# YANTAI XINHAO SWINE FARM MANURE MANAGEMENT SYSTEM GHG MITIGATION PROJECT

Document Prepared by

Search $CO_2$(Shanghai) Environmental Science & Technology Co. Ltd.

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| **Project Title** | Yantai Xinhao Swine Farm Manure Management System GHG Mitigation Project |
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| **Prepared By** | Search $CO_2$(Shanghai) Environmental Science & Technology Co. Ltd |
| **Contact** | Address: Floor 4, No.2815 Longteng Avenue, Xuhui District, Shanghai, China.<br>Tel: +86-21-64693022<br>Email: alg@searchco2.com<br>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 (heinafter referred to as the Project) introduced an Animal Waste Management System (AWMS) to the swine farm in Yadi village, Muping District, Yantai City, Shandong Province, China, which is 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 lagoon.

In this project, AWMS is built to replace the traditional uncovered anaerobic lagoon, and the swine farm installed one AWMS. All the manure and wastewater are collected into the collection tanks and then be separated into solid and liquid matters firstly. And the separated liquid will be sent into an anaerobic digester called an Upflow Anaerobic Sludge Bed reactor (UASB). The 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 boiler for heat production. The biogas boiler has been installed in the swine farm. All of the heat generated are used by AWMS and the swine farm, while the rest (if any) will be burned. The sludge produced by anaerobic digestion is processed by aerobic composting along with separated solids to produce organic fertilizer which is sold to fertilizer companies and finally used for land application, while the effluent is used for agricultural irrigation.

Benefiting from the "waste-biogas-fertilizer" pattern, harmlessness and ecological utilization of the swine manure can be realized. In the project, the biogas generated by AWMS will be utilized as heating energy. As the operation of AWMS needs heat energy to adjust a suitable temperature for fermentation, the generated heating energy are all used in AWMS. 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 for conservativeness. Without this project, the swine farm would remain the baseline scenario where the animal manures are left to decay in uncovered lagoon, for which is a common practice in China that requires only lower costs but results in higher greenhouse gas emissions.

In this project, it is estimated that around 161 tons of manures would be handled per day with AWMS. The biogas generated during the anaerobic process is collected for heat generation and 1,450*$10^4$$m^3$ of biogas are expected to produce annually. The heat production is estimated to be 342,200 GJ annually. All biogas generated after project implementation is used for heat generation. The generated heat is only used for daily operation of AWMS and this swine farm itself and cannot be connected to other users. The baseline scenario is a lagoon, an open site with no other facilities and no heat generation/use. For conservativeness, baseline emissions from heat generation/use are neglected.

The project activity will reduce GHG emissions from manure to the atmosphere in the baseline scenario through the collection and utilization of methane produced by anaerobic treatment of swine manure and wastewater from the swine farm. The project is expected to achieve an annual emission reduction of 92,011 $tCO_2e$ and a total emission reduction of 644,077 $tCO_2e$ in the first crediting period.

| Audit Type | Period | Program | VVB Name | Number of years |
|---|---|---|---|---|
| Joint Validation & Verification | 05-March-2021–30-June-2022 | VCS | Shenzhen CTI International Certification Co., Ltd (CTI) | 2 |
| Total | 05-March-2021–30-June-2022 | N/A | N/A | 2 |

The project has been put into operation on 05-March-2021. During the first monitoring period from 05-March-2021 to 30-June-2022, the total emission reduction is 110,282 $tCO_2e$.

## 1.2 Sectoral Scope and Project Type

The project falls into:

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

Sectoral scope 13: Waste handling and disposal; and

Sectoral scope 15: Livestock and manure management.

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

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

The project is not a grouped project.

## 1.3 Project Eligibility

1 The heat energy generated by biogas boilers is used for farms' heating system, so the sectoral scope 1 Energy Industries (renewable/non-renewable) is applicable in this project.

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

As per section 2.1.1 of VCS Standard (Version 4.4), the scope of the VCS Program includes:

1) The six Kyoto Protocol greenhouse gases: The project is expected to avoid Methane (CH4) emissions from the uncovered anaerobic lagoon 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 digester 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 4.4. Therefore, the project is eligible under the scope of VCS program.

| Reference to VCS Standard (Version 4.4) | Requirement | Justification |
|---|---|---|
| 3.1.1 | Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1 | The project meets all applicable rules and requirements as set out under the VCS Program. |
| 3.1.2 | Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.14.1. The list of methodologies and their validity periods is available on the Verra website. | The project applies CDM approved methodology ACM0010 (Version 08.0) which is an eligible VCS methodology along with tool or modules as applicable. Refer to section 3.1 and 3.2 of the JPM below for more details. |

| | | |
|---|---|---|
| 3.1.3 | Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.21 below. Projects must update to the latest version of the methodology when reassessing the baseline and renewing a crediting period. | The project applies CDM approved methodology ACM0010 (Version 08.0) which is a latest version and eligible VCS methodology. This project adopts a 21-year renewable crediting period, with a first 7-year from 05-March-2021 to 04-March-2028 (both days included), so it does not need to reassess the baseline and renew a crediting period in fixed crediting periods. |
| 3.1.4 | Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced. | Projects are in compliance with currently applicable laws and regulations. Refer to section 1.14 of the JPM below for more details. |
| 3.1.5 | Where projects apply methodologies that permit the project proponent its own choice of model (see the VCS Program document VCS Program Definitions for the definition of model), the model shall meet the requirements set out in the VCS Program document VCS Methodology Requirements, and it shall be demonstrated at validation that the model is appropriate to the project circumstances (i.e., use of the model will lead to an appropriate quantification of GHG emission reductions or removals). | Not applicable.<br><br>The project applies CDM approved methodology ACM0010 (Version 08.0) which is a latest version and eligible VCS methodology, all calculation formulas in this JPM are derived from this methodology, so PP does not choose its own model. |
| 3.1.6 | Where projects apply methodologies that permit the project proponent to choose a third-party default factor or standard to ascertain GHG emission data and any supporting data for establishing baseline scenarios and demonstrating additionality, such default factor or standard shall meet the requirements set out in the VCS | Not applicable. There are no third party default factor or standard need to be chosen by the project proponent as per the applied methodology ACM0010 (Version 08.0). |

| | | |
|---|---|---|
| | Program document VCS Methodology Requirements. | |
| 3.1.7 | Where the rules and requirements under an approved GHG program conflict with the rules and requirements of the VCS Program, the rules and requirements of the VCS Program shall take precedence. | Not applicable. |
| 3.1.8 | Where projects apply methodologies from approved GHG programs, they shall comply with any specified capacity limits (see the VCS Program document *Program Definitions* for definition of capacity limit) and any other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs. | Large-scale Consolidated methodology ACM0010 was applied by the project, which is approved by VCS programs, and the methodology has no specific requirements about the capacity limit.<br>And then the application of the methodology and/or tools referenced by the methodology under the project activity is also applicable, please refer to section 3 for more details.<br>So, it is applicable. |
| 3.1.9 | Where Verra issues new VCS Program rules, the effective dates of these requirements are set out in Appendix 3 Document History and Effective Dates or equivalent for other program documents, and are listed in a companion Summary of Effective Dates document which corresponds with each update. | This project has fellow all the latest requirements of Verra. |

## 1.4 Project Design

The project includes a single location only.

### Eligibility Criteria

This is not a grouped project.

## 1.5 Project Proponent

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|---|---|
| Organization name | Yantai Xinhao agriculture and animal husbandry Co., Ltd. |
| Contact person | Qishou 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 $CO_2$(Shanghai) Environmental Science & Technology Co. Ltd |
| Role in the project | Consultant |
| Contact person | Allen Gang |
| Title | Business Manager |
| Address | Floor 4, No.2815 Longteng Avenue, Xuhui District, Shanghai, China. |
| Telephone | +86-21-64693022 |
| Email | alg@searchco2.com |

## 1.7 Ownership

The project owner of the project is Yantai Xinhao agriculture and animal husbandry Co., Ltd. who has the legal right to control and operate the project activity. The approval of Environmental Impact Assessment (EIA), and the business license of the project owner are evidence for legislative right. Besides, the equipment purchasing contracts and the General design and construction contract are the evidence for the ownership of the project and carbon credits generated.

## 1.8 Project Start Date

As per section 3.8 of VCS Standard (Version 4.4), the project start date of a non-AFOLU project is the date on which the project began generating GHG emission reductions or removals.

The project activity is a non-AFOLU project, and the AWMS has been put into operation on 05-March-2021. Thus, the project start date is 05-March-2021.

## 1.9 Project Crediting Period

This project adopts a 21-year renewable crediting period, with a first 7-year from 05-March-2021 to 04-March-2028 (both days included).

## 1.10 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated volume of emission reduction from the project activity is 92,011 $tCO_2e$, which is less than 300,000 tonnes of $CO_2e$ per year. As per section 3.10.1 of the VCS Standard (Version 4.4), the scale of the project activity is under "Project" category.

| Project Scale | |
|---|---|
| Project | √ |
| Large project | |

| Year | Estimated GHG emission reductions or removals ($tCO_2e$) |
|---|---|
| 05-March-2021 to 31-December-2021 | 75,878[3] |
| 01-January-2022 to 31-December-2022 | 92,011 |
| 01-January-2023 to 31-December-2023 | 92,011 |
| 01-January-2024 to 31-December-2024 | 92,011 |
| 01-January-2025 to 31-December-2025 | 92,011 |
| 01-January-2026 to 31-December-2026 | 92,011 |
| 01-January-2027 to 31-December-2027 | 92,011 |
| 01-January-2028 to 04-March-2028 | 16,133[4] |
| **Total estimated ERs** | 644,077 |

[3] The yearly total amount estimated emission reduction is 92,011 $tCO_2e$, so the values estimated emission reduction from 05-March-2021 to 31-December-2021 is 92,011 $tCO_2e$ *301 days /365 days= 75,878 $tCO_2e$.
[4] The yearly total amount estimated emission reduction is 92,011 $tCO_2e$, so the values estimated emission reduction from 01-January-2028 to 04-March-2028 is 92,011 $tCO_2e$ *64 days /365 days= 16,133 $tCO_2e$.

| | |
|---|---|
| **Total number of crediting years** | 7 |
| **Average annual ERs** | 92,011 |

## 1.11 Description of the Project Activity

The project activity is designed to install a set of new Animal Waste Management System (AWMS) to Xinhao swine farm to treat the manure and wastewater from the swine farm to avoid methane generated in the baseline uncovered anaerobic lagoon. In the project, one AWMS had been implemented in the swine farm that belongs to Yantai Xinhao agriculture and animal husbandry Co., Ltd, involving 13,650 breeding swine and 144,000 market swine. Live swine are kept for 180 days in the farm before shipment and are estimated to produce 161 tons of manure and 1,450*$10^4$ $m^3$ of biogas annually.

**Baseline Scenario**

Without this project, the manure and wastes from the swine farm would be left in uncovered anaerobic lagoon so that the methane would be sent to the atmosphere without any recovery thus leading a higher GHG emission. According to the "Technical Specifications for Sanitary Treatment of Livestock and Poultry Manure", uncovered anaerobic lagoons are a common method of manure treatment recognized by the state in China. In addition, there are no legal provisions that mandate livestock farmers to implement anaerobic digestion, aerobic or other biological treatment technologies, and to collect and/or utilize the methane produced by these lagoons. After the implementation of the project activities, the uncovered anaerobic lagoon is replaced by AWMS, and the parameters of baseline lagoon are shown in table 1-3.

**Project technology description**

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

All the manure and wastewater are collected into the collection tanks and then be separated into solid and liquid matters firstly. The solid is treated in aerobic composting system and the organic fertilizers can be produced, part of the fertilizer is distributed to local farmers for free and the others would be sold on the domestic market. The liquid matters as fermenting materials will be sent to Upflow Anaerobic Sludge Bed Reactor (UASB). In anaerobic treatment process, biogas is produced. The generated biogas will be used for heat generation through the biogas boilers. If there is any remaining biogas, it will be burned through the flare. All the energy generated through the burning process will be used in the swine farm and AWMS merely. The sludge produced from anaerobic digestion are treated through aerobic composting together with the solid, the effluent is used for agriculture irrigation.

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 specific process flow diagram of the project activities is shown in Figure 1-1.

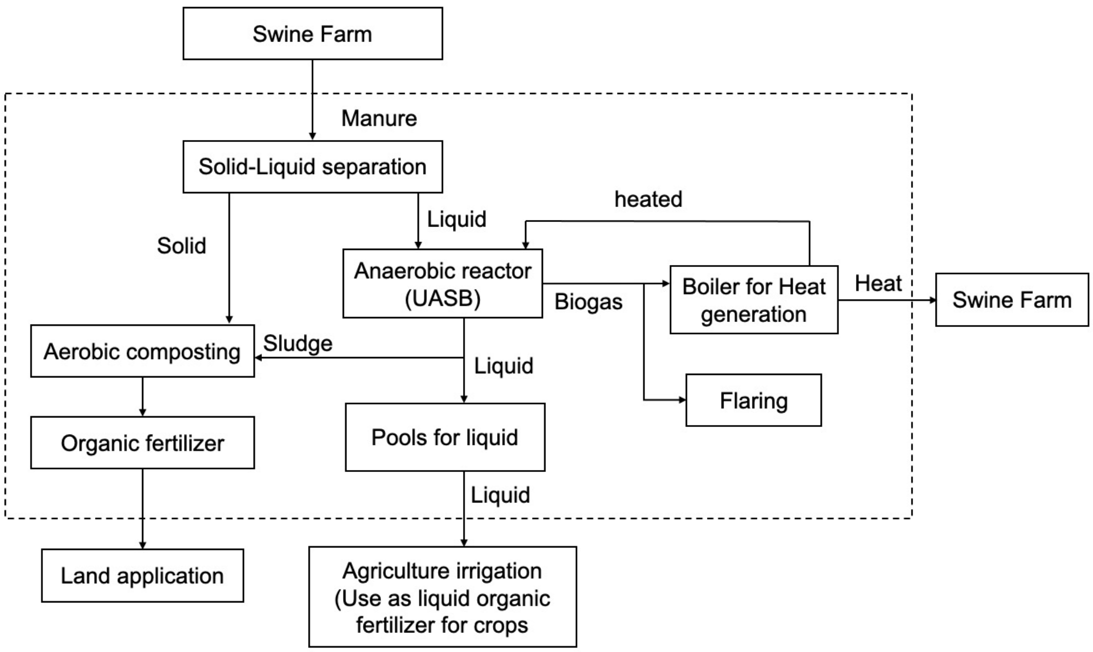


**Figure 1-1 The process flow diagram of the project activities**

The key system involved in the project are as follows：

**1.Livestock farm：**

The project consists of one large farm containing breeding swine and market swine. The Livestock population of breeding swine is 13,650. And the Livestock population of market swine is 144,000. The breeding cycle of market swine is 180 days.

For this monitoring period covering 483 days, total 130,013 heads of market swine, and 13,639 heads of breeding swine are included in the swine farm and total 1,557.04*$10^4$ $m^3$ of biogas are produced.

The existing farm was operated before the implementation of this project, and the detailed information on the date when the farm started running and working is shown in table 1-1 as follows.

Table 1-1. The operation start date of the swine farm

| Swine farm | Operation start date |
|---|---|
| Xinhao Swine Farm<br>(Containing breeding swine and market swine) | 10-April-2020 |

**2. Solid-liquid separation**

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

**3. Anaerobic digester treatment process**

An up-flow anaerobic sludge bed reactor (UASB) anaerobic digester was used in the project activity and the UASB digester was installed on the project site. With this reactor, the liquid removed from the solid-liquid separation will undergo a fermentation process to produce biogas. the UASB has a higher technology that reduces the possibility of manure stratification as the tank is fitted with agitation equipment that allows the manure to be mixed with the biomass in the sludge layer and then fermented. Compared to other anaerobic reactors, this reactor is also suitable for treating high concentrations of wastewater. A heating system installed in the reactor can lead to an increase in the biogas fermentation rate.

The implementation of the UASB can increase the production and utilization of biogas to a large extent. Furthermore, this plant can be operated continuously throughout the year. It is currently one of the most advanced anaerobic reactors in the world.

The project is expected to produce 1,450*$10^4$ $m^3$ of biogas per year at full capacity. The anaerobic digester is expected to run for 7,400 hours, resulting in a plant load factor of 84.47% for the project. The design temperature for the anaerobic treatment of the project is 35 ~ 38°C.

The parameters of the UASB are shown in Table 1-3 below. While the construction date, commissioning date and start of operation date of the AWMS are shown in Table 1-2 below.

Table 1-2. The construction, commissioning and start operation date of AWMS in Xinhao Swine farm involved in this project

| Swine farm name | Construction date of the AWMS | Commissioning date of the AWMS | Start Operation date of the AWMS |
|---|---|---|---|
| Xinhao Swine Farm<br>(Containing breeding swine and market swine) | 02-January-2021 | 20-February-2021 | 05-March-2021 |

**4. Aerobic composting process**

The solid after solid-liquid separation and the sludge produced from anaerobic digestion are used to produce organic fertilizer through aerobic composting process. The project adopts closed aerobic fermentor to treat swine manure, the fermentor is fed from the top and the fermenter is equipped with stirring device to stir swine manure, while stirring, the oxygen required for fermentation is supplied by the blower device, the accumulated fermentation time is about 10 days.

**5. Biogas pre-treatment system**

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

After the pre-treatment, the biogas will be sent to boilers for heat generation. All the heat energy is used in farm and AWMS. And during the first monitoring period, there is no biogas rest to flare.

**6. Biogas combustion facility**

Biogas is combusted in the auxiliary equipment of the project's animal waste treatment system (i.e. biogas boiler). One biogas boiler has been installed to provide heat for winter heating of the anaerobic digester and other project facilities. The parameters of biogas boiler are shown in Table 1-3 below.

Table 1-3 The main technical parameters of equipment involved in this project

| Xinhao Swine Farm | Breeding Swine | Market Swine |
|---|---|---|
| Livestock population | 13,650 | 144,000 |
| Baseline anaerobic lagoon | | |

| | |
|---|---|
| Size of baseline anaerobic lagoon(length*width*depth) ($m^3$) | 120*90*4 |
| Technical life | No Less than 10 years |
| Anaerobic tank（UASB） | |
| Design treatment capacity ($m^3$/d) | 1280 |
| Stay time(hour) | 20 |
| Design flow($m^3$/h) | 65 |
| Equipment Quantity | 1 |
| Technical life | No Less than 30 years |
| Aerobic fermenter | |
| Specification/Type | LTL-91 |
| Size of Aerobic fermenter ($m^3$) | 91 |
| Design treatment capacity ($m^3$/d) | 10 |
| Design air supply capacity (KW) | 12.5 |
| Equipment Quantity | 1 |
| Technical life | No Less than 30 years |
| Biogas Boiler | |
| Specification/Type | CWNS1.05-85/60-Q |
| Rated heating capacity (MW) | 1.05 |
| Rated outlet temperature (℃) | 85/60°C |
| Rated pressure (Mpa) | 0 |
| Equipment Quantity | 1 |
| Technical life | No Less than 30 years |
| Flare system | |
| Type | Open flare |
| Treatment capacities ($m^3$/h) | 0-100 |
| Height (m) | 9m |

| | |
|---|---|
| Equipment Quantity | 1 |
| Technical life | No Less than 15 years |

## 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 and Figure 1-2.

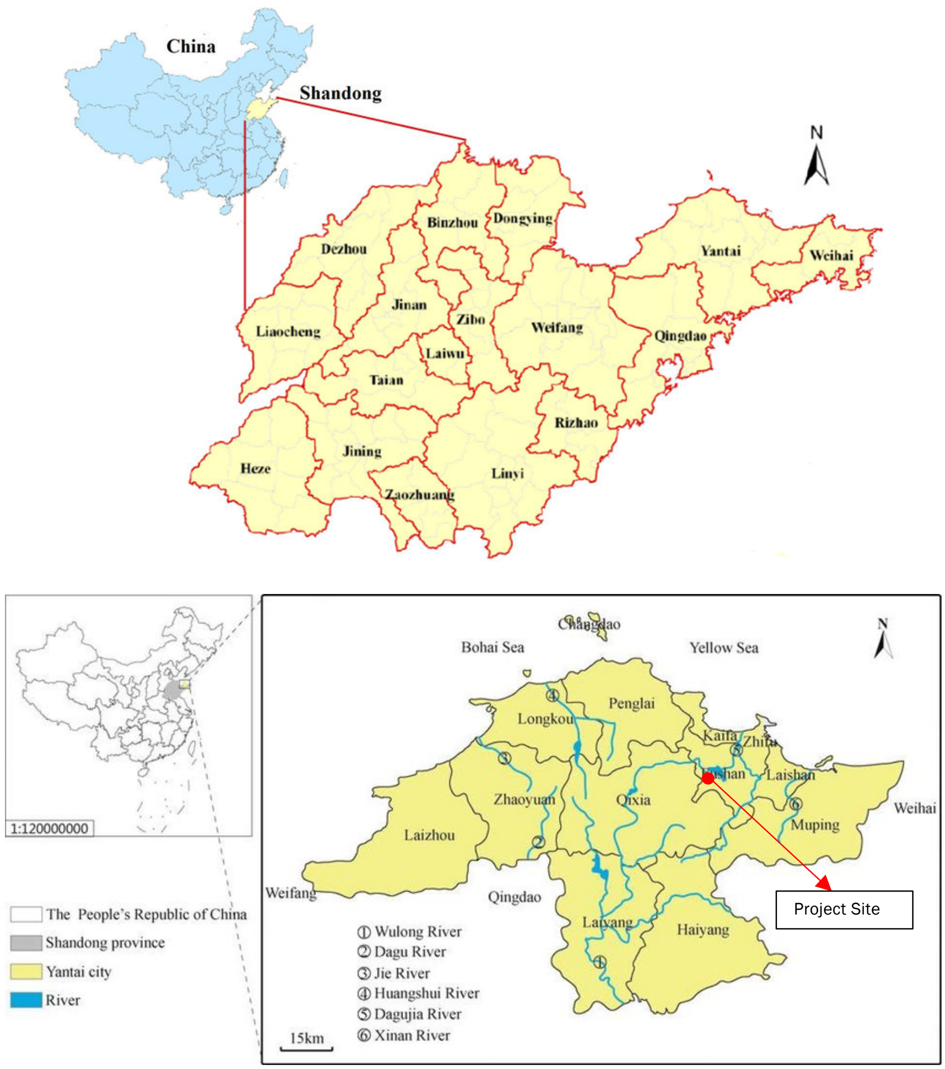


Figure 1-1 Location of the project


Figure 1-2. The geographic location of the project

## 1.13 Conditions Before Project Initiation

The conditions existing prior to project initiation, which is also the baseline scenario of the project, are as follows:

Prior to the implementation of the project, all animal manure waste was left to decay in an anaerobic manure management system (uncovered open lagoon) at the livestock farm and methane is emitted to the atmosphere directly without any methane recovery and destruction facility. According to the "Technical Specifications for Sanitary Treatment of Livestock and Poultry Manure", uncovered anaerobic lagoons are a common method of manure treatment recognized by the state in China. In addition, there are no legal provisions that mandate livestock farmers to implement anaerobic digestion, aerobic or other biological treatment technologies, and to collect and/or utilize the methane produced by these lagoons.

Thus, there are no project activities at the project site before the construction of the project activities. The baseline scenario is the same as the conditions existing prior to the project initiation.

## 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[5]. | 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 animal waste treatment system, which fully complies with the Law. |
| 2 | Regulations on prevention and control of pollution from large scale livestock and poultry breeding[6] | 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 digester to treat animal manures from livestock farm, which fully complies with the Regulation. |
| 3 | Catalogue for the Guidance of Industrial Structure Adjustment (2013 revision) [7] | The Guidance encourages the construction and operation of Large-scale biogas project using waste from livestock and poultry farm as raw materials. The project adopts UASB digester to treat animal manures from livestock farm and recovers the biogas for energy use, which fully complies with the Guidance |
| 4 | Technical Guide for Construction of Manure Treatment Facilities of Livestock and Poultry Farms (Households) in Shandong Province[8] | Yantai is one of the central cities in Shandong Province and an important port city around the Bohai Sea, and a city that vigorously develops agricultural industrialization in Shandong Province. Projects adopting environmentally friendly technologies are welcomed by Shandong Yantai. The project adopts UASB digester to treat animal manures from livestock farm and recovers the biogas for energy use. The |

[5] http://www.npc.gov.cn/englishnpc/c23934/202009/1d5fbeb832eb4a10b33280f1852139f2.shtml
[6] http://www.gov.cn/flfg/2013-11/26/content_2535095.htm
[7] http://www.gov.cn/gongbao/content/2013/content_2404709.htm
[8] http://xm.shandong.gov.cn/art/2021/7/30/art_101448_10292798.html

| | | |
|---|---|---|
| | | implementation of the project complies with the industrial policy of Shandong Yantai. |

Furthermore, the project has obtained the EIA approval from local government authorities: Yantai Muping District Agricultural and Rural Bureau and Ecological Environment Bureau of Yantai City. This approval well demonstrated that local government permits the construction of the project. Meanwhile, the project has obtained the license for production and operation of the farm by the Muping District Administrative Approval Service Bureau on 14-February-2020. 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.

China Emissions Trading Scheme (ETS) has been opened in July 2021. The major industry that includes in ETS is electricity, as well as other seven industries (i.e. oil industry, chemical industry, cement industry, iron and steel industry, non-ferrous metals industry, pulp and paper industry and civil aviation industry). For swine farm manure management doesn't belong to any of the industry mentioned above, the project is not included in China's emission trading system as well.

Besides, the project proponent had signed a declaration of "No Double Counting Statement" and declaration of "Not involved in other GHG scheme" to promise that no double count emissions reductions will appear in this project. Below are excerpts from the declaration.

As the project proponent of the Yantai Xinhao Swine Farm Manure Management System GHG Mitigation Project, commit that the emissions generated in the project will not be double counted, and the only emissions reductions generated in the project is under VCS program.

### 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.

### 1.16.3 Supply Chain (Scope 3) Emissions

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

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

## 1.17 Sustainable Development Contributions

### 1.17.1 Sustainable Development Contributions Activity Description

#### Sustainable Development

The Project provides many benefits that will help achieve China's Sustainable Development Goals, a set of 17 universal goals covering the thematic areas of environmental, economic and social development.


The project contributes to achieving sustainable development as following:

- Access to affordable, reliable, sustainable and clean energy for local farmers (Goal 7);
- Provide more job opportunities for local farmers (Goal 8);
- Mitigate climate changes (Goal 13).

**SDG Goal 7: Affordable and Clean Energy**

The biogas generated during the treatment process is captured for heat generation, the heat generated is used entirely for AWMS. By recycling and combusting biogas, the project can achieve the emission reduction and provide clean energy. The heat production is estimated to be 342,200 GJ annually. And during this monitoring period, a total of 367,461 GJ of heat was generated.

