



**Verified Carbon
Standard**

HENAN ZHUMADIAN YOURAN XIPING DAIRY FARM BIOGAS UTILIZATION PROJECT



**Climate
Bridge**

Project title	Henan Zhumadian Youran Xiping Dairy Farm Biogas Utilization Project
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1 PROJECT DETAILS

1.1 Summary Description of the Project

Henan Zhumadian Youran Xiping Dairy Farm Biogas Utilization Project (hereinafter referred to as “the Project”) is located in Hongcunpu Village, Leizu Town, Xiping County, Zhumadian City, Henan Province, P.R. China. The project is owned and implemented by Zhumadian Youran Animal Husbandry Co., Ltd.

The project is to build an anaerobic animal manure treatment system which collects dairy cattle manure waste from Zhumadian Youran Xiping Dairy Farm. It is expected to manage 14,400 adult dairy cattle and 3,100 breeding cattle per year¹. Four high concentration Completely Stirred Tank Reactor (CSTR) type anaerobic digesters with effective volume of 7,000m³ each, and two low concentration CSTR digesters with the same effective volume and 42,000 m³ in total will be installed. The anaerobic digesters are expected to produce 11,000,000 m³ biogas per year. Some of the recovered biogas will be used for electricity generation for self-consumption and supplied to the farm, and some will be used for heat generation for warming up the anaerobic digesters of the project, and the excess part will be flared. In the future a plan is made to sell the excess biogas to the third party for natural gas upgrading and accordingly the natural gas will be transported and sold by the third party. According to the feasibility study report, the designed installed capacity of the biogas power plant is 1.0MW. A biogas boiler will also be installed to generate the heat supplied to the anaerobic digesters of the project. The biogas residue (dried part) from the CSTR digesters will be used as cattle bedding material, and biogas slurry (liquid part) will be directly returned to the nearby farmland as liquid fertilizer through a lifting pump station and a pipeline network.

Zhumadian Youran Xiping Dairy Farm started operation in July 2022. Before the operation of the project, Zhumadian Youran Xiping Dairy Farm treated all manure in an open anaerobic lagoon with 1.0 meter depth, and the rotation time of the baseline open anaerobic lagoon is greater than one month. The open anaerobic lagoon was located at the project site before the operation of the project. Moreover, according to document from Xiping County agricultural and rural Bureau, more than 80% of livestock farms in Xiping County use the open baseline anaerobic lagoon to treat the manure in the open anaerobic lagoons with 3.5-meter depth, and the rotation time of the baseline open anaerobic lagoon is from 30-45 days.

The baseline scenario is the situation where, in the absence of the project activity, the animal manure waste are left to decay within the project boundary and methane is emitted to the atmosphere.

¹ The total designed amount of dairy cattle is 24,000 heads, including 14,400 adult dairy cattle, 3,100 breeding cattle and 6,500 calves per year. For the project, the 17,500 heads of dairy cattle has been included in the calculation of emission reductions, not including the amount of calves.

The project is expected to avoid GHG emission of methane through recovery and destruction of biogas.

The project started construction on 25-November-2021 and put into operation on 15-April-2023. The project is expected to achieve an annual emission reduction of 59,610 tCO₂e and a total emission reduction of 596,100 tCO₂e during the fixed 10-year crediting period.

In the first monitoring period from 15-April-2023 to 31-December-2024 (both days included), the total emission reductions achieved are 91,275 tCO₂e. The project run continuously. No events or situations, which may impact the applicability of the applied methodology, occurred during this monitoring period.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	15-April-2023 to 14-April-2033	VCS	CTI Certification Co., Ltd.	10
Verification	15-Apr-2023 to 31-Dec-2024	VCS	CTI Certification Co., Ltd.	1.72 years (627 days)

1.3 Sectoral Scope and Project Type

Sectoral scope ²	Scope 1: Energy industries (renewable - / non-renewable sources), Scope 13: waste handling and disposal, and Scope 15: Livestock and manure management.
Project activity type	The project is not AFOLU project and is not a grouped project.

