitored.

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	Use electricity meters installed at the electricity consumption sources.
Frequency of monitoring/recording	Continuous measurement and at least monthly recording
Value applied	18,000 MWh for ex-ante estimation. During the monitoring period, if the electricity consumption is sourced from the grid company, then the value will be determined as per the electricity meters monitoring and Cross-check with the grid statement.
Monitoring equipment	electricity meters
QA/QC procedures to be applied	The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	Should be cross-checked with the grid statement

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" 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 the tool" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"

Frequency of monitoring/recording	This value will change once the tool is updated
Value applied	20%
Monitoring equipment	N/A
QA/QC procedures to be applied	-
Purpose of data	Calculation of project emission
Calculation method	-
Comments	N/A

Data / Parameter	$V_{t,db}$
Data unit	m³ dry gas/h
Description	Volumetric flow of the gaseous stream in time interval t on a dry basis
Source of data	Flowmeters
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 was estimated according to the amount of manure for Ex ante estimation.
Monitoring equipment	N/A
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 the 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	gas analyzers
Description of measurement methods and procedures to be applied	Continuous gas analyzers operating on a dry basis. Volumetric flow measurement should always refer to the actual pressure and temperature
Frequency of monitoring/recording	Continuous measurement
Value applied	70% for pre-calculation which was sourced from the Project evaluation report. In the monitoring period. This value will be monitored by the gas analyzers.
Monitoring equipment	N/A
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 signals (analogical or digital) are required. Examples include thermocouples, thermal resistance, etc

Frequency of monitoring/recording	Continuous
Value applied	25℃ was used in the pre-calculation for the density of CH4 as the applied methodology ACM0010(Version08.0), in the actual monitoring period, the temperature of the gaseous stream will be monitored by the recordable electronic signal.
Monitoring equipment	Instruments with recordable electronic signal
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 the 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 the same frequency).

Data / Parameter	P_t
Data unit	Pa
Description	The 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 signals (analogical or digital) are required. Examples include pressure transducers, etc
Frequency of monitoring/recording	Continuous
Value applied	101.325 kPa for the pre-calculation for the density of CH_4 as the applied methodology ACM0010 (Version 08.0), in actual monitoring period, the temperature of the gaseous stream will be monitored by the recordable electronic signal.
Monitoring equipment	recordable electronic signal.

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 the 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 the same frequency)

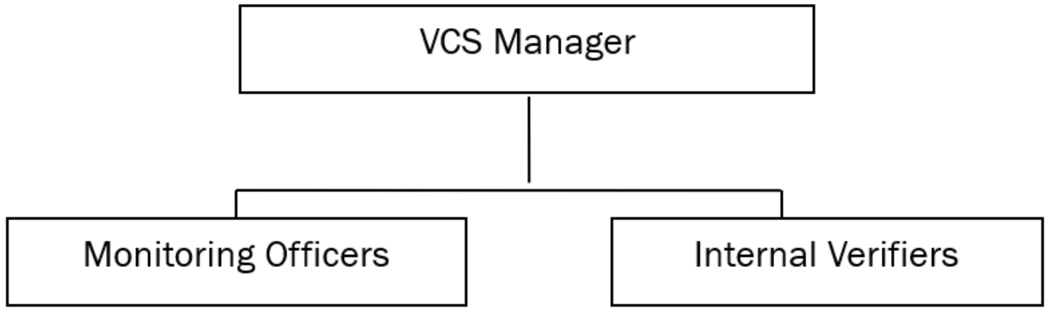
Data / Parameter	$\rho_{i,t}$
Data unit	kg gas i/m^3 gas i
Description	Density of greenhouse gas i in the gaseous stream in time interval t
Source of data	Calculated
Description of measurement methods and procedures to be applied	Calculated based on the temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t.
Frequency of monitoring/recording	N/A
Value applied	0.00067 t/m^3 for ex-estimated. In the monitoring period, this parameter will be calculated based on the temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t
Monitoring equipment	N/A
QA/QC procedures to be applied	N/A
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

Data / Parameter	$MS\%_j$
Data unit	Fraction
Description	Fraction of manure handled in system j in project activity
Source of data	Project proponents
Description of measurement methods and procedures to be applied	N/A
Frequency of monitoring/recording	Annually
Value applied	100% for ex-estimated. As this parameter is not monitored in the actual operation. so, in the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is 100%.
Monitoring equipment	N/A
QA/QC procedures to be applied	The manure flew into digesters by pipes
Purpose of data	Calculation of project emissions
Calculation method	N/A
Comments	N/A

5.3 Monitoring Plan

(1) Monitoring structure

The Project owner organizes a specific VCS team in the project development department to be responsible for data collection, supervision, and witness the whole process of data measuring and recording. A VCS manager is appointed to take full responsibility for the overall monitoring of the project. The monitoring and measurement are to be carried out by designated monitoring officers. In addition, the Project developer appoints internal verifiers who are responsible for internal check of the measurement, collection of relevant receipts and invoices, and the calculation of the emission reductions. A monitoring and management manual of the project that identifies detailed duties and responsibilities of the relevant parties is developed and served as the basis of the project monitoring. Figure 5-1 shows the operation and management structure of the Project.



(2) Data collection

Monitoring officers are responsible for data collection. Designated teams will read and collect the monitored data regularly. The computer system will automatically monitor and record relevant meter data. The operation records will serve as the main data source for emission reductions calculation. All data files, relevant receipts will be collected by a designated monitoring officer, who will prepare backup in time and archive all documents properly.

(3) Quality assurance

All metering equipment for monitoring will be chosen in accordance with VCS requirements and will be calibrated regularly for accuracy by qualified parties according to the national regulations. To assist in future verifications, the Project owner will preserve the calibration records, along with the data files of project monitoring.

Error check routines will be established on-site and at the point of data storage to detect data measuring/transmission failures as well as malfunctions. In the case of malfunction of thermometers, the meter supplier will provide technical support to engage the problem promptly and emission reductions during the corresponding period will be calculated conservatively.

The installation of the electricity metering equipment will fulfill the requirements of "DL/T448–2016 Technical Administrative Code of Electric Energy Metering". The accuracy should not be less than 0.5. The installation of flow meters will fulfill the national standard (MT448-2008). All the meters will be checked and maintained periodically.

(4) Data file management

All monitoring data will be electronically filed by the end of each month and the electronic data files will be archived in both disk copy and printed hard copy. Other document in paper e.g. forms and environment assessment reports will be preserved as well. All data collected as part of monitoring will be archived electronically and be kept at least for 2 years after the end of the crediting period. The Project owner will provide original records and documents if necessary.