**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. So, the impact parameter of the proposed project on SDG8 is the number of full-time jobs created. 20 locals' residents (11 females and 9 males) are employed in the operation of the project.

**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 lagoon. 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. It is estimated that 92,011 $tCO_2e$ emission reductions can be produced annually. In the 1st monitoring period, a total of 110,282 $tCO_2e$ emission reductions is generated.

### 1.17.2 Sustainable Development Contributions Activity Monitoring

During the monitoring period, the project activity that results in achieving SDGs are:

1. 367,461GJ of heat was produced as clean energy used in the swine farm.

2. Job opportunities are provided for 20 locals, among which 11 are women, 9 are man.

3. A total of 110,282 $tCO_2e$ emission reductions is generated.

| Row number | SDG Target | SDG Indicator | Net Impact on SDG Indicator | Current Project Contributions | Contributions Over Project Lifetime |
|---|---|---|---|---|---|
| 1) | 7.2 | 7.2.1 Renewable energy share in the total final energy consumption | Implemented activities to increase | During this monitoring period, the total heat produced is 367,461 GJ. and used as farm's energy. | The project not only recycle biogas used in farm, but also prevent it discharging into the atmosphere. This is the 1st monitoring period, therefore, from the operation start date of the project activity to the end of this monitoring period, the total heat produced is 367,461 GJ. |
| 2) | 8.3 | 8.3.1 Proportion of informal employment in non-agriculture employment, by sex | Implemented activities to increase | During this monitoring period, total job opportunities provided for 20 locals (11 are women, 9 are men). | Provided job opportunities for locals especially for women. The project activity generates permanent job opportunities for 20 persons including 11 females and 9 males during the operation period. |
| 3) | 13.0 | Tonnes of greenhouse gas emissions avoided or removed | Implemented activities to increase | During this monitoring period, by using AWMS, the project has prevented the release of 110,282 $tCO_2e$ GHG emissions into the atmosphere during the monitoring period. | This is the 1st monitoring period, therefore, from the operation start date of the project activity to the end of this monitoring period, the project has achieved GHG emission reductions of 110,282 $tCO_2e$. |

## 1.18 Additional Information Relevant to the Project

### Leakage Management

The leakage involved in this project includes the leakage of anaerobic digestion in a digester, and the leakage of fertilizer into the soil. The project proponent doesn't have the authority, intervention, or control over the leakage of fertilizer into the soil. Moreover, this leakage has been included in the emission reductions calculation as per the applied methodology and tool.

### Commercially Sensitive Information

No commercially sensitive information has been included in the public version of the project description.

### Further Information

There is no further information that may have a bearing on the eligibility of the project, the net GHG emission reductions or removals, or the quantification of the project's net GHG emission reductions or removals.

# 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 approvals: [2021]1) and [2020]16). The EIA report has assessed all aspects of the project's environmental impact and recommended corresponding environmental protection measures (see details in Section 2.3). 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

Before the project, the Stakeholder Identification was conducted through the consultant meeting and questionnaire surveys. The meeting was attended by the representatives of the local agricultural bureaus, the representatives of Yantai Xinhao, the representatives of the local residents in Yantai City, and the representatives of the village committees.

On 20-October-2020, a meeting of stakeholder consultation held in the local area. Before the meeting, the information of the project, contact, and meeting notice had been published on the notice board a week ago. About 30 people participate in the meeting, the background and information about stakeholders are concluded in Table 2-1 below:

**Table 2-1 Background and Information about participants in the meeting**

| Categories | | Amount |
|---|---|---|
| **Gender** | Male | 14 |
| | Female | 16 |
| **Education Level** | College or above | 2 |
| | High school | 8 |
| | Lower secondary school | 10 |
| | Primary school or below | 10 |
| **Occupations** | Worker | 11 |
| | Farmer | 11 |
| | Management of Yantai Xinhao | 5 |
| | Village officials | 3 |
| **Age** | 25~55 | 30 |

During the meeting, the project proponent had explained to stakeholders for the benefits, possible costs and potential risks brought by the project. For stakeholders, they all agreed that the project can bring benefits for they stakeholders and expressed their own opinions. There are some feedback and comments were received and collected, among which there was no objections on the project design and monitoring methods, which is generally concluded in Table 2-2 as follows.

**Table 2-2 Comment and Feedback from Stakeholders in the Meeting**

| No. | Comment and Feedback | Response |
|---|---|---|
| 1. | Do you know the purpose of this project? | 98% of the respondents understand this project, 2% don't know much about this project. |
| 2. | What do you think is the impact of the implementation of this project on the local environment? | 100% of the respondents believe that the implementation of this project has reduced environmental pollution and is an environmental protection project. |
| 3 | What impact do you think the implementation of this project will have on the social economy? | 100% of the respondents believe that the implementation of the project has a good impact on the social economy. |
| 4. | What effect do you think the implementation of this project will | 100% of the respondents believe that the construction of this project can promote energy conservation and |

| | | |
|---|---|---|
| | have on local sustainable development? | emission reduction, improve environmental quality and investment environment, and promote the sustainable development of the local economy. |
| 5. | What effect do you think the implementation of this project will have on local employment? | 98% of the respondents believe that the implementation of this project can promote employment growth; 2% of the respondents believe that it has no impact on local employment. |
| 6. | Do you think other regions should also vigorously promote this type of technology? | 100% of respondents believe that AWMS technology can be vigorously promoted. |
| 7. | Do you have any suggestions and comments on this project? | 100% of respondents support this project. |

The mechanism for on-going communication with local stakeholders:

1. In the stage of project implementation, communications with local stakeholders will take place regularly. There would be a notice board published with telephone numbers of contact people throughout the lifetime of the project as well as the general content of the project (i.e. the project key schedule, project details, carbon development, risks, benefits, etc). Besides, there would be surveys conducted for stakeholders regularly. The surveys distributed is to collect stakeholders' feedback, and the questions are, for example, "Do you know the purpose of the project?", "After the implementation, which one do you think is the largest benefit?", or "Are you satisfied with the environmental protection measures that the proposed project has made?".

2. For stakeholders (i.e. local agricultural bureaus, workers from Yantai Xinhao, local farmers, and the village committees), they can communicate or give feedback to the project owner in a variety of ways. For example, the suggestions or opinions are reflected through the published project manager's telephone, the irregular collective meeting or the opinion collection book on the bulletin board.

3.The views and suggestions (if any) are collected regularly by the project proponent whom will carry out regular spot checks on project implementation. Also, the project proponent will respond to questions (if any) as soon as possible, and the appropriate suggestions would be applied in the project.

In 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 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.

Also, in the monitoring period from 05-March-2021 to 30-June-2022, there was a survey conducted for stakeholders from 10-December-2021 to 15-December-2021. Before the survey, the project proponent put the notes on the notice boards in the villages near the swine farm from 15-November-2021 to 25-November-2021 with contact information and project information that clearly introduced the purpose and impact of the project. The questionnaires were distributed with a total of 80 pieces returned and collected. The background of these stakeholders and the responses from the survey are summarized as Table 2-3 and Table 2-4 below.

**Table 2-3 The background of 80 stakeholders**

| Categories | | Amount |
|---|---|---|
| **Age** | 20~60 | 80 |
| **Gender** | Male | 37 |
| | Female | 43 |
| **Education Level** | College or above | 6 |
| | High school | 14 |
| | Lower secondary school | 23 |
| | Primary school or below | 37 |
| **Occupations** | Worker | 20 |
| | Farmer | 39 |
| | Management of Yantai Xinhao | 12 |
| | Village officials | 5 |
| | Civil servant | 4 |

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

| No. | Question | Response | Amount | Proportion |
|---|---|---|---|---|
| 1. | **Do you know the purpose of the project?** | Yes, very much | 45 | 56.25% |
| | | Yes, a little | 35 | 43.75% |
| | | No, not at all | 0 | 0 |
| 2. | **Which one do you think is the greatest impact on the environment?** | Reduce odor | 32 | 40.00% |
| | | Reduce methane | 24 | 30.00% |
| | | Reduce pollution | 14 | 17.50% |
| | | Above all | 10 | 12.50% |
| | | No impact | 0 | 0 |
| 3. | | Improve the air quality | 27 | 33.75% |
| | | Provide more job | 23 | 28.75% |

| | | | | |
|---|---|---|---|---|
| | **After the implementation, which one do you think is the largest benefit?** | Free fertilizers | 16 | 20.00% |
| | | Above all | 14 | 17.50% |
| | | None | 0 | 0 |
| **4.** | **Are you satisfied with the environmental protection measures that the proposed project has made?** | Yes | 80 | 100.00% |
| | | No | 0 | 0 |
| | | Indifferent | 0 | 0 |
| **5.** | **What do you think of the impact on the employment after the implementation of the project?** | Positive | 80 | 100.00% |
| | | Negative | 0 | 0 |
| | | None | 0 | 0 |
| **6.** | **What do you think of the impact on the local economy after the implementation of the project?** | Positive | 77 | 96.25% |
| | | Negative | 0 | 0 |
| | | None | 3 | 3.75% |
| **7.** | **What is your attitude towards the project generally?** | Supportive | 78 | 97.50% |
| | | Opposed | 0 | 0 |
| | | Indifferent | 2 | 2.50% |
| **8.** | **Do you think other places should also promote this type of technology?** | Yes | 79 | 98.75% |
| | | No | 0 | 0 |
| | | No idea | 1 | 1.25% |

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

Finally, in order to set up the mechanism for on-going communication with local stakeholders, a grievance book was put at the entrance of the swine farm. All stakeholders are allowed to record their grievances or comments in the book at any time. No any grievances or comments were received during this monitoring period.

## 2.3 Environmental Impact

The Environmental Impact Assessment (EIA) Report for the Project has been approved by Yantai Ecological Environment Bureau. A short summary of the environmental impacts is presented below.

1. Construction Phase

1.1 Air pollution

The waste gas during the project construction is mainly construction fugitive dust. Construction dust and road dust during the construction has an effect on the surrounding areas of the construction site, whereas these effects are reversible. As long as to take effective measures and strengthen management, its influence is generally limited to the surrounding area of the construction site and will disappear along with the end of construction.

Solutions: Clean all temporary roads. And the main roads on the construction site would be watered and cleaned in time to prevent 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 solid-liquid separation tank, temporary storage pools for biogas slurry, the combusted waste gas of biogas boiler and biogas flare. The waste gas of the biogas boiler is vented through the exhaust funnel with no less than 9 m height; after meeting the Emission Standard of Air Pollutants for Boiler (GB13271-2014), the remaining biogas is burned by 9 m high torch and the exhaust gas is released into the air; NOx, sulfur dioxide and particulate matter in all waste gases of the project meet the Integrated Emission Standard of Air Pollutants (GB16297-1996).

The emission of all the waste gas will meet the requirements of Discharge Standard of Pollutants for Livestock and Poultry Breeding (GB18596-2001) and Emission Standards for Odor Pollutants (GB14554-93).

2.2 Wastewater

During the operation period of the project, the wastewater mainly includes swine farm flushing wastewater, swine manure liquid after solid-liquid separation, swine urine, wastewater of canteen and other domestic sewage. The sewage is sent into UASB digester together for anaerobic fermentation treatment. UASB adopts the process of "mechanical grid + collection of sewage tank + solid-liquid separator +UASB digester + 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 Emission Standard for Industrial Enterprises Noise at Boundary (GB12348-2008) Class-1 standard.

2.4 Solid waste

The solid wastes are treated with qualified waste management. For example, the general garbage would be temporarily stored in the garbage bin and sent to the designated place regularly for unified recycling and disposal by villages and towns. All the manure sludge are used for fertilizer production. Wasted desulfurizer shall be collected centrally and disposed of in accordance with the regulations on solid waste management. The company's solid waste temporary storage site shall be impermeable in rain and have corresponding sewage collection measures to avoid secondary pollution.

3.Monitoring period

During the monitoring period, according to the Technical Guidelines for the Construction of Faecal Waste Treatment Facilities in Livestock and Poultry Farms (Households)[9], PP carried out the following control measures in the farm to mitigate any potential negative environmental and socio-economic impact of the project activity:

In Anaerobic digester treatment process, as this project adopts UASB to treat faecal waste, it covered and laminated to reduce the emission of malodorous gases and the entry of rainwater to ensure

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

that the manure is fully fermented and putrefied, and the substances such as Ascaris lumbricoides eggs, faecal coliform bacteria, cadmium, mercury, arsenic, lead, chromium, thallium, and so on, meet the "Limit Requirements of Toxic and Hazardous Substances in Fertilizers"[10] after the treatment.

In Aerobic composting process, this project adopts closed aerobic fermentor to treat swine manure, which is equipped with necessary facilities and equipment for deodorisation and prevention of leakage, to ensure that swine manure does not produce odorous gas and leakage of odorous liquid during the fermentation process, which will affect the living environment of the surrounding residents.

In conclusion, the project owner has taken appropriate measures to minimize adverse environmental impacts, the project will not have a significant negative impact on the surrounding environment and socio-economic during neither construction period, operation period nor monitoring period. The project has been approved by the local Bureau of Ecology and Environment, all the activities have been carried under the regulation of local Bureau of Ecology and Environment. The environmental impact analysis and measures used in the project are in accordance with relevant environmental standards. Also, according to the conclusion from EIA report that approved by local government, the environmental impact, both during the project construction period and operation period, won't have a significant and negative on the surrounding environment. On the contrary, the implementation of the project will significantly improve the quality of the local environment, achieve environmentally sound treatment of agricultural organic waste, reduce the impact of agricultural organic waste on surface water and groundwater, and reduce greenhouse gas emissions.

## 2.4 Public Comments

Besides, as per section 3.18.6 of the VCS Standard (Version 4.4), all projects are subject to a 30-day public comment period. The date on which the project is listed on the project pipeline marks the beginning of the project's 30-day public comment period. The project documents have been open on VCS and CCB website for public comments from 15-July-2022 to 14-August-2022[11]. No comments have been received during the public comments period.

[10] https://std.samr.gov.cn/gb/search/gbDetailed?id=9A0A4FA998C8D4A5E05397BE0A0AD02D

[11] https://registry.verra.org/app/projectDetail/VCS/3164

| Yantai Xinhao Swine Farm Manure Management System GHG Mitigation Project | - |
|---|---|

**ID:** 3164
**Program:** VCS
**Public Comment Period Type:** Validation
**Location:** China
**Project Activity:** Manure management
**Sectoral Scope:** 1: Energy industries (renewable - / non-renewable sources) 2: Waste handling and disposal
**Methodology:** ACM0010
**Estimated annual ERRs** 105,655 tCO2e
Public Comment Period: 15 July 2022 – 14 August 2022

## 2.5 AFOLU-Specific Safeguards

For this project belongs to a non-AFOLU project, this section is not required.

# 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) Tool 05: “Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation. (Version 03.0)”;
(b) Tool 02: “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0);
(c) Tool 14: “Project and leakage emissions from anaerobic digesters” (version 02.0);
(d) Tool 08: “Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version03.0)”;
(e) Tool 06: “Project emissions from flaring” (Version 04.0); and
(f) Tool 24: “Common practice[12]” (Version 03.1).

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

(g) Tool 27 : “Methodological tool: Investment analysis” (Version 10.0)

The mentioned methodology and tools can be referred to the website: https://cdm.unfccc.int/methodologies/DB/99QRTE6N5QJEB0V2XP374B25SSIXBB.

## 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 installs a new Animal Waste Management System to treat manure and wastewater from the swine farm to avoid methane emissions generated in the baseline uncovered anaerobic lagoon and the biogas generated during the treatment process is captured for heat generation, which result in less GHG emissions. |
| 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 uncovered anaerobic lagoon with an enclosed anaerobic digester. 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.<br><br>Biogas slurry from the animal waste management system will be used for agricultural irrigation. Project activities will reduce GHG emissions in the atmosphere by avoiding methane |

| | | |
|---|---|---|
| | | emissions from swine manure and anaerobic treatment of wastewater. |
| 3 | This methodology applies to manure management projects under the following conditions: | |
| | (a) Farms where livestock populations, comprising of cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions; | The project introduced a new animal waste management system for the swine farm owned by Yantai Xinhao agriculture and animal husbandry Co., Ltd. in Shenyang City, Shandong Province.<br><br>Yantai Xinhao agriculture and animal husbandry Co., Ltd is one of the subsidiaries of New Hope Liuhe Biotechnology Industry Group, which is a national key leading enterprise of agricultural industrialization mainly in animal husbandry, and is a recyclable modern agricultural industrial base integrating breeding swine, market swine, feed, environmental protection and planting. The swine farm of this project has obtained the license of breeding livestock and poultry production and operation issued by the local government, and the layout of the swine farm's livestock and poultry house should be reasonable according to the requirements of this license. Therefore, all swine are managed in confined conditions and can be identified during the on-site investigation period. |
| | (b) Farms where manure is not discharged into natural water resources (e.g., rivers or estuaries) | The swine manure is dumped into uncovered anaerobic lagoon and it is prohibited to discharge into any natural water resources without treatment according to Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming. |

| | | |
|---|---|---|
| | (c) 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 uncovered anaerobic lagoon considered in the baseline scenario is designed for deep storage. In the context of this project, it is designed with a depth of 4 meters based on the national standard "Design code for wastewater stablization ponds (GJJ/T54-93)", which is necessarily greater than 1 meter. |
| | (d) The annual average ambient temperature at the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C; | The annual average ambient temperature at the site is 13.2°C[13], which is higher than 5°C |
| | (e) In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system is greater than one month; | In the baseline case, according to the Project evaluation report, the minimum retention time of manure waste in the anaerobic treatment system is 60 days which is greater than one month. Furthermore, according to the Notice on the Issuance of Specifications for the Construction of Manure Resource Utilization Facilities for Livestock and Poultry Scale Farms (for Trial Implementation) issued by the General Office of the Ministry of Agriculture and Rural Affairs and the General Office of the Ministry of Ecology and Environment in 2018 and the Notice on the Issuance of Technical Guidelines for the Construction of Manure Treatment Facilities for Livestock and Poultry Farms (Households) issued in 2022, it is clearly mentioned that the minimum retention time of manure waste in the uncovered anaerobic lagoon should be up to 90 days in China. Therefore, it |

[13] https://baijiahao.baidu.com/s?id=1756797821554245444&wfr=spider&for=pc

| | | |
|---|---|---|
| | | was confirmed that the minimum retention time of manure in the uncovered anaerobic lagoon is greater than one month in the baseline case. This has been discussed with the owner of farm. |
| | (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 anaerobic fermentation process is conducted in a sealed tank (i.e. UASB), which is impermeable and leak-proof. Also, the construction of UASB is consistent with local standard and regulations. |

**Table 3-2 Applicability of Tool 02**

| **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 waste management system to the swine farm belonging to Yantai Xinhao agriculture and animal husbandry Co, Ltd. to treat manure and wastewater and to avoid methane emissions in anaerobic lagoon that are not covered by the baseline. Alternatives, Barrier analysis, investment analysis and common practices analysis will be based on tool 02. Refer to section 3.4 and 3.5 of the JPM for more details. |

**Table 3-3 Applicability of Tool 05**

| **Tool 05: "Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)"** | | |
|---|---|---|
| 1 | If emissions are calculated for electricity consumption, the tool is only applicable if | All the electricity used by the project is supplied by North China Power Grid |

| | | |
|---|---|---|
| | one out of the following three scenarios applies to the sources of electricity consumption:<br>(a) Scenario A: Electricity consumption from the grid. The electricity is purchased from the grid only, and either no captive power plant(s) is/are installed at the site of electricity consumption or, if any captive power plant exists on site, it is either not operating or it is not physically able to provide electricity to the electricity consumer;<br>(b) Scenario B: Electricity consumption from (an) off-grid fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants are installed at the site of the electricity consumer and supply the consumer with electricity. The captive power plant(s) is/are not connected to the electricity grid; or<br>(c) Scenario C: Electricity consumption from the grid and (a) fossil fuel fired captive power plant(s). One or more fossil fuel fired captive power plants operate at the site of the electricity consumer. The captive power plant(s) can provide electricity to the electricity consumer. The captive power plant(s) is/are also connected to the electricity grid. Hence, the electricity consumer can be provided with electricity from the captive power plant(s) and the grid. | (NCPG)[14], which falls under scenario A of Tool 05 (Version 03.0). Therefore, emissions related to electricity consumption need to be calculated based on Tool 05. |
| 2 | This tool can be referred to in methodologies to provide procedures to | This methodological tool is applied for calculating for emission by electricity |

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

| | | |
|---|---|---|
| | monitor amount of electricity generated in the project scenario, only if one out of the following three project scenarios applies to the recipient of the electricity generated:<br>(a) Scenario I: Electricity is supplied to the grid;<br>(b) Scenario II: Electricity is supplied to consumers/electricity consuming facilities; or<br>(c) Scenario III: Electricity is supplied to the grid and consumers/electricity consuming facilities. | consumption in project activity. So, this criterion is not applicable. |
| 3 | This tool is not applicable in cases where captive renewable power generation technologies are installed to provide electricity in the project activity, in the baseline scenario or to sources of leakage. The tool only accounts for CO2 emissions. | Tool 05 is only used to calculate project emissions of electricity consumption supplied by NCPG. For conservativeness, baseline emissions of captive biogas heat generation system are ignored. Only $CO_2$ emissions was accounted. |

**Table 3-4 Applicability of Tool 06**

| **Tool 06: "Project emissions from flaring (version 04.0)"** | | |
|---|---|---|
| 1 | This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity. | The biogas generated during the treatment process is captured for heat generation and the residual biogas is flared if there is any surplus biogas. One open flare is constructed in the swine farm, which are used by the project activity. |
| 2 | This tool is applicable to the flaring of flammable greenhouse gases where:<br>(a) Methane is the component with the highest concentration in the flammable residual gas; and | The source of the residual biogas of the project activity is from anaerobic treatment process of the swine manure (biogenic source). As per Project evaluation report of the project, |

| | | |
|---|---|---|
| | (b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g., biogas, landfill gas or wastewater treatment gas). | methane accounts for 70% of the biogas, which is the highest concentration in the flammable residual gas. |
| 3 | The tool is not applicable to the use of auxiliary fuels and therefore the residual gas must have sufficient flammable gas present to sustain combustion. For the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare. | No auxiliary fuels are used by the flaring system. As per Project evaluation report of the project, methane accounts for 70% of the biogas. And methane is a kind of flammable gas. Operating specifications were provided by the manufacturer of the flare. |

**Table 3-5 Applicability of Tool 08**

| **Tool 08: "Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)"** | | |
|---|---|---|
| 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 digester. |
| 2 | Methodologies, where $CO_2$ 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 $CO_2$ | The biogas generated during the treatment process including $CH_4$, $H_2S$、$O_2$ and etc, therefore this tool is adopted used for determining the mass flow of a greenhouse gas. |
| 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 | a) Methodological tool "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" is applied in the JPM.<br><br>b) The mass flow is determined in the monitoring plan of the JPM. |

| | | |
|---|---|---|
| | simplification offered for calculating the molecular mass of the gaseous stream (equations (3) or (17) is not valid (such as the gaseous stream is predominantly composed of a gas other than $N_2$). | c) The flow of the gaseous stream will be measured continuously.<br><br>d) The gaseous stream is dry, equation (18) and (19) are used to calculate the mass flow of greenhouse gas |

**Table 3-6 Applicability of Tool 14**

| **Tool 14: "Project and leakage emissions from anaerobic digesters (Version 02.0)"** | | |
|---|---|---|
| 1 | The following sources of project emissions are accounted for in this tool:<br><br>(a) CO2 emissions from the consumption of electricity are associated with the operation of the anaerobic digester.<br><br>(b) CO2 emissions from the consumption of fossil fuels are associated with the operation of the anaerobic digester.<br><br>(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).<br><br>(d) CH4 emissions from flaring of biogas. | The electricity consumption of the project was supplied by the grid company, and the anaerobic digestion process of this project does not involve the use of fossil fuels. Meanwhile the biogas generated during the treatment process will be captured for heat generation and the residual biogas will be flared if there is any surplus biogas. As all the biogas generated by the project is used for heat production, no surplus biogas is produced. Therefore no residual biogas is flared through the flaring system. So, the project meets the (a) and (c). |
| 2 | The following sources of leakage emissions are accounted for in this tool:<br><br>(a) CH4 and N2O emission from composting of digestate.<br><br>(b) CH4 emissions from the anaerobic decay of digestate disposed in an SWDS or subjected to anaerobic storage, such as in a stabilization pond. | The project activity will replace the uncovered anaerobic lagoon with an enclosed anaerobic digester. The biogas generated during the treatment process will be collected and used for biogas boiler combustion to produce heat. After anaerobic digestion, the fermented sludge will be treated in aerobic composting system, which will be used as fertilizer. So, leakage emissions are not taken into account. |

| | | |
|---|---|---|
| 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. |

**Table 3-7 Applicability of Tool 24**

| **Tool 24: "Methodological tool: "common practice (version03.1)"** | | |
|---|---|---|
| 1 | This methodological tool is applicable to project activities that apply the methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", or baseline and monitoring methodologies that use the common practice test for the demonstration of additionality. | Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0) is applied to identify the baseline scenario by the project. |
| 2 | In case the applied approved baseline and monitoring methodology defines approaches for the conduction of the common practice test that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail. | The latest version of Combined tool to identify the baseline scenario and demonstrate additionality is referred by ACM0010 methodology. |

**Table 3-8 Applicability of Tool 27**

| **Tool 27: "Methodological tool: Investment analysis" (Version 10.0)** | | |
|---|---|---|
| 1 | This methodological tool is applicable to project activities that apply the | Combined tool to identify the baseline scenario and demonstrate |

| | | |
|---|---|---|
| | methodological tool "Tool for the demonstration and assessment of additionality", the methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality", the guidelines "Non-binding best practice examples to demonstrate additionality for SSC project activities", or baseline and monitoring methodologies that use the investment analysis for the demonstration of additionality and/or the identification of the baseline scenario. | additionality (Version 07.0) is applied to identify the baseline scenario by the project.<br><br>Investment analysis based on the " Combined tool to identify the baseline scenario and demonstrate additionality" (version 07.0), taking into account the latest approved tool 27 "Methodological tools: Investment analysis" (version 10.0), as detailed in section 3.4 of the JPM. |
| 2 | In case the applied approved baseline and monitoring methodology contains requirements for the investment analysis that are different from those described in this methodological tool, the requirements contained in the methodology shall prevail. | The latest version of Combined tool to identify the baseline scenario and demonstrate additionality is referred by ACM0010 methodology. |

## 3.3 Project Boundary

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, 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.