1.4 Project Eligibility

1.4.1 General eligibility

The scope of the VCS Program includes:

1) The seven Kyoto Protocol greenhouse gases:

The project is expected to avoid CH₄ emissions, and CH₄ is a Kyoto Protocol greenhouse gas: Methane (CH₄) emissions from the anaerobic animal manure management system in the

² Projects, activities, or methodologies may be developed under any of the 16 VCS sectoral scopes: <https://verra.org/programs/verified-carbon-standard/vcs-program-details/#sectoral-scopes>

baseline scenario, which will be captured and destroyed in the project scenario. Thus, the project applicable 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 methodology AMS-III.D (Version 21.0) of the project utilized 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 project does not belong to projects that can reasonably be assumed to have generated GHG emissions primarily for the purpose of their subsequent reduction, removal, or destruction.

Furthermore, the project does not belong to the project activities excluded in Table 1 of VCS Standard 4.7.

Finally, the project complies with all the general requirements in Section 3.1 of VCS Standard (version 4.7) as shown in the following.

No.	Requirements in VCS Standard 4.7	The project
1.	Projects shall meet all applicable rules and requirements set out under the VCS Program, including this document. Projects shall be guided by the principles set out in Section 2.2.1.	Applicable. The project meets all applicable rules and requirements set out under the VCS Program, including VCS Standard 4.7. And the project is guided by the principles set out in Section 2.2.1.
2	Projects shall apply methodologies eligible under the VCS Program. Methodologies shall be applied in full, including the full application of any tools or modules referred to by a methodology, noting the exception set out in Section 3.14.1. The list of methodologies and their validity periods is available on the Verra website.	Applicable. The project applies the methodology AMS-III.D (Version 21.0) from other approved GHG program, e.g. CDM Program, which complies with VCS program rules. The methodology AMS-III.D. (Version 21.0) and the tools referred to by the methodology are applied in full, the applicability and the methodology and tools are specified in section 3 of this Joint PD-MR.
3	Projects shall apply the latest version of the applicable methodology in all cases unless a grace period applies to the project as set out in 3.22 below. Projects must update to the latest version of the methodology when reassessing the baseline and renewing	Applicable. The project applies the latest version of the applicable methodology AMS-III.D. (Version 21.0), which is valid from 22-September-2017 onwards, and the project adopts fixed crediting periods of 10 years not revolve

	a crediting period.	renewable of crediting period.
4	Projects and the implementation of project activities shall not lead to the violation of any applicable law, regardless of whether or not the law is enforced.	Applicable. The project and the implementation of the project comply with all the applicable laws specified section 1.15 below, not lead to the violation of any applicable law.
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).	As per VCS Program Definitions version 4.5, model means “a formula or set of formulae that uses parameters and input values to establish the value of one or more output variables”. The project activity has applied formulae in methodology AMS-III.D.(Version 21.0), tools referenced, 2006 IPCC Guidelines for National Greenhouse Gas Inventories and its 2019 Refinement to calculate emission reductions. Therefore, this criteria is applicable.
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 Program document VCS Methodology Requirements.	Applicable. The third-party default factor applied by the project meet the requirements set out in the VCS Program document VCS Methodology Requirements.
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.	Applicable. The project complies with the rules and requirements in the VCS Program under all conditions. The project is only seeking registration under the VCS Program. It is not receiving or seeking credit for reductions and removals from a project activity under any other GHG program; it has not registered under any other GHG program, and it has not been rejected by any other GHG program..
8	Where projects apply methodologies from approved GHG programs, they shall conform with any specified capacity limits (see the VCS Program document VCS Program Definitions for the definition of capacity limit) and any	Applicable. According to the methodology AMS-III.D. (Version 21.0), the project activity shall satisfy the following conditions: Measures are limited to those that result in aggregate emission reductions of less than or equal

	other relevant requirements set out with respect to the application of the methodology and/or tools referenced by the methodology under those programs.	to 60 kt CO ₂ equivalent annually from all Type III components of the project activity. The emission reduction from the recovery and destruction of methane (viz. Type III components of the project) is 59,610 tCO ₂ e/yr, which is less than 60 kt CO ₂ equivalent.
9	Where Verra issues new VCS Program rules, the effective dates of these requirements are set out in Appendix 3 Document History and Effective Dates or equivalent for other program documents, and are listed in a companion Summary of Effective Dates document which corresponds with each update.	Applicable. The latest VCS program rules is applied by the project.