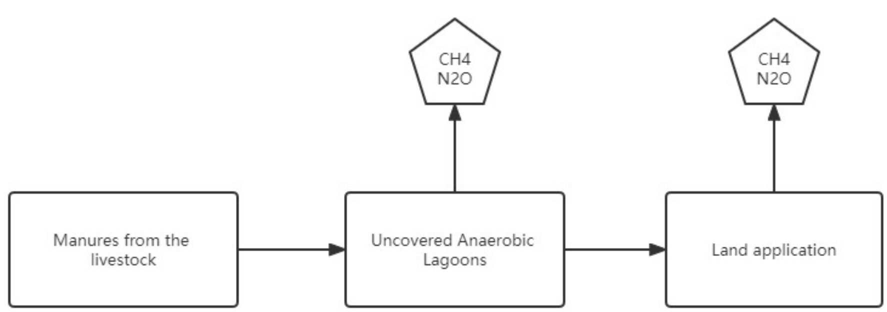


**Figure 3-1 The Baseline Scenario of the Project**

And the project boundary is shown in Figure 3-2(a) (b) below.

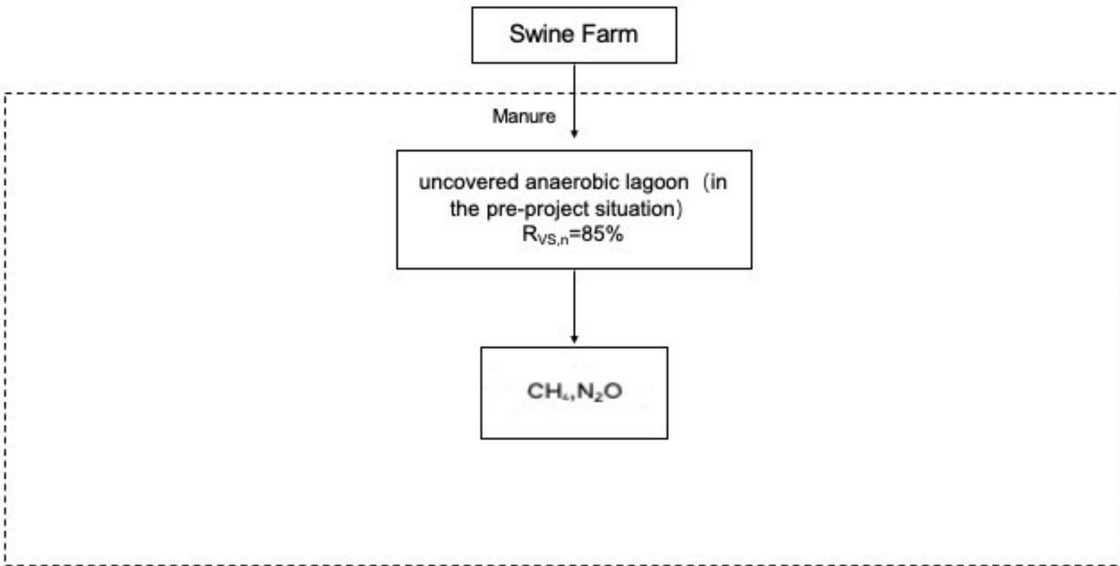


**Figure 3-2(a) Project boundary in the baseline scenario**

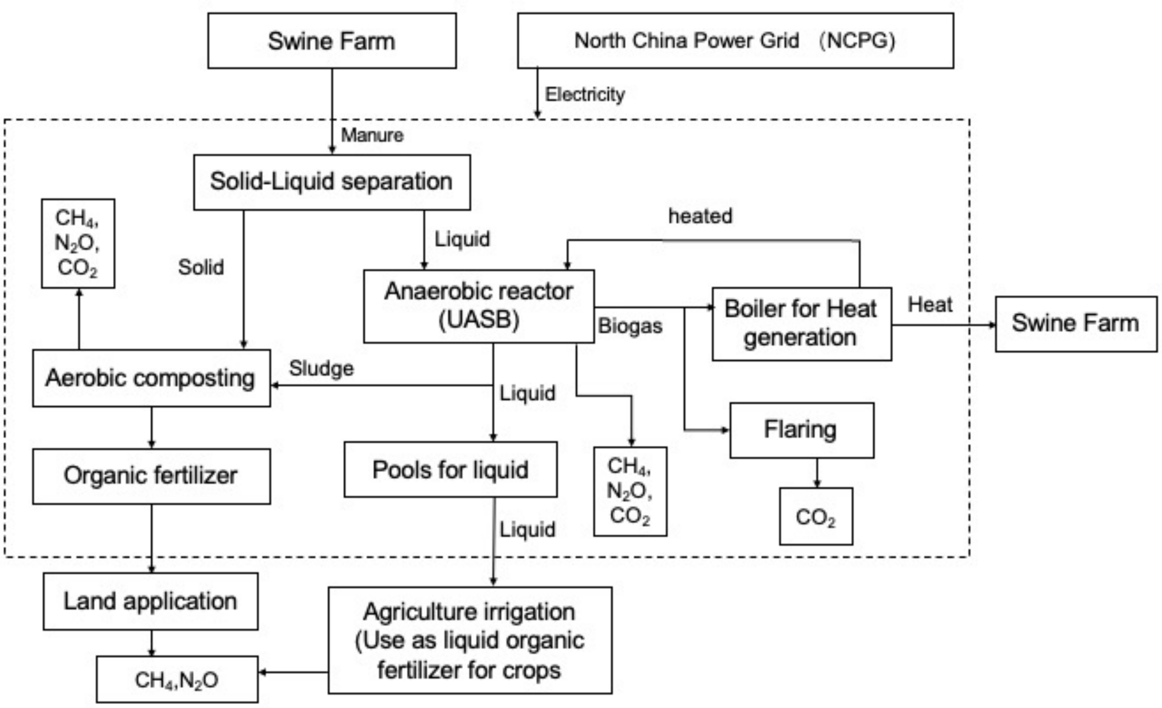


**Figure 3-2(b) The project boundary of the project scenario**

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

Table 3-8 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 |
| | 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 | The operation of project activity needs electricity from NCPG. |
| | | $CH_4$ | 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 digester and aerobic treatment |

| Source | | Gas | Included? | Justification/Explanation |
|---|---|---|---|---|
| | | $N_2O$ | Yes | Direct and indirect $N_2O$ emissions are accounted |
| | Emission sources from open flare system onsite | $CO_2$ | Yes | $CO_2$ emissions from flaring of biogas. |
| | | $CH_4$ | No | Excluded for simplification. |
| | | $N_2O$ | No | Excluded for simplification. |

## 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 lagoon at the swine farm 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 the swine farm was enabled. Therefore, it belongs to the existing facilities.

According to methodology, baseline alternatives for managing the manure for the existing facilities, shall take into consideration, inter alia, the complete set of existing/possible manure management systems listed in the 2019 Refinement to the 2006 IPCC Guidelines (Volume 4, Chapter 10, Table 10.17).

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

| No. | IPCC Alternatives | Applicability | Justification |
|---|---|---|---|
| 1 | The manure is collected from the pasture/Range/Paddock | Not Applicable | The swine in this project is bred in confined barns rather than pasture/range/paddock, so this alternative is excluded. |
| 2 | Daily spread: Manure removed from confinement and applied | 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 |

| | | | |
|---|---|---|---|
| | to pasture within 24 hours of excretion | | 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 farm. The proposed project involves large-scale swine farm 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 farm 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[15]", the uncovered anaerobic lagoon is a kind of harmless treatment of manure. After being treated in the |

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

| | | | |
|---|---|---|---|
| | | | uncovered anaerobic lagoon, 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 lagoon. 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 farm involved in this project is large-scale livestock farm and the manure quantity produced is too large to implement a pit storage structure under the barn. In addition, the manure stored in below animal confinement were removed within 1 month requires a lot of labor work. so, this scenario is excluded. |
| | Pit storage below animal confinements,>1month | Not Applicable | This method is only a storage method of manure, not a disposal method. The farm involved in this project is large-scale livestock farm 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 swine will be quickly killed by the accumulation of toxic fumes. |
| 8 | Anaerobic digester （Anaerobic digester-Aerobic Treatment system） | Applicable | A single Anaerobic digester is suitable for treating manure, but to implement such technology 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. At present a combine Anaerobic Digester-Aerobic Treatment system is considered to be one of the most advanced manure management systems, but to implement such technology need high invest and the proposed project will not be invested and constructed without being registered as a VCS project. |
| 9 | Burned for fuel | Not Applicable | The farm involved in this project is large scale swine farm, 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 farm involved in this project is large-scale swine farm, not the Poultry farm, so no poultry manure is produced. This system is excluded. |
| 16 | Poultry manure without litter | Not Applicable | The farm involved in this project is large-scale swine farm, 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. At present a combine Anaerobic Digester-Aerobic Treatment system is considered to be one of the most advanced manure management systems, but to implement such technology need high invest and the proposed project will not be invested and constructed without being registered as a VCS project. |

**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.

**Step 1b: Consistency with mandatory laws and regulations**

There is no legal law and regulation to mandate the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques to treat the animal manure in China. Only the manure is prohibited to discharge directly into environment without any treatment as per Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming[16] issued by the State Council in Nov. 2013.

According to "Technical specification for sanitation treatment of livestock and poultry manure", in China, the uncovered anaerobic lagoon is a kind of manure treatment method recognized by the state, which need minimum financial cost and is compliance with laws and regulations. Therefore, it is the most economic, viable and reasonable for livestock farm owners. As per "Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)", anaerobic digester, aerobic treatment or other biological treatment techniques methods to dispose manure waste are encouraged by the state and not mandatory.

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

**Step 2: Barrier analysis**

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

**Step 3: Investment analysis**

Undertake investment analysis of all the alternatives that don't face any barriers, as identified in Step 2. For each alternative, all costs and economic benefits attributable to the waste management scenario should be illustrated in a transparent and complete manner.

According to the "Combined tool to identify the baseline scenario and demonstrate additionality" (Version 07.0), the objective of Step 3 is to compare the economic or financial attractiveness of the remaining alternative scenarios after Step 2 by performing an investment analysis. The latest approved version of the Tool 27 of "Methodological tool: Investment analysis" (Version 10.0) should be taken into account when applying this step.

Identify the baseline scenario and demonstrate additionality according to Section 4.4, paragraph 25 of Tool 02 of Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0). Identify the financial indicator that best fit the project type and decision context, such as IRR, NPV, cost-benefit ratio, or unit cost of service (e.g., levelized cost of electricity production in $/kWh

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

or levelized cost of delivered heat in $/GJ). Potential revenues are not addressed in the baseline scenario. There are only negative flows in the uncovered anaerobic lagoon scenario, so economic comparisons should be based on the Net Present Value (NPV) indicator.

The cumulative method is the most commonly used method for NPV discount rate confirmation. The discount rate is equal to the sum of the risk-free rate of profit, the risk rate of profit and the inflation rate and the risk-free rate of profit is typically 3%[17], the risk rate of profit is generally taken as 3-5% and inflation rate for the last ten years is 2.229%[18]. the discount rate is usually no more than 15%[19]. Therefore 9% of NPV discount rate for this project is appropriate.

Table 3-9 shows the investment analysis results of the uncovered anaerobic lagoon.

**Table 3-9 Investment analysis of the uncovered anaerobic lagoon ($10^4$ RMB)**

| Costs and benefits | 1 | 2-15 | 16 |
|---|---|---|---|
| Cash inflow | 0.00 | 0.00 | 0.00 |
| Revenues from fertilizers sales | 0.00 | 0.00 | 0.00 |
| Subsidy income | 0.00 | 0.00 | 0.00 |
| Fixed assets residue value | 0.00 | 0.00 | 0.00 |
| Recovered current capital | 0.00 | 0.00 | 0.00 |
| Cash outflow | 62.00 | 6.00 | 6.00 |
| Construction investment | 56.00 | 0.00 | 0.00 |
| Current capital | 0.00 | 0.00 | 0.00 |
| O&M cost | 6.00 | 6.00 | 6.00 |
| Sales tax and associate charge | 0.00 | 0.00 | 0.00 |
| Net cash flow | -62.00 | -6.00 | -6.00 |
| NPV (discount rate=9%) | ¥-101.25 | | |
| IRR | undefined | | |

There are no potential revenues involved in the baseline scenario. There are only negative flows in the baseline scenario, so the Internal Rate of Return (IRR) cannot be calculated, and the economic comparison should be based on the Net Present Value (NPV) indicator.

Table 3-10 summaries the results of financial analysis of Anaerobic Digester Treatment without VCU revenues.

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

| Coats and benefits | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11-15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

[17] https://xueqiu.com/1422246446/180509860
[18] https://www.0wc.com/26687.html
[19] https://wiki.mbalib.com/wiki/%E6%8A%98%E7%8E%B0%E7%8E%87

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cash inflow | 0.00 | 1,150.58 | 1,150.58 | 1,150.58 | 1,060.88 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 1,264.90 |
| Revenues from fertilizers sales | 0.00 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 | 983.40 |
| Subsidy income | 0.00 | 167.18 | 167.18 | 167.18 | 77.48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fixed assets residue value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 261.50 |
| Recovered current capital | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 80.00 |
| Cash outflow | **3,958.70** | **720.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** | **640.51** |
| Construction investment | 3,958.70 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Current capital | 0.00 | 80.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| O&M cost | 0.00 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 | 620.45 |
| Sales tax and associate charge | 0.00 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 |
| Adjustment of income tax | 0.00 | 27.08 | 30.91 | 34.84 | 0.00 | 0.00 | 0.00 | 6.92 | 10.12 | 13.41 | 20.94 | 20.94 |
| Net cash flow (after tax) | -3,958.70 | 402.98 | 479.16 | 475.22 | 420.37 | 342.89 | 342.89 | 335.97 | 332.77 | 329.48 | 321.95 | 603.45 |
| NPV (discount rate=9%) | **¥-776.97** | | | | | | | | | | | |
| IRR | **5.03%** | | | | | | | | | | | |

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

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 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. Therefore, the PP considered applying for carbon emission reduction projects to supplement the project revenue before the project started.

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)**

The previous steps determine that a proposed project activity is not economically or financially viable if there is no revenue from the sale of VCS-certified emission reductions. For the "simple cost analysis (the option I)", the proposed project activity will generate revenue from the sale of organic fertilizer in addition to VCUs, and therefore is not applicable to option I. For the "investment comparison analysis (option II)", the alternative baseline scenario for the proposed project is not part of the investment project and therefore is not applicable to option II. By Step3's elaboration of the financial and economic indicators identified as most applicable to the project, such as NPV, and based on the consideration of standard parameters in the market, the project's IRR is available and therefore the proposed project is applicable to "the benchmark analysis (Option III)".

In accordance with “Tools for the demonstration and assessment of additionality” (Version 07.0.0) paragraph (6)(b) "Estimates of the cost of financing and required return on capital (e.g. commercial lending rates and guarantees required for the country and the type of project activity concerned), based on bankers views and private equity investors/funds’ required return on comparable projects;", it is stated that the project may use the expected return on equity as a benchmark for comparison with the calculated project IRR for this project.

The construction start date of the project is 02-January-2021 which is defined as the investment decision date, so based on checking the issued date of the Tool 27, it is confirmed that the default value for cost of equity (expected return on equity) defined in Tool 27 version 10.0 (issued on 28-November-2019) is appliable to the project due to it is the latest version.

Meanwhile, in the application of TOOL27, this project falls under "13. Waste handling and disposal" in Appendix , which has a Default value for the expected return on equity of 8.58%.This data is a more reasonable and conservative benchmark to use as an investment comparison compared to the 2013 benchmark of 9.5% from the NDRC. Hence, the benchmark adopted for the project is 8.58 %.

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

(a) Basic parameters

The main parameters for calculation of financial indicators are shown in the following table:

| Item | Value | Source |
|---|---|---|
| Annual organic fertilizers sales | 29,800 t/year | Project evaluation report[20] (September-2020) |
| price of organic fertilizers | 330RMB | |
| Total static investment | $3,958.70*10^4$RMB | |
| O&M cost | $620.45*10^4$RMB | |

[20] All input values used in investment analysis are sourced from project evaluation report (PER), which was completed by an authorized entity on September-2020, while the construction start date of the project is 02-January-2021. The time interval between the project evaluation report complete date and the construction start date is less than 1 year, therefore input values are valid and applicable at the time of the investment decision.

| | | |
|---|---|---|
| Operation period | 20 years | |
| Emission reduction | 92,011 $tCO_2e$ | ER sheet |
| VCU Price | CNY 18/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 5.03%, lower than the the expected return on equity of 8.58% and the proposed project is financially unacceptable because of its low profitability. While considering such income, the IRR of the proposed project is 11.11%, higher than the benchmark, and the proposed project is financially acceptable.

| Item | Without income from VERs | Expected return on equity | With income from VERs |
|---|---|---|---|
| The Project IRR | 5.03% | 8.58% | 11.11% |

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 | 6.70% | 5.83% | 5.03% | 4.30% | 3.61% |
| O&M cost | 2.23% | 3.77% | 5.03% | 6.28% | 7.50% |
| organic fertilizers sales | 6.49% | 5.77% | 5.03% | 4.31% | 3.53% |

The sensitivity analysis was further conducted, and the project IRR (after tax) could reach the benchmark of 8.58% if one of the following conditions can be achieved:

Total static investment; decrease -19.50%;

Organic fertilizers sales: increase 14.55%;

O&M cost: decrease -24.93%

Since all the data used for the investment analysis was sourced from the PER, 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 -19.50%: 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. In addition, the project was put into operation. As per General design and construction contract, which includes flare system, anaerobic tank, boilers, solid-liquid tank, etc., the actual investment costs of the project have reached to 4,030.00*$10^4$ RMB, which is higher than that of the estimated value based on the project evaluation report (3,958.70*$10^4$RMB). As a result, the IRR cannot increase through the change of equipment cost.

Annual organic fertilizers sales increasing 14.55%:

The organic fertilizers are produced through the aerobic composting system, which is determined by the manure of the swine farm. Since the scale of the swine farm will stay stable in the future, at the same time, sales of organic fertilizers are only part of the total organic fertilizers' generation and the price of organic fertilizers is determined by the raw material, production technology, the quality of organic fertilizer and so on. The organic fertilizers produced by the project belong to semi-finished Products, which is harmless but not reaching the Chinese organic fertilizer standard. It can be directly applied to farmland or sold to commercial organic fertilizer plants for further processing. The price of the semi-finished products is lower than the commercial organic fertilizers. And according to the sale agreement of organic fertilizer, the organic fertilizer is sold to fertilizer companies with the fixed price i.e. 330RMB/ton for 25 years, which is consistent with the estimated price based on the project evaluation report (330RMB/ton). Therefore, the increase of annual organic fertilizers sales to threshold is impossible to achieve.

O&M cost decreasing -24.93%: O&M costs in this project include Maintenance expense, Salary, Welfare, Labor insurance expense, housing fund, insurance expense of fixed assets and Other costs.

In estimating project costs, maintenance costs are calculated as a percentage of the fixed asset maintenance rate. There is no regulation or guidance on the maintenance rate of fixed assets in China. Based on the general situation of similar projects in China, the estimated value is 3. 0% to 5. 0%. Therefore, the 5% maintenance rate is reasonable. At the same time, fixed asset purchase contracts and equipment maintenance service contract are used as cross-checking documents for this portion of the operation and maintenance costs.

Salary, Welfare, Labor insurance fees, housing fund are all mentioned in the labour contract.

(a) Average salary: 60,000 RMB

According to the China Statistical Yearbook 2022[21], the average salary in Shandong Province in 2021 for employees in private urban agriculture, forestry, animal husbandry and fishery units was RMB 47,861/year, and the average salary for employees in non-private units was RMB 66,504/year. The average wage of RMB 60,000 for this project is moderate.

(b) Welfare: 14%

According to “Implementation Regulations of the Enterprise Income Tax Law of the People's Republic of China” [22], the welfare shall not exceed 14% of the total salary. Therefore, 14% of welfare is reasonable.

(c) Labor insurance fees : 17%

According to the “Decision of the State Council on Improving the Basic Pension Insurance System for Enterprise Employees” [23], the “Notice of the Ministry of Human Resources and Social Security and the Ministry of Finance on Adjusting the Work-related Injury Insurance Premium Rate Policy” [24] and the “Unemployment Insurance Regulations” [25], the contribution ratio of endowment insurance is 16%, and the contribution ratio of industrial injury insurance and unemployment insurance is about 1%. Therefore, it is reasonable to adopt 17% of the labor insurance premium rate.

[21] http://www.stats.gov.cn/sj/ndsj/2022/indexch.htm
[22] https://www.gov.cn/zwgk/2007-12/11/content_830645.htm
[23] https://www.gov.cn/zhengce/content/2008-03/28/content_7376.htm
[24] http://www.mohrss.gov.cn/xxgk2020/fdzdgknr/zcfg/gfxwj/shbx/201507/t20150729_216271.html
[25] http://www.mohrss.gov.cn/xxgk2020/fdzdgknr/zcfg/fg/202011/t20201103_394936.html

(d) Housing fund 10%

According to the information published on the official website of the Central People's Government of China [26] , the contribution ratio of the legal surplus reserve fund in Shandong Province is 5-12%. Therefore, it is reasonable to use 10% for this project.

These data in IRR are consistent with the labour contracts of farm employees.

The insurance rate is determined by the degree risk of the project. it generally includes construction engineering insurance rate, machinery and equipment insurance rate, and electrical equipment insurance rate. Through checking the public information, the construction engineering insurance rate can be 0.2%-1.5% in general and the machinery and equipment insurance rate, and electrical equipment insurance rate can be 1.5%-5% in China[27]. Therefore, the 2.5% of insurance rate is reasonable.

Concerning the other cost, there are no regulations or guidance on other costs in China. Based on the general situation of similar projects in China, the estimated value of other costs is 20-60 RMB/tons. Therefore, the value of RMB 50/tonne applied to other costs in this project is reasonable. This cost mainly comes from the cost of purchasing the packaging of the organic fertilizer generated by the project activity. As part of the organic fertilizer generated by the project is distributed free of charge to local farmers and the other part is sold in the domestic market, packaging costs are incurred.

The project's IRR (after tax) to reach the baseline value of 8.58% requires that the O&M cost meets the condition of a decrease of -24.93%. 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 -24.93% 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 8.58% 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.

In summary, the NPV of both the project activity and the uncovered anaerobic lagoon are negative and the NPV of the project activity is far more negative than that of the uncovered anaerobic lagoon

[26] https://www.gov.cn/gongbao/content/2019/content_5468861.htm
[27]https://wenku.baidu.com/view/18a5f9375bfafab069dc5022aaea998fcd224045.html?_wkts_=1688436367372&bdQuery=%E5%BB%BA%E7%AD%91%E5%B7%A5%E7%A8%8B%E4%BF%9D%E9%99%A9%E8%B4%B9%E7%8E%87%E4%BE%9D%E6%8D%AE

which means the cost of the project activity without VCS revenues is much higher than the uncovered anaerobic lagoon, so, the uncovered anaerobic lagoon is the most attractive course of action and is considered to be the baseline scenario.

## 3.5 Additionality

And as per Section 3.14.1 of VCS Standard (Version 4.4) “The project shall demonstrate regulatory surplus at validation and each project crediting period renewal. Regulatory surplus means that project activities are not mandated by any law, statute, or other regulatory framework, or for UNFCCC non-Annex I countries, any systematically enforced law, statute, or other regulatory framework.”, the specific demonstration is as follows:

There is no legal law and regulation to mandate the livestock farm owners to implement anaerobic digestion, aerobic or other biological treatment techniques to treat the animal manure in China. Only the manure is prohibited to discharge directly into environment without any treatment as per Regulations on Prevention and Control of Pollution from Livestock and Poultry Farming[28] issued by the State Council in Nov.2013.

According to “Technical specification for sanitation treatment of livestock and poultry manure”[29], in China, the uncovered anaerobic lagoon is a kind of manure treatment method recognized by the state, which need minimum financial cost and is compliance with laws and regulations. Therefore, it is the most economic, viable and reasonable for livestock farm owners.

As the “Specifications for the construction of manure resource utilization facilities for large-scale livestock and poultry farms (for trial implementation)”[30], anaerobic digester, aerobic treatment or other biological treatment techniques methods to dispose manure waste are encouraged by the state and not mandatory.

Therefore, the project activity is not mandated by any law, statute, or other regulatory framework, it is regulatory surplus.

Additionality for the project activity is demonstrated using Tool 02 “Combined tool to identify the baseline scenario and demonstrate additionality (Version 07.0)”. Step 1 to 3 have been finished in Section 3.4 of the JPM.

As per Tool 24 “Common practice (Version 03.1)”, Step 4 common practice analysis will be conducted as follows:

**Step 4: Common practice analysis**

The proposed project will achieve obvious greenhouse gas (GHG) emission reductions through capturing methane generated during the swine manure treatment process and the biogas can be

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

used for heat production. Therefore, according to the “Combined tool to identify the baseline scenario and demonstrate additionality” (version 07.0) and the methodological tool “Common Practice” (Version 03.1), the measure of the proposed project belongs to “Methane formation avoidance”. Thus, sub-steps are adopted to take the common practice analysis.

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

The proposed project is belonged to type (D) measure listed in the latest version of the methodology tool 24 “common practice (Version 03.1)”, i.e., Methane formation avoidance (example: use of biomass that would have been left to decay in a solid waste disposal site resulting in the formation and emission of methane, for energy generation). As per methodology tool 24, the “common practice (Version 03.1)” available on the UNFCCC website is applied as below:

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

For this project, the swine farm involving 144,000 heads of marketing swine, 13,650 heads of breeding swine in stock are included, and are estimated to produce 58,765 tons of manure every year, Therefore, the project belongs to “methane formation avoidance” and can handle manure from 41,115 tons to 63,345 tons are included.

**Sub-step 4a.2: identify similar projects (both CDM and non-CDM) which fulfil all of the following conditions:**

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

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

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

As described above, the project installs a new AWMS to treat the manure from existing the swine farm, which can avoid methane emissions generated in the baseline uncovered anaerobic lagoon. And the measure of the project belongs to “Methane formation avoidance” as per Tool 24“Common practice (version 03.1).

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

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

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

The proposed project can handle 58,765 tons of animal manure waste annually. If the similar projects can treat the manure waste should be considered as the comparable service.

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

Based on the calculation in Sub-step 4a.1, the output/capacity ranges of similar project are that can handle manure from 41,115 tons to 63,345 tons annually.

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

The similar project stared commercial operation before the start date of proposed project is at 05-March-2021, which is earlier date.

Based on above analysis, it can conclude that the project belongs to “Methane formation avoidance” with handle manure operated before 05-March-2021 and can handle manure from 41,115 tons to 63,345 tons annually in Shandong Province, with an estimated annual heat production of 57,030 GJ to 87,865 GJ, which is the similar project as the proposed project activity.

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

Through searching UNFCC website, CDM website, China CER exchange info-platform, GS website, VCS website, Development and Reform Commission of Shandong Province[31] and Department of Agriculture and Rural Affairs of Shandong Province[32], there are no similar projects, therefore $N_{all}$=0.

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

$N_{diff}$=0

**Sub-step 4a.5: calculate factor $F=1-N_{diff}/N_{all}$ representing the share of similar projects (penetration rate of the measure/technology) using a measure/technology similar to the measure/technology used in the proposed project activity that deliver the same output or capacity as the proposed project activity.**

According to the analysis above, $N_{all}= N_{diff} =0$, and the factor $F=1-N_{diff}/N_{all}=1-1 =0< 0.2$. Therefore, the result of common practice assessment is: $N_{all}-N_{diff}=0 < 3$.

[31] http://fgw.shandong.gov.cn
[32] http://nync.shandong.gov.cn

Therefore, the project activity is not a common practice in the region.

**Conclusion of the assessment and demonstration of additionality**

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

## 3.6 Methodology Deviations

No deviations from the procedures indicated by the methodology have been made.

# 4 IMPLEMENTATION STATUS

## 4.1 Implementation Status of the Project Activity

The project activity which involves the construction and operation a new AWMS was implemented in the swine farm containing breeding swine and market swine in Yadi village, Muping District, Yantai City, Shandong Province owned by Yantai Xinhao agriculture and animal husbandry Co., Ltd. It has been designed to install one AWMS in the swine farm, aiming at treating the manure and wastewater from the existing swine farm to avoid methane generated in the baseline uncovered anaerobic lagoon.

The milestone of this project is listed as follows:

| Date | Milestone (s) in the project’s development and implementation |
|---|---|
| August-2020 | EIA |
| September-2020 | Completion of *Project Evaluation Report* (Including prior consideration of carbon revenue). |
| 29-September-2020 | EIA Approval by local Ecology and Environment Bureau |
| 02-January-2021 | The project construction start date |
| 20-February-2021 | Xinhao Swine Farm starts commissioning |
| 05-March-2021 | **The project was put into operation (Start date)** |
| 15-July-2022 | The first submit to Verra of this project |
| 15-July-2022 to 14-August-2022 | Public comment period |

There are no deviations or delays compared to information in approved PD.

During this monitoring period, there was no special event occurred, such as overhaul and downtimes of turnover machine. All the equipment operated well and no equipment was under maintenance during this monitoring period.

# 5 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

## 5.1 Baseline Emissions

As per paragraph 26 of the applied methodology,

Baseline emissions are:

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

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 $CO_2$e/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*. 2019 Refinement to the 2006 IPCC Guidelines , table 10.17, chapter 10, volume 4. |
| $B_{0,LT}$ | Maximum methane producing potential of the volatile solid generated by animal type *LT* (m$^3$$CH_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 $n_{dy}$ (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 $VS_{default}$ 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 $VS_{LT,y}$ (2019 Refinement to the 2006 IPCC 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 ($N_{LT}$) may be calculated as follows:

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

where:

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

There are two types of swine in this project, for both Market swine and Breeding swine, the PP can monitor the daily stock of breeding swine and market swine reliably, discounting dead swine and discarding them from the productive process from the daily stock. So, Option 2 is adopted to calculate $N_{LT}$ for market swine and 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 table 10.16 (2019 Refinement to the 2006 IPCC Guidelines volume 4, chapter10).

The proposed project is located in Shenyang city, Shandong Province, China, Asia. According to 10.16 of 2019 Refinement to the 2006 IPCC Guidelines volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for high productivity system in Asia region is 0.45 $m^3$ $CH_4$/kg VS.

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

(a)The $MCF_j$ values are given in table 10.17, chapter 10, volume 4, 2019 Refinement to the 2006 IPCC Guidelines should be used. $MCF_j$ values depend on the climate zone where the anaerobic manure treatment facility in the baseline existed. For this project, the annual average temperature is 13.2°C[33], more than 10°C , the ratio of potential evapotranspiration to precipitation is 1876.5 mm[34]/1105.1 mm[35]=1.70, more than 1. Therefore, as per Annex 10A.2, 2019 Refinement to the 2006 IPCC Guidelines, the climate zone of the project site can be determined to "Warm temperature moist", and the value of 73% is applied.

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

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

[34] https://www.renrendoc.com/paper/217600319.html

[35] https://baijiahao.baidu.com/s?id=1752967678445584846&wfr=spider&for=pc

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

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

where:

| | |
|---|---|
| $BE_{N20,y}$ | Annual baseline $N_2O$ emissions in (t $CO_2e$/yr) |
| $GWP_{N20}$ | Global Warming Potential (GWP) for $N_2O$ (t $CO_2e$/t$N_2O$) |
| $CF_{N20\text{-}N,N}$ | 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 2019 Refinement to the 2006 IPCC 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 (6) (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 2019 Refinement to the 2006 IPCC Guidelines 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 (6) (number) |

**Estimation of various variables and parameters for above equations:**

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

**Option 1:**

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

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 2019 Refinement to the 2006 IPCC Guidelines, volume 4, chapter 10) may be used and should be corrected for the animal weight atthe project site in the following way:

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

where:

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

$$NEX_{IPCC\ default} = N_{rate(T)} * \frac{TAM}{1000} * 365^{36} \quad \text{Equation (13)}$$

where:

| | |
|---|---|
| $N_{rate(T)}$ | the default N excretion rate, kg N/ (1000 kg animal mass)/ day, table 10.19, chapter 10, volume 4 of 2019 Refinement to the 2006 IPCC 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**

[36] This equation refers to the equation 10.30 in chapter 10 volume 2019 Refinement to the 2006 IPCC Guidelines.

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

where:

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

The baseline scenario of this project is 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.

## 5.2 Project Emissions

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

Project emissions are estimated as follows:n factors and default values).

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

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* |

Regarding the emission factors for electricity generation for the project activity:

According to Tool 05 V3.0, section 2.2, paragraph 5, this project applies to Option A1. Therefore the procedures in the latest approved "Tool to calculate the emission factor for an electricity system"

($EF_{EL,j/k/l,y}$ = $EF_{grid,CM,y}$) needs to be used to calculate the combined margin emission factor of the applicable electricity system.

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

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM}$$

where:

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

Where the NCPG is thermal, so in the first crediting period, $W_{OM}$=0.5, $W_{BM}$=0.5.and $EF_{grid,OM,y}$=0.9419 t$CO_2$/MWh, $EF_{grid,BM,y}$=0.4819 t$CO_2$/MWh for the NCPG[37].

Finally, $EF_{EF,j,y}$ =$EF_{grid,CM,y}$=0.9419t$CO_2$/MWh×0.5+0.4819t$CO_2$/MWh×0.5=0.7119 t$CO_2$/MWh

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 NCPG. And the electricity consumption sourced from the NCPG will be determined through the electricity meter measurement and cross-check with the grid statement.

**ii) the project emissions from flaring of biogas in year y ($PE_{flare,y}$)**

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 04.0).

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

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

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

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

STEP 2: Determination of the flare efficiency.

STEP 3: Calculation of project emissions from flaring.

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

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

The following requirements apply:

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

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

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

As per paragraph 23 of Tool 8:" Tool to determine the mass flow of a greenhouse gas in a gaseous stream (version 03.0)", the way to prove that the gaseous stream is dry needs to demonstrate that the temperature of the gaseous stream (Tt) is less than 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:

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

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

where:

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

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

**Step 2: Determination of 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:

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

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:

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

Where:

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

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

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 $CO_2$e) |
| $Q_{CH4,y}$ | 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 digester 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:

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

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

where:

| | |
|---|---|
| $F_{i,t}$ | Mass flow of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas/h) |
| $V_{t,db}$ | Volumetric flow of the gaseous stream in time interval *t* on a dry basis ($m^3$ dry gas/h) |
| $\upsilon_{i,t,db}$ | Volumetric fraction of greenhouse gas *i* in the gaseous stream in a time interval *t* on a dry basis ($m^3$ gas *i*/$m^3$ dry gas) |
| $\rho_{i,t}$ | Density of greenhouse gas *i* in the gaseous stream in time interval *t* (kg gas *i*/$m^3$ gas *i*) |
| $P_t$ | Absolute pressure of the gaseous stream in time interval *t* (Pa) |

| | |
|---|---|
| $MM_i$ | Molecular mass of greenhouse gas *i* (kg/kmol) |
| $R_u$ | Universal ideal gases constant (Pa.m$^3$/kmol.K) |
| $T_t$ | Temperature of the gaseous stream in time interval *t* (K) |

In summary, the Project emissions associated with the anaerobic digester in year y (t $CO_2e$) 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 $CO_2e$/t$CH_4$) |
| $R_{VS,n}$ | Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated (fraction) |
| $D_{CH4}$ | Density of $CH_4$ (t/m$^3$) |
| $F_{Aer}$ | Fraction of volatile solid directed to aerobic system (fraction) |
| LT | Type of livestock |
| $B_{o,LT}$ | Maximum methane producing potential of the volatile solid generated by animal type LT (m$^3$$CH_4$/kg dm) |
| $VS_{LT,y}$ | Annual volatile solid excretion livestock type LT entering all AWMS on a dry matter weight basis in (kg -dm/animal/yr) |
| $N_{LT}$ | Annual average number of animals of type LT for the year y (number) as estimated in equation (6) |
| $PE_{sl,y}$ | 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) |

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

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

(Equation 26)

where:

| | |
|---|---|
| $GWP_{CH4}$ | Global Warming Potential (GWP) of $CH_4$ (t $CO_2$e/t$CH_4$) |
| $R_{VS,n}$ | Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated (fraction) |
| $D_{CH4}$ | Density of $CH_4$ (t/$m^3$) |
| $F_{Aer}$ | Fraction of volatile solid directed to aerobic system (fraction) |
| LT | Type of livestock |
| $B_{o,LT}$ | Maximum methane producing potential of the volatile solid generated by animal type LT ($m^3CH_4$/kg dm) |
| $VS_{LT,y}$ | Annual volatile solid excretion livestock type LT entering all AWMS on a dry matter weight basis in (kg -dm/animal/yr) |
| $N_{LT}$ | Annual average number of animals of type LT for the year y (number) as estimated in equation (6) |
| $MS\%_j$ | Fraction of manure handled in system j in the project activity (fraction) |

**(3) Project N2O emissions in year y ($PE_{N20,y}$)**

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

(Equation 27)

where:

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

**Option1:**

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

(Equation 28)

where:

$E_{N2O,D,y}$ Direct $N_2O$ emission in year *y* (kg $N_2O$-N/yr)

$EF_{N2O,D,j}$ Direct $N_2O$ emission factor for the treatment system *j* of the manure management system (kg $N_2O$-N/kg N)

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

$MS\%_j$ Fraction of manure handled in system *j* (fraction)

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

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

where:

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

$EF_{N2O,ID}$ Indirect $N_2O$ emission factor for $N_2O$ emissions from atmospheric deposition of nitrogen on soils and water surfaces (kg$N_2O$-N/kg $NH_3$-N and $NO_X$-N)

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

$MS\%_j$ Fraction of manure handled in system *j* (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 (6) (number)

**Option2:**

$$E_{N2O,D,y} = \sum_j EF_{N2O,D,y} \times \sum_{m=1}^{12} \left(Q_{EM,m} + [N]_{EM,m}\right) \qquad \text{(Equation 30)}$$

$$E_{N2O,ID,y} = EF_{N2O,D,y} \times \sum_{j,LT} F_{gasMS,j,LT} \times \sum_{m=1}^{12} \left(Q_{EM,m} + [N]_{EM,m}\right) \qquad \text{(Equation 31)}$$

where:

$E_{N2O,D,y}$ Direct $N_2O$ emission in year *y* (kg $N_2O$-N/yr)

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

$EF_{N2O,D,j}$ Direct $N_2O$ emission factor for the treatment system j of the manure management system (kg $N_2O$-N/kg N)

$Q_{EM,m}$ Monthly volume of the effluent mix entering the manure management system ($m^3$/month)

$[N]_{EM,m}$ Monthly total nitrogen concentration in the effluent mix entering the manure management system (kg $N/m^3$)

$EF_{N2O,ID}$ Indirect $N_2O$ emission factor for $N_2O$ emissions from atmospheric deposition of nitrogen on soils and water surfaces (kg $N_2O$-N/kg $NH_3$-N and $NO_X$-N)

$F_{gasMS,j,LT}$ Default values for nitrogen loss due to volatilisation of $NH_3$ and $NO_X$ from manure management (fraction)

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

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

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

where:

$PE_{EC,y}$ Project emissions from electricity consumption in year y. The project emissions from electricity consumption will be calculated following the latest version of the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption". In case, the electricity consumption is not measured then the electricity consumption shall be estimated as follows $EC_{PJ,y} = \sum_i CP_{i,y} * 8760$, 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, $PE_{elec/heat} = 0$

## 5.3 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.

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

where:

| | |
|---|---|
| $LE_{PJ,\ N2O,\ y}$ | Leakage $N_2O$ emissions released during project activity from land application of the treated manure in year y (t $CO_2e$/yr) |
| $LE_{BL,\ N2O,\ y}$ | Leakage $N_2O$ emissions released during baseline scenario from land application of the treated manure in year y (t $CO_2e$/yr) |
| $LE_{PJ,\ CH4,\ y}$ | Leakage $CH_4$ emissions released during project activity from land application of the treated manure in year y (t $CO_2e$/yr) |
| $LE_{BL,\ CH4,\ y}$ | Leakage $CH_4$ emissions released during baseline scenario from land application of the treated manure in year y (t $CO_2e$/yr) |
| $LE_{AD,\ y}$ | Leakage emissions associated with the anaerobic digester in year y (t $CO_2e$) |

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

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

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

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

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

where:

| | |
|---|---|
| $GWP_{N2O}$ | Global Warming Potential (GWP) for $N_2O$ (t $CO_2e$/t$N_2O$) |
| $CF_{N2O-N,N}$ | Conversion factor $N_2O$-N to $N_2O$ (44/28) |
| $LE_{N2O,land,y}$ | Leakage $N_2O$ emissions from application of manure waste in year y (kg $N_2O$-N/year) |
| $LE_{N2O,runoff,y}$ | Leakage $N_2O$ emissions due to leaching and run-off in year y (kg $N_2O$-N/year) |
| $LE_{N2O,vol,y}$ | Leakage $N_2O$ emissions due to volatilisation in year y (kg $N_2O$-N/year) |
| $F_{gasm}$ | Fraction of N lost due to volatilization (fraction) |
| $N_{LT}$ | Annual average number of animals of type LT estimated as per equation (5(a)) or (5(b)) (number) |
| $NEX_{LT,y}$ | Annual average nitrogen excretion per head of a defined livestock population (kg N/animal/year) estimated as described in appendix 2 |
| $EF_1$ | Emission factor for $N_2O$ emissions from N inputs (kg $N_2O$-N/kg N input) |
| $EF_5$ | Emission factor for $N_2O$ emissions from N leaching and runoff in (kg $N_2O$-N/kg N leached and runoff) |
| $EF_4$ | Emission factor for $N_2O$ emissions from atmospheric deposition of N on soils and water surfaces, [kg N- $N_2O$/ (kg $NH_3$-N + $NO_X$-N volatilized)] |
| $F_{leach}$ | Fraction of all N added to/mineralised in managed soils in regions 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, $LE_{PJ, N2O}$**

$$LE_{PJ,N20} = GWP_{N20-N,N} * \frac{1}{1000} * (LE_{N20,land,y} + LE_{N20,runoff,y} + LE_{N20,vol,y}) \qquad \text{(Equation 38)}$$

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

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

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

where:

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

It is 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 42)

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

where:

| | |
|---|---|
| $LE_{BL,CH4,y}$ | Leakage $CH_4$ emissions released during baseline scenario from land application of the treated manure in year *y* (t $CO_2e$/yr) |
| $LE_{PJ,CH4,y}$ | Leakage $CH_4$ emissions released during project activity from land application of the treated manure in year *y* (t $CO_2e$/yr) |
| $R_{VS,n}$ | Fraction of volatile solid degraded in AWMS treatment method *n* of the *N* treatment steps prior to sludge being treated |
| $GWP_{CH4}$ | Global Warming Potential (GWP) of $CH_4$ (t $CO_2e$/t$CH_4$) |
| $D_{CH4}$ | Density of $CH_4$ (t/$m^3$) |
| $B_{0,LT}$ | Maximum methane producing potential of the volatile solid generated by animal type LT ($m^3CH_4$/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:

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

where:

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

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by ($1-R_N$), where 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).

After anaerobic digestion, the fermented sludge will be treated in aerobic composting system, which will be used as fertilizer. The effluent from anaerobic digestion will be treated aerobically and then used for agriculture irrigation.so, the estimation of leakage emissions associated with the anaerobic digester is 0. i.e., $LE_{AD,y}$ =0.

## 5.4 Estimated Net GHG Emission Reductions and Removals

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

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

Further, in estimating emissions reduction for claiming certified emissions reductions, if the calculated $CH_4$ baseline emissions from anaerobic lagoon 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:**

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

| Parameter | Value | | Unit |
|---|---|---|---|
| species | Market Swine | Breeding Swine | |
| $GWP_{CH4}$ | 28 | 28 | $tCO_2/tCH_4$ |
| $D_{CH4}$ | 0.00067 | 0.00067 | $t/m^3$ |
| $MCF_j$ | 73% | 73% | % |
| Conservative Factor | 0.94 | 0.94 | / |
| $MCF_j$ with cons. Factor | 68.62% | 68.62% | / |
| $B_{o,LT}$ | 0.45 | 0.45 | $m^3$ $CH_4$ /kg_dm |

| | | | |
|---|---|---|---|
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $W_{site}$ | 85.5 | 95.5 | kg |
| $W_{default}$ | 56 | 160 | kg |
| $VS_{default}$ | 0.2856 | 0.368 | Kg-dm/animal/day |
| $VS_{LT,y}$ | 159.16 | 80.17 | kg-dm/animal/yr |
| $MS\%_{BI,j}$ | 100% | 100% | % |
| $nd_y$ | 365 | 365 | days |
| **Sub total** | 132,766 | 6,339 | $tCO_2e$ |
| **$BE_{CH4}$** | **139,106** | | |

| Parameter | Value | | Unit |
|---|---|---|---|
| **species** | **Market Swine** | **Breeding Swine** | |
| $EF_{N2O,D,j}$ | 0 | 0 | kg $N_2O$-N/kg N |
| $EF_{N2O,ID}$ | 0.014 | 0.014 | kg $N_2O$-N/kg N |
| $N_{rate(T)}$ | 0.63 | 0.32 | kg N/1000kg animal mass/day |
| $NEX_{IPCCdefault}$ | 12.88 | 18.69 | kg N/animal/year) |
| $W_{site}$ | 85.5 | 95.5 | kg |
| *TAM* | 56.00 | 160.00 | kg |
| $W_{default}$ | 56 | 160 | kg |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $MS\%_{BI,j}$ | 100% | 100% | / |
| $F_{gasMS,j,LT}$ | 40% | 40% | / |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2/tN_2O$ |
| $CF_{N2O,N-N}$ | 1.57 | 1.57 | Conversion Factor $N_2O$-N to $N_2O$ |
| $E_{N2O,ID,y}$ | 15,854 | 853 | $tCO_2/tN_2O$ |
| **Sub total** | **16,707** | | $tCO_2/tN_2O$ |
| $BE_{N2O,y}$ | **6,957** | | $tCO_2e$ |

Baseline Emissions: $BE_{CH4,y} + BE_{N2O,y}$ = 139,106 $tCO_2e$ +6,957 $tCO_2e$ =146,063 $tCO_2e$

**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** | $tCO_2e$ |

$PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y} = 4{,}101 tCO_2e + 9{,}520\ tCO_2e + 4{,}200\ tCO_2e = 17{,}821\ tCO_2e$

| **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 | / |
| $F_{Aer}$ | 100% | 100% | / |
| $1\text{-}R_{VS,1}$ | 16% | 16% | / |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3\ CH_4$ /kg VS |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $VS_{LT,y}$ | 159.16 | 80.17 | kg-dm/animal/yr |
| $MS\%_j$ | 100% | 100% | / |
| **Sub total** | 31 | 2 | $tCO_2e$ |
| **$PE_{Aer,y}$** | **33** | | |

| **Parameter** | **Value** | | **Unit** |
|---|---|---|---|
| **species** | **Market Swine** | **Breeding Swine** | |
| $EF_{N2O,D,j}$ | 0.0006 | 0.0006 | kg $N_2O$-N/kg N |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $MS\%_j$ | 100% | 100% | / |
| **Sub total** | **1,698.69** | **91.35** | kg $N_2O$-N/year |
| | | | |
| **Parameter** | **Value** | | **Unit** |

| species | Market Swine | Breeding Swine | |
|---|---|---|---|
| $EF_{N2O,D,j}$ | 0.006 | 0.006 | kg $N_2O$-N/kg N |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $MS\%_j$ | 100% | 100% | / |
| **Sub total** | **16,986.87** | **913.55** | kg $N_2O$-N/year |
| **$E_{N2O,D,y}$** | **19,690.45** | | |

| Parameter | Value | | Unit |
|---|---|---|---|
| species | Market Swine | Breeding Swine | |
| $EF_{N2O,iD}$ | 0.014 | 0.014 | kg $N_2O$-N/kg $NH_3$ and $NO_x$-N |
| $F_{gasMS,j,LT}$ | 50% | 50% | / |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $MS\%_j$ | 100% | 100% | % |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2/tN_2O$ |
| **Sub total** | **19,818.01** | **1,065.80** | kg $N_2O$-N/year |
| **$E_{N2O,ID,j}$** | **20,884** | | kg $N_2O$-N/year |
| | | | |
| Parameter | Value | | Unit |
| species | Market Swine | Breeding Swine | |
| $EF_{N2O,iD,j}$ | 0.014 | 0.014 | kg $N_2O$-N/kg $NH_3$ and $NO_x$-N |
| $F_{gasMS,j,LT}$ | 60% | 60% | / |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $MS\%_j$ | 100% | 100% | % |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2/tN_2O$ |
| **Sub total** | **23,781.61** | **1,278.96** | kg $N_2O$-N/year |
| **$E_{N2O,ID,y}$** | **25,061** | | kg $N_2O$-N/year |

$PE_{N2O,y} = 310 * (44/28) * 1/1000 * (E_{N2O,D,y} + E_{N2O,ID,y}) = 27{,}332$ $tCO_2e$

Project emission: $PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y}$ = 17,821 $tCO_2e$ +33 $tCO_2e$ +27,332 $tCO_2e$ = 45,186 $tCO_2e$

**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 |
| $NEX_{LT,y}$ | 19.66 | 11.15 | kg N/animal/yr |
| $R_{N,n}$ | 80% | 80% | / |
| $EF_1$ | 0.006 | 0.006 | kg $N_2O$-N/kg N |
| $EF_5$ | 0.011 | 0.011 | kg $N_2O$-N/kg N |
| $EF_4$ | 0.01 | 0.01 | KgN-$N_2O$-N/kg $NH_3$-N+$NO_X$-N |
| $F_{leach}$ | 0.24 | 0.24 | / |
| $F_{gasm}$ | 0.21 | 0.21 | / |
| $GWP_{N20}$ | 265 | 265 | $tCO_2/tN_2O$ |
| $LE_{N20,land,y}$ | 3397.37 | 182.71 | kg $N_2O$-N/year |
| **Sub total** | **3580.08** | | |
| $LE_{N20,runoff,y}$ | 1494.84 | 80.39 | kg $N_2O$-N/year |
| **Sub total** | **1575.24** | | |
| $LE_{N20,vol,y}$ | 1,189.08 | 63.95 | kg $N_2O$-N/year |
| **Sub total** | **1253.03** | | |
| $LE_{BL,N20,y}$ | **2,669** | | |

| **Parameter** | **Value** | | **Unit** |
|---|---|---|---|
| **species** | **Market Swine** | **Breeding Swine** | |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $NEX_{LT}$ | 19.66 | 11.15 | kg N/animal/yr |
| $R_N$ | 5% | 5% | - |
| $R_N$ | 25% | 25% | |
| $EF_1$ | 0.006 | 0.006 | kg N2O-N/kg N |
| $EF_5$ | 0.011 | 0.011 | kg N2O-N/kg N |
| $EF_4$ | 0.01 | 0.01 | KgN-$N_2O$-N/kg $NH_3$-N+$NO_X$-N |
| $F_{leach}$ | 0.24 | 0.24 | / |
| $F_{gasm}$ | 0.21 | 0.21 | / |
| $LE_{N20,land,y}$ | 12,103.14 | 650.90 | kg $N_2O$-N/year |
| **Sub total** | **12,754.04** | | |
| $LE_{N20,runoff,y}$ | 5325.38 | 286.40 | kg $N_2O$-N/year |
| **Sub total** | **5,611.78** | | |
| $LE_{N20,vol}$ | 4,236.10 | 227.82 | kg $N_2O$-N/year |
| **Sub total** | **4,463.92** | | |
| $LE_{PJ,N20}$ | **9,507** | | |

| **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 | / |
| $VS_{LT,y}$ | 159.16 | 80.17 | kg-dm/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3$ $CH_4$/kg-VS |
| $R_{VS}$ | 85% | 85% | / |
| $MS\%_j$ | 100% | 100% | / |
| **$LE_{BL,CH4,y}$** | **29,022.06** | **1,385.78** | $tCO_2e$ |
| **Total** | **30,408** | | |

| **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 | / |
| $VS_{LT,y}$ | 159.16 | 80.17 | kg-dm/animal/yr |
| $N_{LT}$ | 144,000 | 13,650 | No of heads |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3$ $CH_4$/kg-VS |
| $R_{VS}$ | 20% | 20% | / |
| $R_{VS}$ | 80% | 80% | / |
| $MS\%_j$ | 100% | 100% | / |
| **$LE_{PJ,CH4,y}$** | **30,956.87** | **1,478.16** | $tCO_2e$ |
| **Total** | **32,435** | | $tCO_2e$ |

$LE_y = (LE_{PJ,N2O,y} - LE_{BL,N2O,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y})$ = (9,507 $tCO_2e$ − 2,669 $tCO_2e$) + (32,435 $tCO_2e$−30,408 $tCO_2e$) = 8,866 $tCO_2e$

Emission Reduction: $ER_y = BE_y - PE_y - LE_y$ = 146,063 $tCO_2e$ - 45,186 $tCO_2e$ - 8,866 $tCO_2e$ = 92,011 $tCO_2e$

| 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 31-December-2021 | 120,452[38] | 37,263[39] | 7,311[40] | 75,878 |
| 01-January-2022 to 31-December-2022 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2023 to 31-December-2023 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2024 to 31-December-2024 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2025 to 31-December-2025 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2026 to 31-December-2026 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2027 to 31-December-2027 | 146,063 | 45,186 | 8,866 | 92,011 |
| 01-January-2028 to 04-March-2028 | 25,611[41] | 7,923[42] | 1,555[43] | 16,133 |
| **Total** | **1,022,441** | **316,302** | **62,062** | **644,077** |

# 6 MONITORING

## 6.1 Data and Parameters Available at Validation

| | |
|---|---|
| **Data / Parameter** | $GWP_{CH4}$ |
| **Data unit** | t $CO_2e/tCH_4$ |

[38] The yearly total amount estimated baseline emission reductions is 146,063 $tCO_2e$, so the values estimated baseline emission reductions from 05-March-2021 to 31-December-2021 is 146,063 $tCO_2e$ *301 days /365 days= 120,452 $tCO_2e$.
[39] The yearly total amount estimated project emission reductions is 45,186 $tCO_2e$, so the values estimated project emission reductions from 05-March-2021 to 31-December-2021 is 45,186 $tCO_2e$ *301 days /365 days= 37,263 $tCO_2e$.
[40] The yearly total amount estimated leakage emission reductions is 8,866 $tCO_2e$, so the values estimated leakage emission reductions from 05-March-2021 to 31-December-2021 is 8,866 $tCO_2e$ *301 days /365 days= 7,311 $tCO_2e$.
[41] The yearly total amount estimated baseline emission reductions is 146,063 $tCO_2e$, so the values estimated baseline emission reductions from 01-January-2028 to 04-March-2028 is 146,063 $tCO_2e$ *64 days /365 days= 25,611 $tCO_2e$.
[42] The yearly total amount estimated project emission reductions is 45,186 $tCO_2e$, so the values estimated project emission reductions from 01-January-2028 to 04-March-2028 is 45,186 $tCO_2e$ *64 days /365 days= 7,923 $tCO_2e$.
[43] The yearly total amount estimated leakage emission reductions is 8,866 $tCO_2e$, so the values estimated leakage emission reductions from 01-January-2028 to 04-March-2028 is 8,866 $tCO_2e$ *64 days /365 days= 1,555 $tCO_2e$.

| | |
|---|---|
| Description | Global Warming Potential of $CH_4$ |
| Source of data | IPCC Fifth Assessment Report |
| Value applied | *28* |
| Justification of choice of data or description of measurement methods and procedures applied | 100-year values are adopted from Box 3.2, table 1, IPCC Fifth Assessment Report, 2014[44], which complies with the requirement described in Section 3.15.4 of VCS Standard (V4.4). |
| 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 Fifth Assessment Report |
| Value applied | *265* |
| Justification of choice of data or description of measurement methods and procedures applied | 100-year values are adopted from Box 3.2, table 1, IPCC Fifth Assessment Report, 2014, which complies with the requirement described in Section 3.15.4 of VCS Standard (V4.4). |
| 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 |
| Justification of choice of data or description of | 0.00067 t/m$^3$ at room temperature 20℃ and 1 atm pressure. |

44 https://www.ipcc.ch/site/assets/uploads/2018/02/SYR_AR5_FINAL_full.pdf

| | |
|---|---|
| measurement methods and procedures applied | |
| 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 | 2019 Refinement to the 2006 IPCC Guidelines table 10.17, chapter 10, volume 4 |
| Value applied | 68.62% |
| Justification of choice of data or description of measurement methods and procedures applied | MCF value for uncovered anaerobic lagoon (baseline AWMS) is chosen.<br>A conservativeness factor has been applied by multiplying MCF value (i.e. 73%) with a value of 0.94, to account for the 20 per cent uncertainty in the MCF values as reported by 2019 Refinement to the 2006 IPCC Guidelines. For this project, the annual average temperature is 13.2°C , more than 10°C, the ratio of potential evapotranspiration to precipitation is 1876.5 mm /1105.1 mm =1.70, more than 1. Therefore, as per Annex 10A.2, 2019 Refinement to the 2006 IPCC Guidelines, the climate zone of the project site can be determined to "Warm temperature moist", and the value of 73% is applied. Therefore, MCFj value of 68.62% will be applied. |
| Purpose of Data | Used in project emission/baseline calculations |
| Comments | *N/A* |

| | |
|---|---|
| Data / Parameter | $MS\%_{Bl,j}$ |
| Data unit | Fraction |
| Description | Fraction of manure handled in system j in the baseline. |
| Source of data | Project 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 | 2019 Refinement to the 2006 IPCC Guidelines table 10A.5, chapter 10, volume 4 |
| Value applied | $W_{default}$ (Market swine) = 56 kg<br>$W_{default}$ (Breeding swine) = 160 kg |
| Justification of choice of data or description of measurement methods and procedures applied | The values in 2019 Refinement to the 2006 IPCC Guidelines and US-EPA are compared and the lower value from 2019 Refinement to the 2006 IPCC Guidelines is applied. |
| Purpose of Data | Calculation of baseline emissions |
| Comments | *N/A* |

| | |
|---|---|
| Data / Parameter | $VS_{default}$ |
| Data unit | kg-dm/animal/day |
| Description | Default value for the volatile solid excretion per day on a dry-matter basis for a defined livestock population. |
| Source of data | Calculated according to the default value in table 10.13A and 10A.5, chapter 10, volume 4, 2019 Refinement to the 2006 IPCC Guidelines |
| Value applied | $VS_{default}$ (Market swine) = 0.2856<br>$VS_{default}$ (Breeding swine) = 0.368 |
| Justification of choice of data or description of | The values in 2019 Refinement to the 2006 IPCC Guidelines and US-EPA are compared and the lower value from 2019 Refinement to the 2006 IPCC Guidelines is applied. |

| | |
|---|---|
| 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: <br> $NEX_{IPCC\ default} = N_{rate(T)} * TAM/1000*365$ |
| Value applied | $NEX_{IPCC\ default}$ (Market swine) = 12.88 <br> $NEX_{IPCC\ default}$ (Breeding swine) = 18.69 |
| Justification of choice of data or description of measurement methods and procedures applied | $NEX_{IPCC\ default}$ is calculated as equation 10.30 in 2019 Refinement to the 2006 IPCC Guidelines, $N_{rate(T)}$) and TAM are default value from 2019 Refinement to the 2006 IPCC Guidelines. |
| 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 | 2019 Refinement to the 2006 IPCC Guidelines table 10.19, chapter 10, volume 4 |
| Value applied | $N_{rate(T)}$ (Market swine)=0.63 <br> $N_{rate(T)}$ (Breeding swine)= 0.32 |
| Justification of choice of data or description of measurement methods and procedures applied | Default value from 2019 Refinement to the 2006 IPCC Guidelines is applied |
| Purpose of Data | $NEX_{IPCC\ default}$ calculations |

| | |
|---|---|
| Comments | *N/A* |

| | |
|---|---|
| Data / Parameter | TAM |
| Data unit | Kg animal $^{-1}$ |
| Description | typical animal mass for livestock category |
| Source of data | 2019 Refinement to the 2006 IPCC Guidelines table 10A.5, chapter 10, volume 4 |
| Value applied | TAM (Market swine) =56<br>TAM (Breeding swine) =160 |
| Justification of choice of data or description of measurement methods and procedures applied | Default value from 2019 Refinement to the 2006 IPCC Guidelines is applied |
| Purpose of Data | $NEX_{IPCC\ default}$ calculations |
| Comments | *N/A* |

| | |
|---|---|
| Data / Parameter | $F_{gas\ MS,j,LT}$ |
| Data unit | Fraction |
| Description | Default values for nitrogen loss due to volatilisation of NH3 and NOX from manure management |
| Source of data | 2019 Refinement to the 2006 IPCC Guidelines table 10.22, chapter 10, volume 4 |
| Value applied | $F_{gasMS,j,LT,}$ (Uncovered anaerobic lagoon) : 40%<br>$F_{gasMS,j,LT}$ , (Anaerobic digester) : 50%<br>$F_{gasMS,j,LT,}$ (Composting - In Vessel) : 60% |
| 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 | 2019 Refinement to the 2006 IPCC Guidelines table 10.21, chapter 10, volume 4 |
| Value applied | $EF_{N20, D}$=0 for Uncovered anaerobic lagoon,<br>$EF_{N20, D}$=0.0006 for Anaerobic Digester<br>$EF_{N20,D,j}$=0.006 for Composting – In Vessel |
| Justification of choice of data or description of measurement methods and procedures applied | Site specific data is unavailable therefore default values are opted for. |
| Purpose of Data | Used in project/baseline emission calculations |
| Comments | *N/A* |

| | |
|---|---|
| Data / Parameter | $EF_{N20,ID,j}$ |
| Data unit | kg$N_2O$-N/kg $NH_3$-N and $NO_X$-N |
| Description | Indirect N20 emission factor for the treatment system j of the manure management system |
| Source of data | 2019 Refinement to the 2006 IPCC Guidelines table 11.3, chapter 11, volume 4 |
| Value applied | 0.014 |
| 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 | Tool 14:" Project and leakage emissions from anaerobic digesters (version 02.0)" |
| Value applied | 0.05 |
| Justification of choice of data or description of measurement methods and procedures applied | UASB type digester[45], floating gas holders with no external water seal |
| Purpose of Data | Calculation of project emissions |
| Comments | $PE_{CH4,y}$ for ex ante estimation adopted equation(4) of Methodological tool " Project and leakage emissions from anaerobic digesters", the amount of biogas collected at the digester will be monitored in section 7.1 of JPM. |

| | |
|---|---|
| Data / Parameter | $R_{VS,n}$ |
| Data unit | Fraction |
| Description | Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated |
| Source of data | Refer to Annex 1 of methodology ACM0010 (version 08.0) and PER. |
| Value applied | $R_{VS,n}$, anaerobic digester [46]: 20%, 80% leakage $CH_4$ emission released during project activity<br><br>$R_{VS,n}$, uncovered anaerobic lagoon [47]: 85% for leakage $CH_4$ emission released during baseline scenario |

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

[46] For project, Before the treated manure is applied to the land, it undergoes two stages of pre-treatment and an anaerobic treatment technology, the pre-treatment belong to "underfloor pit storage" in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{VS,n}$ is 20% which is the most conservative value. The anaerobic treatment technology is UASB that belongs to "Open Top Tank" in the Appendix 1 of applied methodology ACM0010 (version 08.0), but the $R_{VS}$ value of this type is not available. Based on the technical process description in the Project evaluation report, the UASB design parameters were used, so the $R_{N,n}$ is 80% which is the most conservative value.

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

| | |
|---|---|
| Justification of choice of data or description of measurement methods and procedures applied | Estimated from Table provided in Annex 1 of ACM0010 (version 08.0) and PER. The most conservative value for the given technology must be used. |
| Purpose of Data | project emission/ leakage calculation |
| Comments | The most conservative value for the given technology must be used |

| | |
|---|---|
| Data / Parameter | $R_{N,n}$ |
| Data unit | Fraction |
| Description | Nitrogen reduction factor |
| Source of data | Refer to Annex 1 of methodology ACM0010 |
| Value applied | $R_{N,n}$, anaerobic digester: 5%, 25% [48] for leakage $N_2O$ emission released during project activity<br><br>$R_{N,n}$, uncovered anaerobic lagoon: 80%[49] for leakage $N_2O$ emission released during baseline scenario |
| Justification of choice of data or description of measurement methods and procedures applied | Estimated from Table provided in Annex 1 of ACM0010 (version 08.0). The most conservative value for the given technology must be used. |
| Purpose of Data | project emission/ leakage calculation |
| Comments | The most conservative value for the given technology must be used |

| | |
|---|---|
| Data / Parameter | $EF_1$, $EF_4$, $EF_5$ |
| 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 |

[48] For project, Before the treated manure is applied to the land, it undergoes two stages of pre-treatment and the an anaerobic-aerobic combined treatment technology, the pre-treatment belong to “underfloor pit storage” in the Appendix 1 of applied methodology ACM0010 (version 08.0), so, the $R_{N,n}$ is 5% which is the most conservative value. The anaerobic treatment technology is UASB that belongs to “Open Top Tank” in the Appendix 1 of applied methodology ACM0010 (version 08.0), so the $R_{N,n}$ is 25% which is the most conservative value.

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

| | |
|---|---|
| Source of data | 2019 Refinement to the 2006 IPCC 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 | $EF_1$=0.006<br>$EF_4$=0.01<br>$EF_5$=0.011 |
| Justification of choice of data or description of measurement methods and procedures applied | Site specific data is unavailable therefore default values are opted for. |
| Purpose of Data | Calculation of leakage emission |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $F_{gasm}$ |
| Data unit | Fraction |
| Description | Fraction of N lost due to volatilization |
| Source of data | Default values from table 11.3, chapter 11, volume 4 of 2019 Refinement to the 2006 IPCC Guidelines |
| Value applied | 0.21 |
| Justification of choice of data or description of measurement methods and procedures applied | Site specific data is unavailable therefore default values are opted for. |
| Purpose of Data | Used in project/baseline emission calculations |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $F_{leach}$ |
| Data unit | Fraction |
| Description | Fraction of all N added to/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 2019 Refinement to the 2006 IPCC Guidelines |
| Value applied | 0.24 |
| Justification of choice of data or description of measurement methods and procedures applied | Site specific data is unavailable therefore default values are opted for. |
| Purpose of Data | 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 | The electricity for the project comes from NCPG. Emission factor for electricity generation published by Ministry of Ecology and Environment of China, which is the DNA of China[50] |
| Value applied | 0.7119[51] |

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

| | |
|---|---|
| Justification of choice of data or description of measurement methods and procedures applied | According to 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 | $Pa.m^3/kmol.K$ |
| 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 | $MM_i$ |
| Data unit | kg/kmol |
| Description | Molecular mass of greenhouse gas i |
| Source of data | / |
| Value applied | 16.04 kg/mol for methane |
| Justification of choice of data or description of measurement methods and procedures applied | / |
| Purpose of Data | Calculation of project emission |
| Comments | N/A |

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

## 6.2 Data and Parameters Monitored

| Data / Parameter | $N_{AA,LT}$ |
|---|---|
| Data unit | Number |
| Description | Daily stock of animals in the farm, discounting dead and discarded animals |
| Source of data | Project proponents |
| Description of measurement methods and procedures to be applied | Each swine involved in this project has a unique electronic ear tag when was born, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag will be connected to the Data Collection System (DCS), which can store and read information. The technicians in farm monitor and record the number of market swine and breeding swine in “Swine daily stock record” through the auto tracking devices of electronic ear tag daily, of which new imported animals are included and dead and discharge animals are excluded. The annual average number of animals ($N_{AA,LT}$) is calculated as an average of the daily stock of market and breeding |

| | |
|---|---|
| | swine in the farm without considering dead animals and discarded animals. |
| **Frequency of monitoring/recording** | daily |
| **Value applied** | 144,000 heads of market swine and 13,650 heads of breeding swine are used to ex-estimated. And this value is sourced from Project evaluation report, which is the design scale of swine farm, and it is also the maximum population of swine in the swine farm. |
| **Monitoring equipment** | N/A |
| **QA/QC procedures to be applied** | Archive electronically during project plus 5 years. |
| **Purpose of data** | Used for the calculation of $N_{LT}$ of market swine and breeding swine, which used in the calculation of the baseline emission, Project emission and leakages emission. |
| **Calculation method** | N/A |
| **Comments** | The project proponents monitor the population of market swine and breeding swine through the auto tracking device, which is connected to the Data Collection System (DCS). Therefore, the data of $N_{AA,LT}$ can be obtained through DCS. |

| | |
|---|---|
| **Data / Parameter** | $W_{site}$ |
| **Data unit** | kg |
| **Description** | Average animal weight of a defined livestock population at the project site |
| **Source of data** | Project proponents |
| **Description of measurement methods and procedures to be applied** | Measured by the weight measurer |
| **Frequency of monitoring/recording** | monthly |
| **Value applied** | 85.5kg for market swine and 95.5kg for breeding swine |
| **Monitoring equipment** | Weight measurer |
| **QA/QC procedures to be applied** | This parameter is used in equation 4 for estimating $VS_{LT,y}$ using option 3, and in equation 2 (appendix 2) for estimating $NEX_{LT,y}$ when using 2019 Refinement to the 2006 IPCC Guidelines default |

| | |
|---|---|
| | values . Sampling procedures can be used to estimate this variable, taking into account the following guidance:<br>(a) To ensure representativeness, each defined livestock population should be classified into a minimum of three age categories;<br>(b) For each defined livestock population, a minimum of one monthly sample per age category should be taken;<br>(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;<br>(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.<br>The weight measurer will be calibrated annually to ensure the reliability of the parameter. |
| Purpose of data | Used for estimating $VS_{LT,y}$ and $NEX_{LT,y}$ |
| Calculation method | N/A |
| Comments | Sampling procedures and method is described in Section 6.3 of JPM. |

| | |
|---|---|
| Data / Parameter | $n_{dy}$ |
| Data unit | number |
| Description | Number of days treatment plant was operational in year y. |
| Source of data | Project proponents |
| Description of measurement methods and procedures to be applied | The number of days treatment plant was operational will be recorded manually by the responsible staff. |
| Frequency of monitoring/recording | daily |
| Value applied | 365 days for ex-ante estimation. The actual number of days 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 | Production record from the DCS system can be demonstrated that the AWMS is actually running on a daily basis. |
| Purpose of data | Calculation of Baseline emissions |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $F_{Aer}$ |
| Data unit | Fraction |
| Description | Fraction of volatile solids directed to aerobic treatment |
| Source of data | Project evaluation report |
| Description of measurement methods and procedures to be applied | the maximum value will be applied during the monitoring period due to not monitored in operation period. |
| Frequency of monitoring/recording | Annually |
| Value applied | 100% for ex ante estimation, which sourced from Project evaluation report. As this parameter is not monitored in the actual operation. So, in the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is 100%. |
| Monitoring equipment | N/A |
| QA/QC procedures to be applied | the value of this parameter in the emission reduction calculation is 100%, which is conservative. |
| Purpose of data | Calculation of project emission |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $V_f$[52] |

[52] 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 unit | $m^3$ |
| Description | Biogas flow |
| Source of data | Project proponents |
| Description of measurement methods and procedures to be applied | Measured by the Electronic flowmeter. |
| Frequency of monitoring/recording | Continuously monitored by flow meters and reported cumulatively on a weekly basis |
| Value applied | In pre-calculation, 1,450*$10^4$ $m^3$ of biogas can be generated by the project annually, which is sourced from the Project evaluation report. |
| Monitoring equipment | Electronic flowmeter |
| QA/QC procedures to be applied | The calibration of flow meters, including the frequency of calibration, should be done in accordance with national standards or requirements. |
| Purpose of data | Calculation of project emissions and leakage |
| Calculation method | N/A |
| Comments | The biogas flow will be measured at four points. But if the project participants can demonstrate that leakage in distribution pipeline is zero, it need be measured at any three points. The biogas flow to electricity or heat equipment in a moment can be considered destroyed, by monitoring that the equipment was working at this time. For this project, all the biogas produced will be used for heat generation, therefore the biogas produced from the anaerobic digestion and the amount of biogas used for heat generation will be monitored through electronic flowmeter. The amount of biogas flared will also be monitored (if any). |

| | |
|---|---|
| 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 one electricity meter |

| | |
|---|---|
| Description of measurement methods and procedures to be applied | Use electricity meter installed at the electricity consumption sources. |
| Frequency of monitoring/recording | Continuous measurement and at least monthly recording |
| Value applied | 4,800 MWh for ex-ante estimation, which is the source from Project evaluation report. During the monitoring period, if the electricity consumption is sourced from the grid company, then the value will be determined as per the electricity meter monitoring and Cross-check with the grid statement. |
| Monitoring equipment | Electricity meter |
| QA/QC procedures to be applied | The value will be cross-check with the Electricity Statement issued by NCPG. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements. |
| Purpose of data | Calculation of project emissions |
| Calculation method | N/A |
| Comments | N/A |

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

| | |
|---|---|
| QA/QC procedures to be applied | Default value of 20% is applied, which is the maximum value as per Methodology tool 05 Version 03.0 and conservative |
| Purpose of data | Calculation of project emission |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $V_{t,db}$ |
| Data unit | $m^3$ dry gas/h |
| Description | Volumetric flow of the gaseous stream in time interval t on a dry basis |
| Source of data | Electronic flowmeter |
| Description of measurement methods and procedures to be applied | Monitored continuously, record hourly and saved automatically in the Data Collection System (DCS). The data can be obtained from this system and the monthly data was exported by the staff at the beginning of next month. The daily biogas flow is equal to the cumulative value of 24 hours, and monthly biogas flow can be accumulated on daily basis |
| Frequency of monitoring/recording | Continuous measurement |
| Value applied | Biogas were estimated according to the amount of manure for Ex ante estimation. Total 1,450*$10^4 m^3$ of biogas is expected to be generated by the project annually, which sourced from project evaluation report |
| Monitoring equipment | Electronic flowmeter |
| 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 analyzer |
| Description of measurement methods and procedures to be applied | Measured continuously and record hourly by online gas analyzer installed at the outlet of the anaerobic digester and saved automatically in the DCS (Data Collection System)<br>The data can be obtained from this system and the monthly data was exported by the staff at the beginning of next. Daily and monthly $CH_4$ concentration was calculated based on the 24-hour average and daily average $CH_4$ concentration |
| 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 analyzer. |
| Monitoring equipment | Gas analyzer |
| QA/QC procedures to be applied | Calibration should include zero verification with an inert gas (e.g., $N_2$) and at least one reading verification with a standard gas (single calibration gas or mixture calibration gas). All calibration gases must have a certificate provided by the manufacturer and must be under their validity period. |
| Purpose of data | Calculation of project emissions |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $T_t$ |
| Data unit | K |
| Description | Temperature of the gaseous stream in time interval t |
| Source of data | Measured by Electronic flowmeter |
| Description of measurement methods and procedures to be applied | Measured continuously by the biogas flow meters, since the flowmeters can monitor other parameter such as $V_{t,db}$, $T_t$ and $P_t$ simultaneously. And record hourly and saved automatically in the DCS system. |

| | |
|---|---|
| Frequency of monitoring/recording | Continuous measurement and the data can be obtained from this system and the monthly data was exported by the staff at the beginning of next month and then recorded in monthly operation report. Daily and monthly temperature was calculated based on the 24-hour average and daily average temperature. |
| Value applied | 288.15 K was used in 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 is monitored by the recordable electronic signal. The temperature Tt(K) is calculated as the equation T(K)=t(°C) +273.15.. |
| Monitoring equipment | Electronic flowmeter |
| QA/QC procedures to be applied | Periodic calibration against a primary device provided by an independent accredited laboratory is mandatory. 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 Electronic flowmeter |
| Description of measurement methods and procedures to be applied | Measured continuously by the biogas flow meters since the flowmeters can monitor other parameter such as $V_{t,db}$, $T_t$ and $P_t$ simultaneously. And record hourly and saved automatically in the DCS system. |
| Frequency of monitoring/recording | Continuous measurement and the data can be obtained from this system and the monthly data was exported by the staff at the beginning of next month and then recorded in monthly operation report. Daily and monthly temperature was calculated based on the 24-hour average and daily average temperature. |

| | |
|---|---|
| Value applied | 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 | Electronic flowmeter |
| 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 | Pressure and temperature are measured continuously by the electronic flow meter |
| Value applied | 0.67 kg/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 | Calculated value according to the pressure and temperature |

| | |
|---|---|
| Purpose of data | Calculation of project emissions |
| Calculation method | Calculation as Equation 19 and Equation 24 |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $MS\%_j$ |
| Data unit | Fraction |
| Description | Fraction of manure handled in system j in project activity |
| Source of data | Project proponents |
| Description of measurement methods and procedures to be applied | All the manure flew into AWMS to be treated; no any manure will be discharged outside. Therefore, the value of this parameter is 100% or total $MS\%_j$ in different treatment system is 100%. |
| Frequency of monitoring/recording | Annually |
| Value applied | 100% for ex-estimated. As this parameter is not monitored in the actual operation. so, in the monitoring period, to be conservative, the value of this parameter in the emission reduction calculation is 100%. |
| Monitoring equipment | N/A |
| QA/QC procedures to be applied | 100% is the maximum value and conservative. |
| Purpose of data | Calculation of project emissions |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $B_{0,LT}$ |
| Data unit | $m^3CH_4$/kg -dm |
| Description | Maximum methane producing potential of the volatile solid generated by animal type LT |
| Source of data | 2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4 |

| | |
|---|---|
| Description of measurement methods and procedures to be applied | $B_{0,LT}$ can be measured as per ISO 11734:1995. As this parameter is not monitored in the actual operation. so, in the monitoring period 0.45 $m^3CH_4/kg$ -dm is still applied. While the actual methane producing potential of the volatile solid generated by swine manure is 479.4ml/g VS according to the public literature[53],which is higher. Therefore 0.45 $m^3CH_4/kg$ -dm applied in monitoring period is conservative. |
| Frequency of monitoring/recording | Annually |
| Value applied | $B_{0, LT}$ (Market swine) =0.45[54]<br><br>$B_{0, LT}$ (Breeding swine) =0.45 |
| Monitoring equipment | N/A |
| QA/QC procedures to be applied | The value is taken from 2019 Refinement to the 2006 IPCC Guidelines table 10.16, chapter 10, volume 4. The parameter value should be updated on latest available IPCC. |
| Purpose of Data | Used in project emission/baseline calculations |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | $NEX_{LT,y}$ |
| Data unit | kg N/animal/year |
| Description | Annual average nitrogen excretion per head of a defined livestock population estimated as described in Appendix 2 |
| Source of data | Calculated as the equation below:<br><br>$NEX_{LT,y} = \frac{W_{site}}{W_{default}} * NEX_{IPCC\ default}$<br><br>While, $NEX_{IPCC\ default}$ calculated as equation 30 of the 2019 Refinement to the 2006 IPCC Guidelines, volume 4, chapter 10<br><br>$NEX_{IPCC\ default} = N_{rate(T)} * TAM/1000*365$ |
| Description of measurement methods | $W_{default}$, $N_{rate(T)}$ and TAM are default value from 2019 Refinement to the 2006 IPCC Guidelines. |

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

[54] The proposed project is located in Shandong Province, China, Asia. According to Table 10.16 of 2019 Refinement to the 2006 IPCC Guidelines volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for high productivity system in Asia region is 0.45 $m^3$ $CH_4/kg$ VS.

| | |
|---|---|
| and procedures to be applied | The measurement methods and procedures for $W_{site}$, please refer to the monitoring parameter $W_{site}$ |
| Frequency of monitoring/recording | Annually |
| Value applied | $NEX_{LT,y}$(Market swine) =19.66<br><br>$NEX_{LT,y}$ (Breeding swine) =11.15 |
| Monitoring equipment | N/A |
| QA/QC procedures to be applied | The parameter is calculated as the equation in "Source of Data" from methodology ACM0010 Version 08 and the value of other parameter applied in the equation is taken from published sources (2019 Refinement to the 2006 IPCC Guidelines). The value should be updated on latest available IPCC.<br><br>QA/QC procedure for $W_{site}$, please refer to the monitoring parameter $W_{site}$ |
| Purpose of Data | Used in project emission/baseline calculations |
| Calculation method | Calculated as the equation of option 2 in Appendix 2. |
| Comments | N/A |

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

| | |
|---|---|
| Purpose of Data | Confirm whether the implementation of project as design |
| Calculation method | N/A |
| Comments | N/A |

| | |
|---|---|
| Data / Parameter | T |
| Data unit | °C |
| Description | Annual average ambient temperature at project site |
| Source of data | Official public information |
| Description of measurement methods and procedures to be applied | The data published by Official public information can prove that the annual average ambient temperature at project site. |
| Frequency of monitoring/recording | monthly |
| Value applied | 13.2 °C for ex-ante estimated |
| Monitoring equipment | N/A |
| QA/QC procedures to be applied | The actual Annual average ambient temperature at project site from Official public information during this monitoring period will be compared with the value of ex-ante estimated, i.e., 13.2°C. In the monitoring period, to be conservative, corresponding $MCF_j$ with lower annual average ambient temperature as per Appendix 3 of ACM0010 (Version08.0) will be used for calculation after comparing the actual value and the value of ex-ante estimated. |
| Purpose of Data | Used to determine the climate zones of the project site and then select the annual $MCF_j$ from 2019 Refinement to the 2006 IPCC Guidelines |
| Calculation method | *N/A* |
| Comments | N/A |

## 6.3 Monitoring Plan

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

(1) Monitoring Process

**Monitoring Framework**

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.

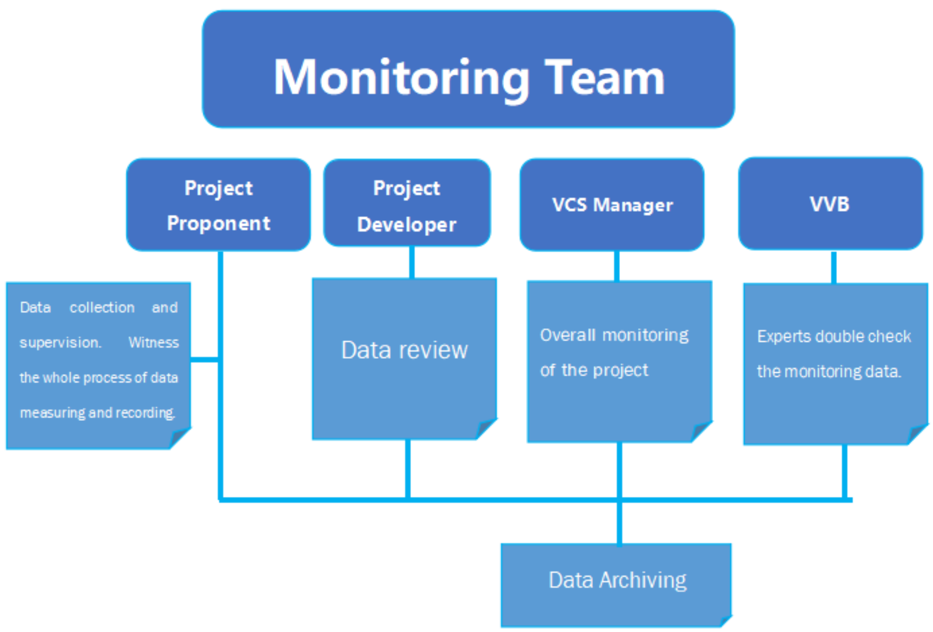


Figure 6-1 The Monitoring Team of the Project

**Monitoring Equipment and Installation**

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

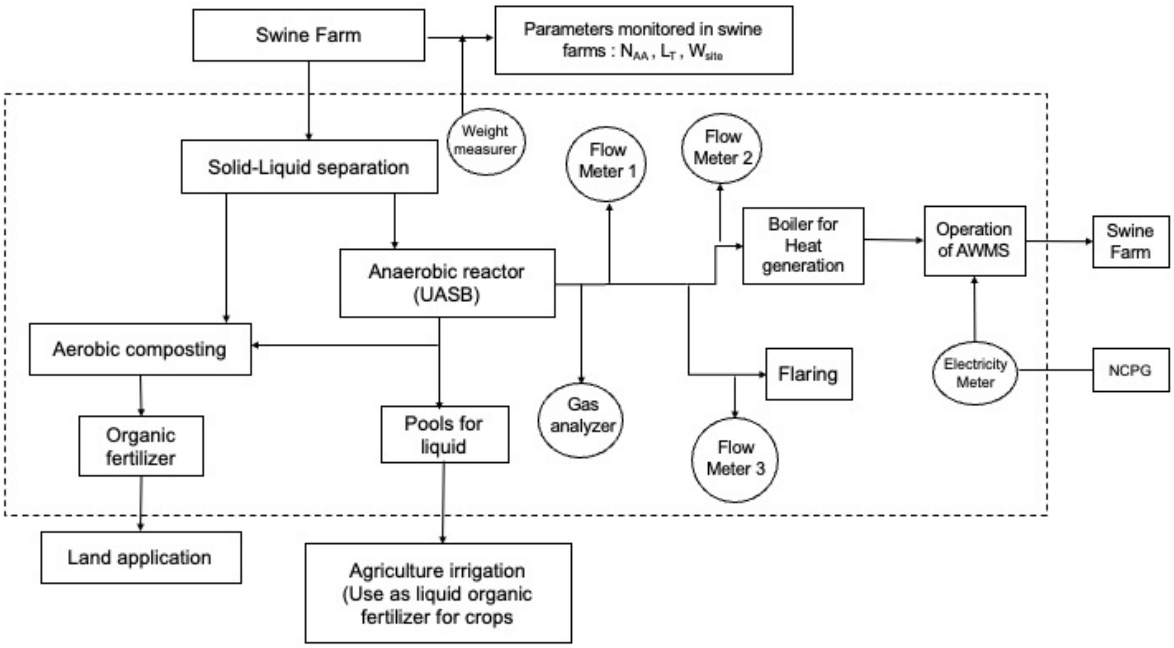


**Figure 6-2 Installation and Configuration of Meters (Same monitoring system for this farm)**

### Principle of Monitoring

All data from the swine farm should be monitored and mentioned. The relevant monitoring instruments shall be carried out in accordance with industry requirements and manufacturer specifications, among which will be calibrated periodically as required. During the crediting period, if any changes or additions happened on the monitoring tools, a record should carry out in the monitoring report transparently, following the procedure for post registration changes.

### Monitored Parameters

As per methodology, the monitoring parameters includes parameters for baseline emission, project emissions and leakage calculations. All provisions in the methodology and relevant tools shall apply, as described for each parameter in Section 6.2. In this project, the parameters that should be monitored are concluded as follows:

| Item | Parameter to be monitored | Method to monitor/record |
|---|---|---|
| a | Daily stock of breeding swine and market swine in the farm, discounting dead and discarded animals, $N_{AA,LT}$ | Each swine involved in this project has a unique electronic ear tag when was born, which is an electronic device dedicated to the identification and electronic management of animals. This electronic ear tag will be connected to the Data Collection System (DCS), which can store and read information. The technicians in farm monitor and record the number of market swine and breeding |

| | | |
|---|---|---|
| | | swine in "Swine daily stock record" through the auto tracking devices of electronic ear tag daily, of which new imported animals are included and dead and discharge animals are excluded. The annual average number of animals ($N_{AA,LT}$) is calculated as an average of the daily stock of market and breeding swine in the farm without considering dead animals and discarded animals. |
| b | Average animal weight of a defined livestock population at the project site, $W_{site}$ | 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 2019 Refinement to the 2006 IPCC Guidelines default values. Sampling procedures can be used to estimate this variable, taking into account the following guidance:<br>(a) To ensure representativeness, each defined livestock population should be classified into a minimum of three age categories;<br>(b) For each defined livestock population, a minimum of one monthly sample per age category should be taken;<br>(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;<br>(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. |
| c | Number of days treatment plant was operational in year y, $n_{dy}$ | Monitored by PP and sourced from data logged in each of the manure treatment plant. |
| d | Quantity of electricity consumed by the proposed project in year y, $EC_{PJ,j,y}$ | Measured continuously by the electricity meter installed in project site in the farm and recorded daily by the staff. The grid statement issued by the NCPG can be cross-checked. |
| e | Average technical transmission and distribution losses for providing electricity to source j in year y, $TDL_{j,y}$ | Sourced from tool 05" Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation (version 03.0)". This value will be renewed once the tool is updated. |
| f | Biogas flow, $V_f$ | Continuously measurement by the electronic biogas flowmeters (biogas flowmeter 1 installed at the outlet of the anaerobic digestion, biogas flowmeter 2 installed at the inlet of boiler and biogas |

| | | |
|---|---|---|
| | | flowmeter 3 installed in the inlet of flare and record hourly and saved automatically in DCS system. |
| g | Volumetric flow of the gaseous stream in time interval t on a dry basis, $V_{t,db}$ | Measured by the same electronic biogas flowmeters that monitor parameter $V_f$, which can record hourly and saved automatically in the DCS system since the flowmeters can monitor other parameter such as $V_{t,db}$, $T_t$ and $P_t$ simultaneously. |
| h | Volumetric fraction of greenhouse gas i in a time interval t on a dry basis, m³ gas i/m³ dry gas, $V_{i,t,db}$ | Continuously measurement and record hourly by online gas analyser installed at the outlet of the anaerobic digester and saved automatically in the DCS system. |
| i | Temperature of the gaseous stream in time interval t, $T_t$ | Measured by the same electronic biogas flowmeters that monitor parameter $V_f$, which can record hourly and saved automatically in the DCS system since the flowmeters can monitor other parameter such as $V_{t,db}$, $T_{tj}$and $P_t$ simultaneously. |
| j | Pressure of the gaseous stream in time interval t, $P_t$ | Measured by the same electronic biogas flowmeters that monitor parameter $V_f$, which can record hourly and saved automatically in the DCS system since the flowmeters can monitor other parameter such as $V_{t,db}$, $T_t$ and $P_t$ simultaneously. |
| k | Density of greenhouse gas i in the gaseous stream in time interval t, $\rho_{i,t}$ | Calculated based on the temperature and pressure of the gaseous stream in time interval t. the monitor of the temperature and pressure of the gaseous stream, please refer the description of the above two parameters. |
| l | Fraction of volatile solids directed to aerobic treatment, $F_{Aer}$ | According to the methodology, $F_{Aer}$ should be monitored annually. 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 still 100%. |
| m | Fraction of manure handled in system j in project activity, $MS\%_j$ | According to the methodology, $MS\%_j$ should be monitored annually. However, there is no equip installed in the project activity to monitor. Therefore, to be conservative, the value of this parameter in the emission reduction calculation is 100%. |
| n | Maximum methane producing potential of the volatile solid generated by animal type LT, $B_{0,\,LT}$ | Not monitored during this monitoring period since the value is taken from 2019 Refinement to the 2006 IPCC Guidelines, which is a published source. The parameter value will be updated on latest available public data source. |

| | | |
|---|---|---|
| o | Type of barn and AWMS, Type | The swine barn and AWMS layout and configuration are collected, which can be prove the Type of barn and AWMS, and only changes in the type of barn and AWMS will be reported after the first verification. |
| p | Annual average ambient temperature at project site, T | The data can be sourced from Official public information. During the monitoring period, corresponding $MCF_j$ with lower annual average ambient temperature as per Appendix 3 of ACM0010 (Version08.0) will be used for calculation after comparing the actual value and the value of ex-ante estimated. |
| q | Annual average nitrogen excretion per head of a defined livestock population estimated as described in Appendix 2, $NEX_{LT,y}$ | The parameter is calculated as the equation of option 2 in Appendix 2 of methodology ACM0010 Version 08.0 and the value of other parameter applied in the equation is taken from 2019 Refinement to the 2006 IPCC Guidelines, which is a published source. The parameter value will be updated on latest available public data source. While for parameter $W_{site}$, it is monitored during this monitoring period, please refer to monitoring parameter $W_{site}$. |

**(2) Quality control and quality assurance procedures**

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

**Training**

Necessary training on AWMS provided by the project proponent shall be taken in all members involved in the project. In addition, the project proponent ensured that only employees with skills and experience can be allowed to do the monitoring job. The training also shall take account of both general condition and technical side of the project, as well as the basic understandings of VCS Standard and climate change.

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

**Corrective actions**

The project will sign an agreement that it will not participate in other environment credits, other GHG programs and has not been rejected by any other GHG Programs. The whole VCS monitoring team will follow recognized standard data evaluation methods to guarantee that the data is reliable and accurate. The quality control and quality assurance procedures include the handling and correction of nonconformities in the implementation of the project or the monitoring plan. In case such nonconformities are observed:

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

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

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

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

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

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

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

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

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

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

(3) Sample Plan

**Sample Target**

The average weight of a defined livestock population ($W_{site}$) at the project site during the crediting period is determined by a 95/10 confidence/precision.

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

| Parameter | $W_{site}$ |
|---|---|
| Target and reliability requirements | The average weight of a defined livestock population ($W_{site}$) at the project site during the crediting period is determined by a 95/10 confidence/precision.<br>According to the “Sampling and surveys for CDM project activities and programmes of activities (Version 09.0)”, PP shall use 95/10 confidence/precision as the criteria for the reliability of sampling efforts for large-scale project. According to the methodology” ACM0010” GHG emission reductions from manure management systems (Version 08.0)”, each defined livestock population should be classified into a minimum of three age categories; The three age categories of marketing swine are classified according to the age in days, i.e. Nursery phase with 30-60 days, Growing phase with 60-130 days and Mature phase with 130-180 days. The three age categories of breeding swine are classified according to the age in days, i.e. Nursery phase with 30-70 days, Growing phase with 70-220 days and Mature phase with 220-310days. For each defined livestock population, a minimum of one monthly sample per age category should be taken. In this project, the monitoring activities of the average animal weight of a defined livestock population at the project site is conducted in the three age groups of Nursery phase, Growing phase and Mature phase in each swine farm at least one monthly. |
| Target population and sampling frame | For the ex-calculation, A total of 144,000 Market swine and 13,650 Breeding swine included in this project and the data of the average animal weight of a defined livestock population at the project site is from the Project evaluation report. As the applied value of 144,000 Market swine and 13,650 Breeding swine is the design |

| | |
|---|---|
| | scale, during the monitoring periods, the actual breeding scale of the farm is not exceeding the design value, so the sample size calculated from the design values can be used in the monitoring period and it is conservative. |
| Sampling method | For this project, the swine farm have breeding swine and market swine in stock.<br>As this project involved one swine farm and 2 types of swine i.e., Market swine and Breeding swine, and as per applied methodology, each defined livestock population should be classified into a minimum of three age categories, so the sampling method is Stratified random sampling. The specific sampling methods are as follows:<br>For the sampling, PP should calculate the overall sample size based on the population of swine in stock firstly. As the project involved one swine farm, so the sample size in this swine farm should be determined based on the proportion of the total number of this farm. Similarly, the sample size of each age group of Market swine and Breeding swine in a farm were also calculated based on the proportion of the number of each age group of Market swine and Breeding swine to the total number of swine in the farm. After the sample size in each age group of Market swine and Breeding swine of this swine farm determined, the sample can be conducted in the swine farm. Since swine in different age are kept in the different barns, samples can be randomly selected from barns of this age group. After the samples are selected, the weight is measured by weight measurers and recorded in the weight record table. |

**Sample Sizes**

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

As per to statistical principles and sampling survey method, the sample size should be determined as follows:

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

$n_2 = n_1N/(N+n_1)$

$n_3 = Bn_2$

$n_4 = n_3/r$

$n = n_4 (110\%)$

Where:

Z the Z-statistic and the value taken is 1.96 (corresponding to 95% confidence level);

σ the standard deviation;

d the maximum error of estimate;

X the mean value of samples;

V the coefficient of variation, V= σ/X≤1 and its maximum value 1 is taken;

e the allowed relative sampling error ("precision") and the value taken is 10%;

N the total number of involved swine 157,650;

B the survey design effect and the value taken is 1 because for stratification sampling the B value is less than or equal to 1;

r the survey replies rate and the value taken is 100%;

110% 10% contingency was added to produce the final sample size;

$n_1$, $n_2$, $n_3$, $n_4$, n the adjusted values after each step with n being the final number of samples to be taken. Actually, $n_4$ is the required number of samples based on calculation, 10% contingency was added to $n_4$ to produce n in this sampling.

For pre-calculation, since the total number of involved swine is 157,650, N in the calculation of sample size is 157,650, and the calculation result is as follows:

| Z | V | e | N | B | r |
|---|---|---|---|---|---|
| 1.96 | 1 | 10% | 157,650 | 1 | 100% |
| $n_1$ | $Z^2V^2/e^2$ | 384 | | | |
| $n_2$ | $n_1N/(N+n_1)$ | 383 | | | |
| $n_3$ | $Bn_2$ | 383 | | | |
| $n_4$ | $n_3/r$ | 383 | | | |
| $n$ | $n_4 (110\%)$ | 422 | | | |

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

As the applied value of 144,000 Market swine and 13,650 Breeding swine is the design scale, during the monitoring periods, the actual breeding scale of the farm is not exceeding the design value, so the sample size calculated from the design values can be used in the monitoring period and it is conservative.

Stratified sampling (with samples of 422) was used for the monitoring of the $W_{site}$. The specific sampling methods are as follows: For the sampling, PP should calculate the overall sample size based on the population of swine in stock firstly. Since this project involves only one swine farm, the sample size of this farm should be determined according to the proportion of the two types of swine contained in this farm to the total number of swine in the farm. Similarly, the sample size of each age group of Market swine and Breeding swine in a farm were also calculated based on the proportion of the number of each age group of Market swine and Breeding swine to the total number of swine in the farm. To be conservative, both the samples number of the farm is adjusted to be integer value. As a result, 426 samples of swine population were selected for the monitoring of the $W_{site}$.

The distribution of the samples in each age category in each farm shows as follow:

| NO. | Swine farm | Swine type | Age catagory | Sample size |
|---|---|---|---|---|
| 1 | Xinhao Swine Farm | Breeding | Nursery phase | 11 |
| | | | Growing phase | 13 |
| | | | Mature phase | 15 |
| | | Market | Nursery phase | 128 |
| | | | Growing phase | 126 |
| | | | Mature phase | 133 |
| Total | | | | 426 |

**Implementation and Monitoring frequency**

The Sampling process started as soon as the target population is determined, and the sampling should be done once a month. The monthly monitoring on samples is conducted in the swine farm every monitoring period.

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

**Procedures for Administering Data Collection and Minimizing Non-sampling Errors**

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

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

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

1) The general principle is that zero value is used for the missing or damaged data. This is most conservative approach. The monitoring personnel are trained before the starting of the project operation to ensure that each team member is fully aware of and able to strictly follow this conservative principle. During the monitoring process, the monitoring personnel are required to

strictly abide by the above conservative principle in data recording, i.e., use zero values for all the missing or damaged data.

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

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

4) If some data recorded are significantly higher than the normal range and inconsistent with normal growth, the monitoring personnel should ask for the reason. If the measurement is high due to the damage of weighing scales or other measurement equipment, zero value is used for that day's data. And need to calibrate and maintain the weighing scale or replace the measuring equipment immediately and avoid this situation in the future.

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

**QA/QC Procedures**

Before implementing the project, the members in monitoring team would be trained to comprehend the direct way of monitoring process. The training was conducted by the project proponent as well.

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

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

# 7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

## 7.1 Data and Parameters Monitored

| Data / Parameter | $N_{AA,LT}$ |
|---|---|
| Data unit | Number |
| Description | Daily stock of animals in the farm, discounting dead and discarded animals |
| Value applied: | Data source: Daily stock record of breeding swine and market swine. |

| Time | $N_{AA,LT}$ (heads of Market swine) | $N_{AA,LT}$ (heads of breeding swine) |
|---|---|---|
| 05-March-2021-31-March-2021 | 130041 | 13639 |
| 01-April-2021-30-April-2021 | 129968 | 13644 |
| 01-May-2021-31-May-2021 | 130003 | 13633 |
| 01-June-2021-30-June-2021 | 129952 | 13650 |
| 01-July-2021-31-July-2021 | 129975 | 13642 |
| 01-August-2021-31-August-2021 | 129988 | 13643 |
| 01-September-2021-30-September-2021 | 129972 | 13636 |
| 01-October-2021-31-October-2021 | 130075 | 13634 |
| 01-November-2021-30-November-2021 | 130006 | 13643 |
| 01-December-2021-31-December-2021 | 130055 | 13642 |
| 01-January-2022-31-January-2022 | 130031 | 13635 |
| 01-February-2022-28-February-2022 | 130038 | 13641 |
| 01-March-2022-31-March-2022 | 130079 | 13631 |
| 01-April-2022-30-April-2022 | 129978 | 13637 |
| 01-May-2022-31-May-2022 | 129979 | 13646 |

| | | | |
|---|---|---|---|
| | 01-June-2022-30-June-2022 | 130074 | 13633 |
| | 05-March-2021-30-June-2022(average) | 130041 | 13650 |
| **Comments** | Monitored daily through the auto tracking devices of electronic ear tag and the data can be obtained from DCS. The technicians in farm record the daily stock number of animals, and this record data including the new imported animal and discounting dead and discharge animals. | | |

| | | | |
|---|---|---|---|
| **Data / Parameter** | $W_{site}$ | | |
| **Data unit** | kg | | |
| **Description** | Average animal weight of a defined livestock population at the project site | | |
| **Value applied:** | Period | Market Swine | Breeding Swine |
| | 05-March-2021-31-March-2021 | 79.20 | 89.40 |
| | 01-April-2021-30-April-2021 | 79.00 | 90.20 |
| | 01-May-2021-31-May-2021 | 78.80 | 89.50 |
| | 01-June-2021-30-June-2021 | 79.10 | 91.90 |
| | 01-July-2021-31-July-2021 | 79.40 | 89.70 |
| | 01-August-2021-31-August-2021 | 78.60 | 91.40 |
| | 01-September-2021-30-September-2021 | 79.10 | 90.20 |
| | 01-October-2021-31-October-2021 | 79.00 | 89.70 |
| | 01-November-2021-30-November-2021 | 79.30 | 90.70 |
| | 01-December-2021-31-December-2021 | 78.80 | 91.60 |
| | 01-January-2022-31-January-2022 | 79.30 | 90.60 |

| | | | |
|---|---|---|---|
| | 01-February-2022-28-February-2022 | 78.70 | 91.50 |
| | 01-March-2022-31-March-2022 | 78.80 | 90.10 |
| | 01-April-2022-30-April-2022 | 79.10 | 91.10 |
| | 01-May-2022-31-May-2022 | 79.00 | 90.20 |
| | 01-June-2022-30-June-2022 | 79.10 | 90.40 |
| **Comments** | Sampling procedures and method is described in Section 6.3 of JPM. Measured by the weight measurers and recorded by the technical staff in each farm monthly. Weight measurers were calibrated on 28-January-2021 and 25-January-2022 by an officially accredited entity in compliance with JJG539-2016 "Verification Regulation of Digital Indicating Weighting Instruments" in China. | | |

| Swine farm | Type | Accuracy | Series number | Calibration date | Validity |
|---|---|---|---|---|---|
| Xinhao Swine Farm | SCS-2t | III level | 202004035 | 28-January-2021 | 1 year |
| | | | 202004037 | 25-January-2022 | |

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

| | |
|---|---|
| **Data / Parameter** | $n_{dy}$ |
| **Data unit** | number |

| | |
|---|---|
| **Description** | Number of days treatment plant was operational in year y. |
| **Value applied:** | (see table below) |

| Time | $n_{dy}$ (days) |
|---|---|
| 05-March-2021-31-March-2021 | 27 |
| 01-April-2021-30-April-2021 | 30 |
| 01-May-2021-31-May-2021 | 31 |
| 01-June-2021-30-June-2021 | 30 |
| 01-July-2021-31-July-2021 | 31 |
| 01-August-2021-31-August-2021 | 31 |
| 01-September-2021-30-September-2021 | 30 |
| 01-October-2021-31-October-2021 | 31 |
| 01-November-2021-30-November-2021 | 30 |
| 01-December-2021-31-December-2021 | 31 |
| 01-January-2022-31-January-2022 | 31 |
| 01-February-2022-28-February-2022 | 28 |
| 01-March-2022-31-March-2022 | 31 |
| 01-April-2022-30-April-2022 | 30 |
| 01-May-2022-31-May-2022 | 31 |
| 01-June-2022-30-June-2022 | 30 |
| **05-March-2021-30-June-2022** | **483** |

The actual number of days treatment plant that was operational are 483 days during this monitoring period.

| | |
|---|---|
| **Comments** | The daily accumulated meter reading of flowmeters installed in the outlet of anaerobic digester can be demonstrated that the AWMS are actually running on a daily basis. |

| | |
|---|---|
| **Data / Parameter** | $V_f$ |
| **Data unit** | $m^3$ |
| **Description** | Biogas flow |
| **Value applied:** | (see table below) |

| period | Vf- at outlet of the anaerobic digestion ($m^3$) | Vf- at the inlet of boiler ($m^3$) | Vf- in inlet of flare system ($m^3$) |
|---|---|---|---|
| 05-March-2021-31-March-2021 | 983827.53 | 975893.51 | 0.00 |

| | | | |
|---|---|---|---|
| 01-April-2021-30-April-2021 | 954123.91 | 953224.33 | 0.00 |
| 01-May-2021-31-May-2021 | 957532.92 | 954823.78 | 0.00 |
| 01-June-2021-30-June-2021 | 979658.14 | 962307.72 | 0.00 |
| 01-July-2021-31-July-2021 | 990760.61 | 984992.56 | 0.00 |
| 01-August-2021-31-August-2021 | 962898.11 | 952022.39 | 0.00 |
| 01-September-2021-30-September-2021 | 956978.54 | 951744.28 | 0.00 |
| 01-October-2021-31-October-2021 | 967750.01 | 955817.79 | 0.00 |
| 01-November-2021-30-November-2021 | 980828.76 | 975328.59 | 0.00 |
| 01-December-2021-31-December-2021 | 979555.83 | 974277.44 | 0.00 |
| 01-January-2022-31-January-2022 | 971875.86 | 953923.27 | 0.00 |
| 01-February-2022-28-February-2022 | 970443.71 | 953965.25 | 0.00 |
| 01-March-2022-31-March-2022 | 967159.94 | 962384.98 | 0.00 |
| 01-April-2022-30-April-2022 | 957849.53 | 951414.96 | 0.00 |
| 01-May-2022-31-May-2022 | 992470.99 | 961694.67 | 0.00 |
| 01-June-2022-30-June-2022 | 996694.01 | 963115.31 | 0.00 |
| **05-March-2021-30-June-2022** | 15,570,408.40 | 15,386,930.83 | **0.00** |

| Comments | Monitored continuously by flowmeter 1 installed at the outlet of the anaerobic digestion, flowmeter 2 installed at the inlet of the boiler and flowmeter 3 installed in inlet of flare. Recorded hourly and saved automatically in the Data Collection System (DCS). The data can be obtained from this system and the monthly data was exported by the staff at the beginning of next month and then recorded in monthly operation report.<br>Flowmeters were calibrated on 26-January-2021 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China.<br>For this monitoring period, all the biogas produced is used for heat generation, no surplus biogas for the flaring system. |
|---|---|

| Swine farm | Type | Accuracy | Series number | Calibration date | Validity |
|---|---|---|---|---|---|
| Xinhao Swine Farm | FCTMF-DN80 | 1.5 level | Flowmeter1: 202006006 | 26-January-2021 | 2 years |
| | | | Flowmeter2: 202006008 | | |
| | | | Flowmeter3: 202006012 | | |

| Data / Parameter | $EC_{PJ,j,y}$ |
|---|---|
| Data unit | MWh |
| Description | Quantity of electricity consumed by the project in year y |
| Value applied: | |

| Period | Electricity supplied by the grid company (MWh) |
|---|---|
| 05-March-2021-31-March-2021 | 315.23 |
| 01-April-2021-30-April-2021 | 313.42 |
| 01-May-2021-31-May-2021 | 320.78 |
| 01-June-2021-30-June-2021 | 312.82 |
| 01-July-2021-31-July-2021 | 320.87 |
| 01-August-2021-31-August-2021 | 310.46 |
| 01-September-2021-30-September-2021 | 321.51 |
| 01-October-2021-31-October-2021 | 316.78 |
| 01-November-2021-30-November-2021 | 310.11 |
| 01-December-2021-31-December-2021 | 324.65 |
| 01-January-2022-31-January-2022 | 314.61 |
| 01-February-2022-28-February-2022 | 322.48 |
| 01-March-2022-31-March-2022 | 326.06 |
| 01-April-2022-30-April-2022 | 311.05 |
| 01-May-2022-31-May-2022 | 318.82 |

| | |
|---|---|
| | 01-June-2022-30-June-2022 \| 319.62<br>**05-March-2021-30-June-2022** \| 5079.3 |
| **Comments** | Monitored continuously by electricity meter installed in the manure treatment plant. The electricity consumption was recorded daily by the staff in electricity daily report and cross-checked with Electricity Statement issued by grid company.<br>Electricity meter were calibrated on 13-January-2021 by an officially accredited entity in compliance with JJG596-2012" Verification Regulation of electrical meters" in China. |

| Swine farm | Type | Accuracy | Series number | Calibration date | Validity |
|---|---|---|---|---|---|
| Xinhao Swine Farm | YPD760E-9SY | 0.5 level | 20201019002 | 13-January-2021 | 5 years |

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

| Data / Parameter | $V_{t,db}$ |
|---|---|
| Data unit | $m^3$ dry gas/h |
| Description | Volumetric flow of the gaseous stream in time interval t on a dry basis |

**Value applied:**

| Period | $V_{t,db}$ ($m^3$ dry gas/h) monitored by flow meter 1 | $V_{t,db}$ ($m^3$ dry gas/h) monitored by flow meter 3 |
|---|---|---|
| 05-March-2021-31-March-2021 | 1518.25 | 0 |
| 01-April-2021-30-April-2021 | 1325.17 | 0 |
| 01-May-2021-31-May-2021 | 1287.01 | 0 |
| 01-June-2021-30-June-2021 | 1360.64 | 0 |
| 01-July-2021-31-July-2021 | 1331.67 | 0 |
| 01-August-2021-31-August-2021 | 1294.22 | 0 |
| 01-September-2021-30-September-2021 | 1329.14 | 0 |
| 01-October-2021-31-October-2021 | 1300.74 | 0 |
| 01-November-2021-30-November-2021 | 1362.26 | 0 |
| 01-December-2021-31-December-2021 | 1316.61 | 0 |
| 01-January-2022-31-January-2022 | 1306.28 | 0 |
| 01-February-2022-28-February-2022 | 1444.11 | 0 |
| 01-March-2022-31-March-2022 | 1299.95 | 0 |
| 01-April-2022-30-April-2022 | 1330.35 | 0 |
| 01-May-2022-31-May-2022 | 1333.97 | 0 |
| 01-June-2022-30-June-2022 | 1384.3 | 0 |

**Comments**

Monitored continuously by flowmeter 1 installed at the outlet of the anaerobic digestion and flowmeter 3 installed in inlet of flare. Recorded hourly and saved automatically in the Data Collection System (DCS). The data can be obtained from this system.
Flowmeters were calibrated on 26-January-2021 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China. For information

| | |
|---|---|
| | about flowmeter, please refer to monitored parameter “$v_f$” for details. |

| | |
|---|---|
| **Data / Parameter** | $V_{i,t,db}$ |
| **Data unit** | $m^3$ gas i/$m^3$ dry gas |
| **Description** | Volumetric fraction of greenhouse gas i in a time interval t on a dry basis |
| **Value applied:** | (see table below) |

| period | Average $V_{i,t,db}$ ($m^3$ gas i/$m^3$ dry gas) |
|---|---|
| 05-March-2021-31-March-2021 | 68.91 |
| 01-April-2021-30-April-2021 | 70.42 |
| 01-May-2021-31-May-2021 | 69.35 |
| 01-June-2021-30-June-2021 | 68.38 |
| 01-July-2021-31-July-2021 | 68.28 |
| 01-August-2021-31-August-2021 | 69.22 |
| 01-September-2021-30- | 69.11 |
| 01-October-2021-31-October-2021 | 70.27 |
| 01-November-2021-30-November- | 68.79 |
| 01-December-2021-31-December- | 69.21 |
| 01-January-2022-31-January-2022 | 70.85 |
| 01-February-2022-28-February- | 70.05 |
| 01-March-2022-31-March-2022 | 70.02 |
| 01-April-2022-30-April-2022 | 70.27 |
| 01-May-2022-31-May-2022 | 70.66 |
| 01-June-2022-30-June-2022 | 68.33 |

| Comments | |
|---|---|
| | Measured continuously and recorded hourly by online gas analyser installed at the outlet of the anaerobic digester and saved automatically in the DCS (Data Collection System). The data can be obtained from this system. Daily and Monthly $CH_4$ concentration was calculated based on the 24-hour average and daily average $CH_4$ concentration.<br><br>The gas analyser was calibrated on 19-January-2021 and 15-January-2022 by an officially accredited entity in compliance with JJG693-2011" Verification Regulation of Alarmer Detectors of Combustible Gas" in China. And the zero verification with an inert gas (N2) and one reading verification with a standard gas (single calibration gas) are implemented in the process of calibration, which is in accordance with JJG693-2011. All calibration gases are from Nanjing Changyuan Industrial Gas Co., Ltd,[55] which is a qualified reference materials manufacturer issued by the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China on 06-Septemner-2017. |

| Swine farm | Type | Accuracy | Series number | Calibration date | Validity |
|---|---|---|---|---|---|
| Xinhao Swine Farm | Gasboard-9060 | ±1% | 2020175 | 19-January-2021<br>15-January-2022 | 1 year |

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

| period | Average Temperature(K) |
|---|---|
| 05-March-2021-31-March-2021 | 308.35 |
| 01-April-2021-30-April-2021 | 308.85 |
| 01-May-2021-31-May-2021 | 308.75 |
| 01-June-2021-30-June-2021 | 308.65 |
| 01-July-2021-31-July-2021 | 309.65 |
| 01-August-2021-31-August-2021 | 309.95 |
| 01-September-2021-30-September-2021 | 309.05 |
| 01-October-2021-31-October-2021 | 309.55 |

[55] http://www.cygyqt.cn

| | | |
|---|---|---|
| | 01-November-2021-30-November-2021 | 309.35 |
| | 01-December-2021-31-December-2021 | 309.25 |
| | 01-January-2022-31-January-2022 | 308.25 |
| | 01-February-2022-28-February-2022 | 309.95 |
| | 01-March-2022-31-March-2022 | 309.45 |
| | 01-April-2022-30-April-2022 | 309.75 |
| | 01-May-2022-31-May-2022 | 309.35 |
| | 01-June-2022-30-June-2022 | 308.55 |
| **Comments** | Measured continuously by the biogas flowmeters, since the flowmeters can monitor other parameter such as $V_{t,db}$, Tt and Pt simultaneously. And recorded hourly and saved automatically in the DCS system. The readout of flowmeter was indicated degrees Celsius (°C). Therefore, the temperature $T_t$(K) is calculated as the equation T(K)=t(°C) +273.15. The data can be obtained from DCS system. Daily and Monthly temperature was calculated based on the 24-hour average and daily average temperature.<br><br>Flowmeters were calibrated on 26-January-2021 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China. For information about flowmeter, please refer to monitored parameter "vf" for details. | |

| | |
|---|---|
| **Data / Parameter** | $P_t$ |
| **Data unit** | Pa |
| **Description** | Pressure of the gaseous stream in time interval t |
| **Value applied:** | |

| period | Average Pressure (Pa) |
|---|---|
| 05-March-2021-31-March-2021 | 101325 |
| 01-April-2021-30-April-2021 | 101325 |
| 01-May-2021-31-May-2021 | 101325 |
| 01-June-2021-30-June-2021 | 101325 |
| 01-July-2021-31-July-2021 | 101325 |
| 01-August-2021-31-August-2021 | 101325 |
| 01-September-2021-30-September-2021 | 101325 |
| 01-October-2021-31-October-2021 | 101325 |
| 01-November-2021-30-November-2021 | 101325 |
| 01-December-2021-31-December-2021 | 101325 |
| 01-January-2022-31-January-2022 | 101325 |
| 01-February-2022-28-February-2022 | 101325 |
| 01-March-2022-31-March-2022 | 101325 |
| 01-April-2022-30-April-2022 | 101325 |
| 01-May-2022-31-May-2022 | 101325 |

| | | |
|---|---|---|
| | 01-June-2022-30-June-2022 | 101325 |

| | |
|---|---|
| Comments | Measured continuously by the biogas flowmeters, since the flowmeters can monitor other parameter such as $V_{t,db}$, Tt and Pt simultaneously. And recorded hourly and saved automatically in the DCS system. Daily and Monthly pressure was calculated based on the 24-hour average and daily average pressure.<br><br>Flowmeters were calibrated on 26-January-2021 by an officially accredited entity in compliance with JJG1029-2007" Verification Regulation of Vortex-shedding Flowmeter" in China. For information about flowmeter, please refer to monitored parameter "vf" for details. |

| | |
|---|---|
| Data / Parameter | $\rho_{i,t}$ |
| Data unit | kg gas i/m³ gas i |
| Description | Density of greenhouse gas i in the gaseous stream in time interval t |
| Value applied: | see table below |
| Comments | Calculated based on temperature of the gaseous stream in time interval t and pressure of the gaseous stream in time interval t using Equations (19) and (24). The monitoring result of Pressure and temperature are listed in the above two tables. |

| period | $\rho_{i,t}$(kg gas i/m³ gas i) |
|---|---|
| 05-March-2021-31-March-2021 | 0.00063 |
| 01-April-2021-30-April-2021 | 0.00063 |
| 01-May-2021-31-May-2021 | 0.00063 |
| 01-June-2021-30-June-2021 | 0.00063 |
| 01-July-2021-31-July-2021 | 0.00063 |
| 01-August-2021-31-August-2021 | 0.00063 |
| 01-September-2021-30-September-2021 | 0.00063 |
| 01-October-2021-31-October-2021 | 0.00063 |
| 01-November-2021-30-November-2021 | 0.00063 |
| 01-December-2021-31-December-2021 | 0.00063 |
| 01-January-2022-31-January-2022 | 0.00063 |
| 01-February-2022-28-February-2022 | 0.00063 |
| 01-March-2022-31-March-2022 | 0.00063 |
| 01-April-2022-30-April-2022 | 0.00063 |
| 01-May-2022-31-May-2022 | 0.00063 |
| 01-June-2022-30-June-2022 | 0.00063 |

| Data / Parameter | $MS\%_j$ |
|---|---|
| Data unit | Fraction |
| Description | Fraction of manure handled in system j in project activity |
| Value applied: | 100%. As this parameter is not monitored during this monitoring period. so, to be conservative, the value of this parameter in the emission reduction calculation is 100% since the treatment process of this project is an anaerobic treatment technology. |
| Comments | All the manure flew into AWMS to be treated; no any manure will be discharged outside. Therefore, the value of this parameter is 100% |

| Data / Parameter | $B_{0,\,LT}$ |
|---|---|
| Data unit | $m^3CH_4$/kg-dm |
| Description | Maximum methane producing potential of the volatile solid generated by animal type *LT* |
| Value applied: | $B_{0,\,LT}$ (Market swine) =0.45[56]<br><br>$B_{0,\,LT}$ (Breeding swine) =0.45 |
| Comments | $B_{0,\,LT}$ can be measured as per ISO 11734:1995. As this parameter is not monitored in the actual operation. so, in the monitoring period 0.45 $m^3CH_4$/kg-dm is still applied. While the actual methane producing potential of the volatile solid generated by swine manure is 479.4ml/gVS according to the public literature[57], which is higher. Therefore 0.45 $m^3CH_4$/kg -dm applied in monitoring period is conservative. |

| Data / Parameter | $NEX_{LT,y}$ |
|---|---|
| Data unit | kg N/animal/year |
| Description | Annual average nitrogen excretion per head of a defined livestock population estimated as described in Appendix 2 |
| Value applied | <table><tr><th>Period</th><th>Market swine</th><th>Breeding swine</th></tr><tr><td>05-March-2021-31-March-2021</td><td>1.35</td><td>0.77</td></tr></table> |

[56] The proposed project is located in Shandong Province, China, Asia. According to Table 10.16 of 2019 Refinement to the 2006 IPCC Guidelines volume 4, chapter10, the maximum methane producing potential($B_{0,LT}$) for high productivity system in Asia region is 0.45 $m^3$ $CH_4$/kg VS.
[57] http://www.doc88.com/p-9902182440715.html

| | | | |
|---|---|---|---|
| | 01-April-2021-30-April-2021 | 1.49 | 0.87 |
| | 01-May-2021-31-May-2021 | 1.54 | 0.89 |
| | 01-June-2021-30-June-2021 | 1.49 | 0.88 |
| | 01-July-2021-31-July-2021 | 1.55 | 0.89 |
| | 01-August-2021-31-August-2021 | 1.54 | 0.91 |
| | 01-September-2021-30-September- | 1.49 | 0.87 |
| | 01-October-2021-31-October-2021 | 1.54 | 0.89 |
| | 01-November-2021-30-November- | 1.50 | 0.87 |
| | 01-December-2021-31-December- | 1.54 | 0.91 |
| | 01-January-2022-31-January-2022 | 1.55 | 0.90 |
| | 01-February-2022-28-February-2022 | 1.39 | 0.82 |
| | 01-March-2022-31-March-2022 | 1.54 | 0.89 |
| | 01-April-2022-30-April-2022 | 1.49 | 0.87 |
| | 01-May-2022-31-May-2022 | 1.54 | 0.89 |
| | 01-June-2022-30-June-2022 | 1.49 | 0.87 |
| Comments | The parameter is calculated as the equation of option 2 in Appendix 2 of methodology ACM0010 Version 08 and the value of other parameter applied in the equation is taken from published sources (2019 Refinement to the 2006 IPCC Guidelines). The value should be updated on latest available public data source.<br><br>For $W_{site}$, please refer to the monitoring parameter $W_{site}$ | | |

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

| | |
|---|---|
| Data / Parameter | T |
| Data unit | °C |
| Description | Annual average ambient temperature at project site |

| | |
|---|---|
| **Value applied:** | <table><tr><th>Time</th><th>T (°C)</th></tr><tr><td>2021</td><td>13.6[58]</td></tr><tr><td>2022</td><td>13.2[59]</td></tr></table> |
| **Comments** | Cross-Check with the value of ex-ante estimated, i.e., 13.2 ℃. After compared the actual temperature in 2021, 2022 and the temperature of ex-ante estimated, it can be determined that the project site has >10℃ mean annual temperature during the 1st monitoring period.<br>MCF value is still 73% with the temperature of 13.4°C, and as per Annex 10A.2, 2019 Refinement to the 2006 IPCC Guidelines, the climate zone of the project site can be determined to "Warm temperature moist". Then multiplying MCF values with a value of 0.94, so 68.62% of $MCF_j$ (73%*0.94) is used for calculation during this monitoring period, which is consistent with the valued of ex-ante. |

## 7.2 Baseline Emissions

As described in methodology ACM0010 (version 8.0) mentioned above, the baseline scenario is the continuation of the current practice, the baseline emissions are calculated as follows: $\mathrm{BE_y} = \mathrm{BE_{CH4,y}} + \mathrm{BE_{N2O,y}} + BE_{elec/heat,y}$

As described in section 5.1, the baseline scenario of this project is uncovered anaerobic lagoon, and no heat used in the baseline, only minor electricity will be used, so the emission can be excluded for simplification. In addition, the biogas generated during the treatment process in this project will be captured for heat generation and all the heat generated from this project will be used by the daily operation of AWMS and the swine farm. The heat generated is not connected to another user. So, the baseline $CO_2$ emission from electricity and/or heat used in the baseline is 0, which is conservative. So, $BE_y = BE_{CH4,y} + BE_{N2O,y}$ .

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

58 https://baijiahao.baidu.com/s?id=1727982990945009906&wfr=spider&for=pc
59 https://baijiahao.baidu.com/s?id=1756797821554245444&wfr=spider&for=pc

Table 7-1 the basic monitoring data values used in the calculation of baseline emissions

| Time | $N_{LT}$ | $N_{AA,LT}$ | $W_{site}$ (kg) | | $n_{dy}$(day) | $VS_{LT,y}$ (kg-dm/ animal/year) | | $NEX_{IPCC}$ (kg N/animal/year) | | $NEX_{LT,y}$ (kg N/animal/year) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Market swine | Breeding swine | Market swine | Breeding swine | | Market swine | Breeding swine | Market swine | Breeding swine | Market swine | Breeding swine |
| 05-March-2021-31-March-2021 | 130,041 | 13,639 | 79.2 | 89.4 | 27 | 10.91 | 5.55 | 0.95 | 1.38 | 1.35 | 0.77 |
| 01-April-2021-30-April-2021 | 129,968 | 13,644 | 79.0 | 90.2 | 30 | 12.09 | 6.22 | 1.06 | 1.54 | 1.49 | 0.87 |
| 01-May-2021-31-May-2021 | 130,003 | 13,633 | 78.8 | 89.5 | 31 | 12.46 | 6.38 | 1.09 | 1.59 | 1.54 | 0.89 |
| 01-June-2021-30-June-2021 | 129,952 | 13,650 | 79.1 | 91.9 | 30 | 12.10 | 6.34 | 1.06 | 1.54 | 1.49 | 0.88 |
| 01-July-2021-31-July-2021 | 129,975 | 13,642 | 79.4 | 89.7 | 31 | 12.55 | 6.40 | 1.09 | 1.59 | 1.55 | 0.89 |
| 01-August-2021-31-August-2021 | 129,988 | 13,643 | 78.6 | 91.4 | 31 | 12.43 | 6.52 | 1.09 | 1.59 | 1.54 | 0.91 |
| 01-September-2021-30-September-2021 | 129,972 | 13,636 | 79.1 | 90.2 | 30 | 12.10 | 6.22 | 1.06 | 1.54 | 1.49 | 0.87 |
| 01-October-2021-31-October-2021 | 130,075 | 13,634 | 79.0 | 89.7 | 31 | 12.49 | 6.40 | 1.09 | 1.59 | 1.54 | 0.89 |
| 01-November-2021-30-November-2021 | 130,006 | 13,643 | 79.3 | 90.7 | 30 | 12.13 | 6.26 | 1.06 | 1.54 | 1.50 | 0.87 |
| 01-December-2021-31- | 130,055 | 13,642 | 78.8 | 91.6 | 31 | 12.46 | 6.53 | 1.09 | 1.59 | 1.54 | 0.91 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| December-2021 | | | | | | | | | | | |
| 01-January-2022-31-January-2022 | 130,031 | 13,635 | 79.3 | 90.6 | 31 | 12.54 | 6.46 | 1.09 | 1.59 | 1.55 | 0.90 |
| 01-February-2022-28-February-2022 | 130,038 | 13,641 | 78.7 | 91.5 | 28 | 11.24 | 5.89 | 0.99 | 1.43 | 1.39 | 0.82 |
| 01-March-2022-31-March-2022 | 130,079 | 13,631 | 78.8 | 90.1 | 31 | 12.46 | 6.42 | 1.09 | 1.59 | 1.54 | 0.89 |
| 01-April-2022-30-April-2022 | 129,978 | 13,637 | 79.1 | 91.1 | 30 | 12.10 | 6.29 | 1.06 | 1.54 | 1.49 | 0.87 |
| 01-May-2022-31-May-2022 | 129,979 | 13,646 | 79.0 | 90.2 | 31 | 12.49 | 6.43 | 1.09 | 1.59 | 1.54 | 0.89 |
| 01-June-2022-30-June-2022 | 130,074 | 13,633 | 79.1 | 90.4 | 30 | 12.10 | 6.24 | 1.06 | 1.54 | 1.49 | 0.87 |

Table 7-2 The calculation result of $BE_y$

| Parameter | Value | | Unit |
|---|---|---|---|
| species | **Market Swine** | **Breeding Swine** | |
| $GWP_{CH4}$ | 28 | 28 | $tCO_2/tCH_4$ |
| $D_{CH4}$ | 0.00067 | 0.00067 | $t/m^3$ |
| $MCF_j$ | 73% | 73% | % |
| Conservative Factor | 0.94 | 0.94 | / |
| MCFj with cons. Factor | 68.62% | 68.62% | / |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3$ $CH_4$ /kg_dm |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $W_{site}$ | Refer to Table 6-1 | | |
| $W_{default}$ | 56 | 160 | kg |
| $VS_{default}$ | 0.2856 | 0.368 | Kg-dm/animal/day |
| $VS_{LT,y}$ | Refer to Table 6-1 | | |
| $MS\%_{Bl,j}$ | 100% | 100% | % |
| $n_{dy}$ | Refer to Table 6-1 | | |
| **$BE_{CH4,y}$ from** 05-March-2021 to 31-December-2021 | **96,628** | | **$tCO_2e$** |
| **$BE_{CH4,y}$ from** 01-January-2022 to 30- June-2022 | **57,914** | | **$tCO_2e$** |
| **$BE_{CH4,y}$ in this monitoring period** | **154,542** | | **$tCO_2e$** |
| $EF_{N20,D,j}$ | 0 | 0 | kg $N_2O$-N/kg N |
| $EF_{N20,ID,j}$ | 0.014 | 0.014 | kg $N_2O$-N/kg N |
| $N_{rate(T)}$ | 0.63 | 0.32 | kg N/1000kg animal mass/day |
| $NEX_{IPCC\ default}$ | Refer to Table 6-1 | | |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| *TAM* | 56.00 | 160.00 | kg |
| $F_{gasMS,j,LT}$ | 40% | 40% | / |
| $GWP_{N20}$ | 265 | 265 | $tCO_2$/t $N_2O$ |
| $CF_{N20,N-N}$ | 1.57 | 1.57 | Conversion Factor $N_2O$-N to $N_2O$ |
| **$BE_{N20,y}$ from** 05-March-2021 to 31-December-2021 | **4,836** | | **$tCO_2e$** |
| **$BE_{N20,y}$ from** 01-January-2022 to 30- June-2022 | **2,899** | | **$tCO_2e$** |
| **$BE_{N20,y}$ in this monitoring period** | **7,735** | | **$tCO_2e$** |
| **$BE_y$ from** 05-March-2021 to 31-December-2021 | **101,464** | | **$tCO_2e$** |
| **$BE_y$ from** 01-January-2022 to 30- June-2022 | **60,813** | | **$tCO_2e$** |
| **$BE_y$ in this monitoring period** | **162,277** | | **$tCO_2e$** |

Baseline Emissions: $BE_{CH4,y} + BE_{N20,y}$ = 154,542 $tCO_2e$ + 7,735 $tCO_2e$ = 162,277 $tCO_2e$

## 7.3 Project Emissions

As described in Section 5.2, project emissions can be calculated by Equation 15.

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

For $PE_{AD,y}$, according to the Tool14" Project and leakage emissions from anaerobic digesters (Version 02.0)", the project emissions associated with the anaerobic digester ($PE_{AD,y}$) are determined by $PE_{AD,y} = PE_{EC,y} + PE_{FC,y} + PE_{CH4,y} + PE_{flare,y}$

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

All thermal energy used by the project is supplied by the new installed boilers, which is utilizing biogas generated during the treatment process in this project for heat generation. No other thermal energy from outside source is used for the project. And the anaerobic digestion process of this project does not involve the use of fossil fuels, so the project emissions from fossil fuel consumption associated with the anaerobic digester is 0, i.e., $PE_{FC,y}$=0

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

In summary, the Project emissions associated with the anaerobic digester in year y (t $CO_2$e) is the Project emissions of methane from the anaerobic digester in year y (t $CO_2$e). i.e., $PE_{AD,y}$= $PE_{CH4,y}$+$PE_{EC,y}$.

The basic monitored parameter used in the and the calculation result of $PE_{EC,y}$ ,$PE_{CH4,y}$ and $PE_{AD,y}$ are shown in the Table 7-3, Table 7-4 and Table 7-5.

Table 7-3 the calculation result of $PE_{EC,y}$

| Time | $EC_{PJ,j,y}$ (MWh) | $EF_{EF,j,y}$ ($tCO_2$/MWh) | $TDL_{j,y}$ | **$PE_{EC,y}$($tCO_2e$)** |
|---|---|---|---|---|
| 05-March-2021-31-March-2021 | 315.23 | 0.7119 | 20% | **269.30** |
| 01-April-2021-30-April-2021 | 313.42 | 0.7119 | 20% | **267.75** |
| 01-May-2021-31-May-2021 | 320.78 | 0.7119 | 20% | **274.04** |
| 01-June-2021-30-June-2021 | 312.82 | 0.7119 | 20% | **267.24** |
| 01-July-2021-31-July-2021 | 320.87 | 0.7119 | 20% | **274.12** |
| 01-August-2021-31-August-2021 | 310.46 | 0.7119 | 20% | **265.22** |
| 01-September-2021-30-September-2021 | 321.51 | 0.7119 | 20% | **274.66** |

| | | | | |
|---|---|---|---|---|
| 01-October-2021-31-October-2021 | 316.78 | 0.7119 | 20% | **270.62** |
| 01-November-2021-30-November-2021 | 310.11 | 0.7119 | 20% | **264.93** |
| 01-December-2021-31-December-2021 | 324.65 | 0.7119 | 20% | **277.35** |
| 01-January-2022-31-January-2022 | 314.61 | 0.7119 | 20% | **268.77** |
| 01-February-2022-28-February-2022 | 322.48 | 0.7119 | 20% | **275.49** |
| 01-March-2022-31-March-2022 | 326.06 | 0.7119 | 20% | **278.55** |
| 01-April-2022-30-April-2022 | 311.05 | 0.7119 | 20% | **265.73** |
| 01-May-2022-31-May-2022 | 318.82 | 0.7119 | 20% | **272.37** |
| 01-June-2022-30-June-2022 | 319.62 | 0.7119 | 20% | **273.05** |

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

| Time | $GWP_{CH4}$ ($tCO_2/tCH_4$) | $EF_{CH4,default}$ ($tCH_4$ leaked / $tCH_4$ produced) | $Q_{CH4,y}$ ($tCH_4$) | **$PE_{CH4,y}$($tCO_2e$)** |
|---|---|---|---|---|
| 05-March-2021-31-March-2021 | 28 | 0.05 | 427.11 | **598** |
| 01-April-2021-30-April-2021 | 28 | 0.05 | 423.29 | **593** |
| 01-May-2021-31-May-2021 | 28 | 0.05 | 418.35 | **586** |
| 01-June-2021-30-June-2021 | 28 | 0.05 | 422.03 | **591** |
| 01-July-2021-31-July-2021 | 28 | 0.05 | 426.19 | **597** |
| 01-August-2021-31-August-2021 | 28 | 0.05 | 419.91 | **588** |
| 01-September-2021-30-September-2021 | 28 | 0.05 | 416.66 | **584** |
| 01-October-2021-31-October-2021 | 28 | 0.05 | 428.42 | **600** |
| 01-November-2021-30-November-2021 | 28 | 0.05 | 425.07 | **596** |
| 01-December-2021-31-December-2021 | 28 | 0.05 | 427.11 | **598** |
| 01-January-2022-31-January-2022 | 28 | 0.05 | 433.80 | **608** |
| 01-February-2022-28-February-2022 | 28 | 0.05 | 428.27 | **600** |

| | | | | |
|---|---|---|---|---|
| 01-March-2022-31-March-2022 | 28 | 0.05 | 426.64 | **598** |
| 01-April-2022-30-April-2022 | 28 | 0.05 | 424.04 | **594** |
| 01-May-2022-31-May-2022 | 28 | 0.05 | 441.81 | **619** |
| 01-June-2022-30-June-2022 | 28 | 0.05 | 429.06 | **601** |

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

| **Period** | $PE_{EC,y}$ ($tCO_2e$) | $PE_{CH4,y}$ ($tCO_2e$) | $PE_{flare,y}$ ($tCO_2e$) | $PE_{AD,y}$ ($tCO_2e$) |
|---|---|---|---|---|
| 05-March-2021-31-December-2021 | **2,705** | **5,931** | **0** | **8,636** |
| 01-January-2022-30-June-2022 | **1,634** | **3,620** | **0** | **5,254** |
| **1st monitoring period** | **4,339** | **9,551** | **0** | **13,890** |

$PE_{AD,y} = PE_{EC,y} + PE_{CH4,y} + PE_{flare,y}$ = 4,339 $tCO_2e$ + 9,551 $tCO_2e$ + 0 =13,890 $tCO_2e$

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

The project $CH_4$ emissions from aerobic AWMS treatment is calculated using Equation 26 described in above Section 5.2. The specific calculation results are shown in Table 7-6.

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

| **Parameter** | **Value** | | **Unit** |
|---|---|---|---|
| **species** | **Market Swine** | **Breeding Swine** | |
| $GWP_{CH4}$ | 28 | 28 | $tCO_2/tCH_4$ |
| $D_{CH4}$ | 0.00067 | 0.00067 | $t/m^3$ |
| | 0.001 | 0.001 | kg N/1000kg animal mass/day |
| $F_{Aer}$ | 100% | 100% | / |
| $1-R_{VS,1}$ | 16% | 16% | / |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3CH_4/kg\text{-}dm$ |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $VS_{LT,y}$ | Refer to Table 6-1 | | |
| $MS\%_j$ | 100% | 100% | |
| **$PE_{Aer,y}$ in this monitoring period** | **37** | | **$tCO_2e$** |

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

The project $N_2O$ emissions in year y can be calculated using Equation 27-29 described in above Section 5.2. The specific calculation result is shown in Table 7-7.

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

| Parameter | Value | | Unit |
|---|---|---|---|
| species | Market Swine | Breeding Swine | |
| $EF_{N2O,D,j}$ | 0.0006 | 0.0006 | kg $N_2O$-N/kg N |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $MS\%_j$ | 100% | 100% | / |
| **$E_{N2O,D,y}$ from 05-March-2021 to 31-December-2021** | **1,244** | | **kg $N_2O$-N/year** |
| **$E_{N2O,D,y}$ from 01-January-2022 to 30- June-2022** | **746** | | **kg $N_2O$-N/year** |
| **$E_{N2O,D,y}$ in this monitoring period** | **1,990** | | **kg $N_2O$-N/year** |
| $EF_{N2O,D,j}$ | 0.006 | 0.006 | kg $N_2O$-N/kg N |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $MS\%_j$ | 100% | 100% | / |
| **$E_{N2O,D,y}$ from 05-March-2021 to 31-December-2021** | **12,443** | | **kg $N_2O$-N/year** |
| **$E_{N2O,D,y}$ from 01-January-2022 to 30- June-2022** | **7,458** | | **kg $N_2O$-N/year** |
| **$E_{N2O,D,y}$ in this monitoring period** | **19,901** | | **kg $N_2O$-N/year** |
| $EF_{N2O,iD,j}$ | 0.014 | 0.014 | kg $N_2O$-N/kg $NH_3$ and $NO_X$-N |
| $F_{gasMS,j,LT}$ | 50% | 50% | / |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $MS\%_j$ | 100% | 100% | % |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2/tN_2O$ |
| **$E_{N2O,ID,y}$ from 05-March-2021 to 31-December-2021** | **14,517** | | **kg $N_2O$-N/year** |
| **$E_{N2O,ID,y}$ from 01-January-2022 to 30- June-2022** | **8,701** | | **kg $N_2O$-N/year** |
| **$E_{N2O,ID,y}$ in this monitoring period** | **23,218** | | **kg $N_2O$-N/year** |
| $EF_{N2O,iD,j}$ | 0.014 | 0.014 | kg $N_2O$-N/kg $NH_3$ and $NO_X$-N |
| $F_{gasMS,j,LT}$ | 60% | 60% | / |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $MS\%_j$ | 100% | 100% | % |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2/tN_2O$ |
| **$E_{N2O,ID,y}$ from 05-March-2021 to 31-December-2021** | **17,421** | | **kg $N_2O$-N/year** |
| **$E_{N2O,ID,y}$ from 01-January-2022 to 30- June-2022** | **10,441** | | **kg $N_2O$-N/year** |
| **$E_{N2O,ID,y}$ in this monitoring period** | **27,862** | | **kg $N_2O$-N/year** |
| **$PE_{N2O,y}$ from 05-March-2021 to 31-December-2021** | **18,999** | | **$tCO_2e$** |
| **$PE_{N2O,y}$ from 01-January-2022 to 30- June-2022** | **11,387** | | **$tCO_2e$** |
| **$PE_{N2O,y}$ in this monitoring period** | **30,386** | | **$tCO_2e$** |

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

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

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

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

In summary, the project emission of the proposed project in this monitoring period are summarized in Table 7-8.

Table 7-8 the calculation result of project emissions in this monitoring period

| Period | $PE_{AD,y}$ ($tCO_2e$) | $PE_{Aer,y}$ ($tCO_2e$) | $PE_{N20,y}$ ($tCO_2e$) | $PE_y$ ($tCO_2e$) |
|---|---|---|---|---|
| 05-March-2021-31-December-2021 | 8,636 | 23 | 18,999 | 27,658 |
| 01-January-2022-30-June-2022 | 5,254 | 14 | 11,387 | 16,655 |
| **1st monitoring period** | **13,890** | **37** | **30,386** | **44,313** |

In conclusion, the Project emission is: $\mathrm{PE_y} = \mathrm{PE_{AD,y}} + \mathrm{PE_{Aer,y}} + \mathrm{PE_{N2O,y}}$= 44,313 $tCO_2e$

## 7.4 Leakage

As described in section 5.3, Leakage emissions can be calculated by Equation 33: $LE_y = (LE_{PJ,N2O,y} - LE_{BL,N2O,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y}) + LE_{AD,y}$.

Also, as described in Section 5.3, The leakage emissions associated with the anaerobic digester ($LE_{AD,y}$) depend on how the digestate is managed. For this project, the anaerobic digestion process of this project is carried out in a fully enclosed system. The biogas generated during the treatment process is captured for heat generation or flared (if any). The Emissions from combustion is calculated in project emissions (if any). After anaerobic digestion, the fermented sludge will be treated in aerobic composting system, which will be used as fertilizer. Wastewater from the new animal waste management systems are used for agriculture irrigation. So, the Estimation of leakage emissions associated with the anaerobic digester is 0. i.e., $LE_{AD,y}$ =0. Therefore, the $LE_y = (LE_{PJ,N2O,y} - LE_{BL,N2O,y}) + (LE_{PJ,CH4,y} - LE_{BL,CH4,y})$.

The $LE_{BL,N2O,y}$, $LE_{PJ,N2O,y}$, $LE_{BL,CH4,y}$ $and$ $LE_{PJ,CH4,y}$ can be calculated by Equation 34-43 described in Section 5.3 and the specific calculation and the result are shown in Table 7-9. The calculation result of leakage emission is shown in Table 7-10.

Table 7-9 the calculation result of $LE_{BL,N2O,y}$, $LE_{PJ,N2O,y}$, $LE_{BL,CH4,y}$ $and$ $LE_{PJ,CH4,y}$

| Parameter | Value | | Unit |
|---|---|---|---|
| species | Market Swine | Breeding Swine | |

| | | | |
|---|---|---|---|
| $N_{LT}$ | Refer to Table 6-1 | | |
| $NEX_{LT,y}$ | Refer to Table 6-1 | | |
| $R_{N,n}$ | 80% | 80% | / |
| $EF_1$ | 0.006 | 0.006 | kg $N_2O$-N/kg N |
| $EF_5$ | 0.011 | 0.011 | kg $N_2O$-N/kg N |
| $EF_4$ | 0.01 | 0.01 | KgN-$N_2O$-N/kg $NH_3$-N+$NO_x$-N |
| $F_{leach}$ | 0.24 | 0.24 | / |
| $F_{gasm}$ | 0.21 | 0.21 | / |
| $GWP_{N2O}$ | 265 | 265 | $tCO_2$/t $N_2O$ |
| $LE_{N2O,land,y}$ from 05-March-2021 to 31-December-2021 | 2,489 | | kg $N_2O$-N/year |
| $LE_{N2O,land,y}$ from 01-January-2022 to 30-June-2022 | 1,492 | | kg $N_2O$-N/year |
| **$LE_{N2O,land,y}$ in the 1st monitoring period** | **3,981** | | kg $N_2O$-N/year |
| $LE_{N2O,runoff,y}$ from 05-March-2021 to 31-December-2021 | 1,095 | | kg $N_2O$-N/year |
| $LE_{N2O,runoff,y}$ from 01-January-2022 to 30-June-2022 | 656 | | kg $N_2O$-N/year |
| **$LE_{N2O,runoff,y}$ in the 1st monitoring period** | **1,752** | | kg $N_2O$-N/year |
| $LE_{N2O,vol,y}$ from 05-March-2021 to 31-December-2021 | 871 | | kg $N_2O$-N/year |
| $LE_{N2O,vol,y}$ from 01-January-2022 to 30-June-2022 | 522 | | kg $N_2O$-N/year |
| **$LE_{N2O,vol,y}$ in the 1st monitoring period** | **1,393** | | kg $N_2O$-N/year |
| $LE_{BJ,N2O,y}$ from 05-March-2021 to 31-December-2021 | 1,855 | | **$tCO_2e$** |
| $LE_{BJ,N2O,y}$ from 01-January-2022 to 30-June-2022 | 1,111 | | **$tCO_2e$** |
| **$LE_{BJ,N2O,y}$ in the 1st monitoring period** | **2,966** | | **$tCO_2e$** |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $NEX_{LT}$ | Refer to Table 6-1 | | |
| $R_{N,1}$ | 5% | 5% | / |
| $R_{N,2}$ | 25% | 25% | / |
| $EF_1$ | 0.006 | 0.006 | kg $N_2O$-N/kg N |
| $EF_5$ | 0.011 | 0.011 | kg $N_2O$-N/kg N |
| $EF_4$ | 0.01 | 0.01 | KgN-$N_2O$-N/kg $NH_3$-N+$NO_x$-N |
| $F_{leach}$ | 0.24 | 0.24 | / |
| $F_{gasm}$ | 0.21 | 0.21 | / |
| $LE_{N2O,land,y}$ from 05-March-2021 to 31-December-2021 | 8,866 | | kg $N_2O$-N/year |
| $LE_{N2O,land,y}$ from 01-January-2022 to 30-June-2022 | 5,314 | | kg $N_2O$-N/year |
| **$LE_{N2O,land,y}$ in the 1st monitoring period** | **14,180** | | kg $N_2O$-N/year |
| $LE_{N2O,runoff,y}$ from 05-March-2021 to 31-December-2021 | 3,901 | | kg $N_2O$-N/year |
| $LE_{N2O,runoff,y}$ from 01-January-2022 to 30-June-2022 | 2,338 | | kg $N_2O$-N/year |
| **$LE_{N2O,runoff,y}$ in the 1st monitoring period** | **6,239** | | kg $N_2O$-N/year |

| | | | |
|---|---|---|---|
| $LE_{N2O,vol,y}$ from 05-March-2021 to 31-December-2021 | 3,103 | | kg $N_2O$-N/year |
| $LE_{N2O,vol,y}$ from 01-January-2022 to 30-June-2022 | 1,860 | | kg $N_2O$-N/year |
| **$LE_{N2O,vol,y}$ in the 1st monitoring period** | **4,963** | | kg $N_2O$-N/year |
| $LE_{PJ,N2O}$ from 05-March-2021 to 31-December-2021 | 6,609 | | **$tCO_2e$** |
| $LE_{PJ,N2O}$ from 01-January-2022 to 30-June-2022 | 3,961 | | **$tCO_2e$** |
| **$LE_{PJ,N2O}$ in the 1st monitoring period** | **10,570** | | **$tCO_2e$** |
| $GWP_{CH4}$ | 28 | 28 | $tCO_2e/t\ CH_4$ |
| $D_{CH4}$ | 0.00067 | 0.00067 | $t/m^3$ |
| $MCF_d$ | 1 | 1 | / |
| $VS_{LT,y}$ | Refer to Table 6-1 | | |
| $N_{LT}$ | Refer to Table 6-1 | | |
| $B_{0,LT}$ | 0.45 | 0.45 | $m^3\ CH_4/kg$-VS |
| $R_{VS}$ | 85% | 85% | / |
| $MS\%_j$ | 100% | 100% | / |
| $LE_{B,CH4,y}$ from 05-March-2021 to 31-December-2021 | 23,298 | | **$tCO_2e$** |
| $LE_{B,CH4,y}$ from 01-January-2022 to 30-June-2022 | 12,659 | | **$tCO_2e$** |
| **$LE_{B,CH4,y}$ in this monitoring period** | **35,957** | | **$tCO_2e$** |
| $GWP_{CH4}$ | 28 | 28 | $tCO_2/tCH_4$ |
| $D_{CH4}$ | 0.00067 | 0.00067 | $t/m^3$ |
| $MCF_d$ | 1 | 1 | / |
| $VS_{LT,y}$ | Refer to Table 6-1 | | |
| NLT | Refer to Table 6-1 | | |
| $B_0$ | 0.45 | 0.45 | $m^3\ CH_4/kg$-VS |
| $R_{VS,1}$ | 20% | 20% | / |
| $R_{VS,2}$ | 80% | 80% | / |
| $MS\%_j$ | 100% | 100% | / |
| $LE_{pJ,CH4}$ from 05-March-2021 to 31-December-2021 | 22,531 | | **$tCO_2e$** |
| $LE_{pJ,CH4}$ from 01-January-2022 to 30-June-2022 | 13,504 | | **$tCO_2e$** |
| **$LE_{pJ,CH4}$ in this monitoring period** | **36,035** | | **$tCO_2e$** |

Table 7-10 The calculation result of leakage emission

| **Period** | **$LE_{PJ,CH4,y}$** ($tCO_2e$) | **$LE_{BL,CH4,y}$** ($tCO_2e$) | **$LE_{BL,N2O,y}$** ($tCO_2e$) | **$LE_{PJ,N2O,y}$** ($tCO_2e$) | **$LE_y$** ($tCO_2e$/yr) |
|---|---|---|---|---|---|
| 05-March-2021-31-December-2021 | **22,531** | **23,298** | **1,855** | **6,609** | **3,987** |

| | | | | | |
|---|---|---|---|---|---|
| 01-January-2022-30-June-2022 | **13,504** | **12,659** | **1,111** | **3,961** | **3,695** |
| **1st monitoring period** | **36,035** | **35,957** | **2,966** | **10,570** | **7,682** |

$LE_y = \left(LE_{PJ,N2O,y} - LE_{BL,N2O,y}\right) + \left(LE_{PJ,CH4,y} - LE_{BL,CH4,y}\right) =$ 7,682 $tCO_2e$.

Emission Reduction: $ER_y = BE_y - PE_y - LE_y$ = 110,282 $tCO_2e$

## 7.5 Net GHG Emission Reductions and Removals

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

Biogas captured during monitoring period is 15,570,408.40 $m^3$, which equals to 190,897 $tCO_2e$ that emission from methane production[60]. Baseline methane emission ($BE_{CH4,y}$) in this monitoring period is 154,542 $tCO_2e$. project emissions associated with anaerobic digester in this monitoring period is ($PE_{AD,y}$) is 13,890 $tCO_2e$. Actual methane captured from anaerobic digester is higher than the difference of $BE_{CH4,y}$ and $PE_{AD,y}$ (140,652 $tCO_2e$ =154,542 $tCO_2e$ -13,890 $tCO_2e$). Therefore, the equation ($BE_{CH4,y}$ - $PE_{AD,y}$) can be used to calculate emission reduction. So, the Net GHG Emission Reductions and Removals can be calculated using Equation 45 in Section 5.4. The Net GHG Emission Reductions and Removals in this monitoring period is shown in following table.

| Year | Baseline emissions or removals ($tCO_2e$) | Project emissions or removals ($tCO_2e$) | Leakage emissions ($tCO_2e$) | Net GHG emission reductions or removals ($tCO_2e$) |
|---|---|---|---|---|
| 05-March-2021-31-December-2021 | 101,464 | 27,658 | 3,987 | 69,819 |
| 01-January-2022-30-June-2022 | 60,813 | 16,655 | 3,695 | 40,463 |
| **Total** | 162,277 | 44,313 | 7,682 | 110,282 |

The difference and the justification for the difference between the estimated ex-ante GHG

[60] Biogas captured during this monitoring period is 15,570,408.40 $m^3$. The quality of methane is 6,817.76 $tCH_4$, which can be calculated by the amount of biogas, the density of biogas and the content of methane in this monitoring period. Then the quality of methane multiplied by the global warming potential of CH4 i.e. $28tCO_2/tCH_4$ is the result of 190,897 $tCO_{2e}$. Please refer ER sheet, tab "monitoring results" for detail calculation process and final results.

emission reductions and removals and the achieved emission reductions and removals for this monitoring period (05-March-2021 to 30-June-2022) is shown in following table.

| Year | Ex-ante emissions reductions/removals ($tCO_2e$) | Achieved emissions reductions/removals ($tCO_2e$) | Percent difference | Justification for the difference |
|---|---|---|---|---|
| 05-March-2021-31-December-2021 | 83,944[61] | 69,819 | -16.8% | The mainly difference between the ex-ante estimated value and actual value is due to the changes of the number of animals in the swine farm (NLT), the average animal weight (Wsite) and the amount of biogas generation and utilized during the anaerobic treatment. |
| 01-January-2022-30-June-2022 | 45,627[62] | 40,463 | -11.3% | |
| Total | 129,571 | 110,282 | -14.9% | |

[61] The ex-ante estimated annual emission reduction is 92,011 tCO2e. This period is from 05-March-2021-31-December-2021, total 333 days. So, the ex-ante estimated emission reduction in this monitoring period is 92,011 tCO2e/365d*333d=83,944 tCO2e.

[62] The ex-ante estimated annual emission reduction is 92,011 tCO2e. This period is from 01-January-2022 to 30-June-2022, total 181 days. So, the ex-ante estimated emission reduction in this monitoring period is 92,011 tCO2e/365d*181d=45,627 tCO2e.

# APPENDIX 1: <EVIDENCE OF ACHIEVED SDGS>

**Supporting evidence for contribution to SDG 13.0 Tons of greenhouse gas emissions avoided or removed**

The project design document has estimated that 92,011 $tCO_2e$ emission reductions will be produced annually. This is the 1st monitoring period, which is covering from 05-March-2021 to 30-June-2022, and the emission reductions of first monitoring period is 110,282 $tCO_2e$. Please see Section 7 of JPM for details.

Table showing the emission reductions during the first monitoring period

| Year | Baseline emissions or removals ($tCO_2e$) | Project emissions or removals ($tCO_2e$) | Leakage emissions ($tCO_2e$) | Net GHG emission reductions or removals ($tCO_2e$) |
|---|---|---|---|---|
| 05-March-2021-30-June-2022 | 162,277 | 44,313 | 7,682 | 110,282 |

**Supporting evidence for contribution to SDG 7.2 Renewable energy share in the total final energy consumption**

The project design document has estimated that 342,200 GJ of heat generated annually by the project. This is the 1st monitoring period, which is covering from 05-March-2021 to 30-June-2022, and during this monitoring period, 367,461 GJ of heat was generated by the project.

| 烟台新好农牧有限公司养殖场环保项目生产运行月报表<br>产热量GJ | |
|---|---|
| | 种猪育肥猪养殖场 |
| 05/03/2021-31/03/2021 | 23218.29 |
| 01/04/2021-30/04/2021 | 22517.29 |
| 01/05/2021-31/05/2021 | 22597.74 |
| 01/06/2021-30/06/2021 | 23119.89 |
| 01/07/2021-31/07/2021 | 23381.91 |
| 01/08/2021-31/08/2021 | 22724.36 |
| 01/09/2021-30/09/2021 | 22584.65 |
| 01/10/2021-31/10/2021 | 22838.86 |
| 01/11/2021-30/11/2021 | 23147.52 |
| 01/12/2021-31/12/2021 | 23117.48 |
| 01/01/2022-31/01/2022 | 22936.23 |
| 01/02/2022-28/02/2022 | 22902.43 |
| 01/03/2022-31/03/2022 | 22824.93 |
| 01/04/2022-30/04/2022 | 22605.21 |
| 01/05/2022-31/05/2022 | 23422.27 |
| 01/06/2022-30/06/2022 | 23521.94 |
| 小计： | **367461** |
| 合计： | **367461** |

Supporting evidence for contribution to SDG 8.3 Proportion of informal employment in non-agriculture employment by sex

The project activity generates permanent job opportunities for 20 persons including 11 females and 9 males during the operation period. During this monitoring period, total 20 jobs for local people were created (including 11 females and 9 males) by the project.

Yantai Xinhao Farming and Animal Husbandry Co., Ltd. farm environmental protection project staff roster

| No | Position Name | Name | Gender | Affiliated Farm | Address | ID number |
|---|---|---|---|---|---|---|
| 1 | Environmental Protection Specialist | Luo Hong | Female | Yantai Xinhao | Zhang Shanzi Town, Taierzhuang District, Zaozhuang City, Shandong Province | 37040519781226**** |
| 2 | Environmental Protection Specialist | Liu Yong | Male | Yantai Xinhao | Longquan Town, Muping District, Yantai City, Shandong Province | 14272319980129**** |
| 3 | Environmental Protection Specialist | Sun Fanyue | Female | Yantai Xinhao | Gonggezhuang Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37062919760803**** |
| 4 | Environmental Protection Specialist | Sun Houjin | Male | Yantai Xinhao | Nai Village, Guanshui Town, Muping, Yantai City, Shandong Province | 37062819700324**** |
| 5 | Environmental Protection Specialist | Qiu Rui | Female | Yantai Xinhao | Gonggezhuang Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37120219841115**** |
| 6 | Environmental Protection Specialist | Zhou Jindong | Male | Yantai Xinhao | Artemisiakuang Village, Xujadian Town, Haiyang City, Yantai, Shandong Province | 37061219840306**** |
| 7 | Environmental Protection Specialist | Song Jianjun | Male | Yantai Xinhao | Artemisiakuang Village, Xujadian Town, Haiyang City, Yantai, Shandong Province | 37063019710108**** |
| 8 | Environmental Protection Specialist | Hao Cuixin | Female | Yantai Xinhao | Yadi Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119670616**** |
| 9 | Environmental Protection Specialist | Shao Minyi | Female | Yantai Xinhao | Longquan Town, Muping District, Yantai City, Shandong Province | 37062919690605**** |
| 10 | Environmental Protection Specialist | Hu Yi | Female | Yantai Xinhao | Gonggezhuang Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119641121**** |
| 11 | Environmental Protection Specialist | Leng Yanbo | Female | Yantai Xinhao | Yangjiawa Village, Hovengo Town, Zhucheng City, Shandong Province | 23032119900821**** |
| 12 | Environmental Protection Specialist | Jiao Liman | Male | Yantai Xinhao | Gonggezhuang Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119631111**** |
| 13 | Environmental Protection Specialist | Lv Shu | Female | Yantai Xinhao | Yadi Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37078219900128**** |
| 14 | Environmental Protection Specialist | Wei Xiliang | Male | Yantai Xinhao | Artemisiakuang Village, Xujadian Town, Haiyang City, Yantai, Shandong Province | 37242219711123**** |
| 15 | Environmental Protection Specialist | Yin Kaisheng | Male | Yantai Xinhao | Nai Village, Guanshui Town, Muping, Yantai City, Shandong Province | 37063119711030**** |
| 16 | Environmental Protection Specialist | Han Jie | Male | Yantai Xinhao | Gonggezhuang Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119701111**** |
| 17 | Environmental Protection Specialist | Shan Yaoqing | Female | Yantai Xinhao | Nai Village, Guanshui Town, Muping, Yantai City, Shandong Province | 37068219690606**** |
| 18 | Environmental Protection Specialist | Ke Ruiyi | Female | Yantai Xinhao | Yadi Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119701001**** |
| 19 | Environmental Protection Specialist | Han Mingyi | Male | Yantai Xinhao | Yadi Village, Guanshui Town, Muping District, Yantai City, Shandong Province | 37063119660927**** |
| 20 | Environmental Protection Specialist | Yang Chanping | Female | Yantai Xinhao | Artemisiakuang Village, Xujadian Town, Haiyang City, Yantai, Shandong Province | 37062919660803**** |