According to the Section 3.8.1 of VCS standard v4.7, non-AFOLU projects shall complete validation within two years of the project start date. The project start date is dated on 15-April-2023. The project completes validation on 02-April-2025, which was within two years of the project start date.

The project is a non-AFOLU project, there is no other pipeline listing process requirements. Thus, the timeline of the project complies with VCS Standard requirements.

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

1.4.2 AFOLU project eligibility

Not applicable as the project is a Non-AFOLU project.

1.4.3 Transfer project eligibility

Not applicable as the project is neither a transfer project nor CPAs seeking registration.

1.5 Project Design

- ☒ Single location or installation
- ☐ Multiple locations or project activity instances (but not a grouped project)
- ☐ Grouped project

1.6 Project Proponent

Organization name	Zhumadian Youran Animal Husbandry Co., Ltd.
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Contact person	Tian Yanfeng
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1.7 Other Entities Involved in the Project

Organization name	Climate Bridge (Shanghai) Ltd.
Role in the project	Consultancy
Contact person	Gao Zhiwen
Title	General Manager
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Email	gao.zhiwen@climatebridge.com

1.8 Ownership

The project owner is Zhumadian Youran Animal Husbandry Co., Ltd. who has the legal right to control and operate the project activity. The business license, Project approval, approval of the Environmental Impact Assessment (EIA), the equipment purchasing contract, and the construction contract are evidence of the ownership of the project and carbon credits generated.

1.9 Project Start Date

Project start date	15-April-2023
Justification	According to VCS standard v4.7, the project start date is the date on which the project began generating GHG emission reductions or removals. The project began generate biogas on 15-April-2023, which is the earliest date that the project started generating emission reductions.

1.10 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☒ Ten years, fixed ☐ Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	15-April-2023 to 14-April-2033

1.11 Project Scale and Estimated GHG Emission Reductions or Removals

The estimated annual GHG emission reductions/removals of the project are:

- ☒ < 300,000 tCO₂e/year (project)
☐ ≥ 300,000 tCO₂e/year (large project)

Calendar year of crediting period	Estimated GHG emission reductions or removals (tCO ₂ e)
15-April-2023 to 31-Dec-2023	42,625 ³
01-Jan-2024 to 31-Dec-2024	59,610
01-Jan-2025 to 31-Dec-2025	59,610
01-Jan-2026 to 31-Dec-2026	59,610
01-Jan-2027 to 31-Dec-2027	59,610
01-Jan-2028 to 31-Dec-2028	59,610
01-Jan-2029 to 31-Dec-2029	59,610
01-Jan-2030 to 31-Dec-2030	59,610
01-Jan-2031 to 31-Dec-2031	59,610
01-Jan-2032 to 31-Dec-2032	59,610

³ The annual estimated emission reduction is 59,610 tCO₂e. It is covering 261 days from 15-Apr-2023 to 31-Dec-2024, thus the estimated emission reduction is 42,626 tCO₂e, e.g. 42,625 tCO₂e = 59,610 tCO₂e * 261 days / 365 days.

01-Jan-2033 to 14-April-2033	16,985 ⁴
Total estimated ERRs during the first or fixed crediting period	596,100
Total number of years	10
Average annual ERRs	59,610

1.12 Description of the Project Activity

The project involves construction of a centralized animal manure management system which collects manure waste from dairy cow from Zhumadian Youran Xiping Dairy Farm. The project uses animal manure waste as ferment material to produce biogas in the Completely Stirred Tank Reactor (CSTR) type anaerobic digesters. The recovered biogas will be used for electricity generation at the biogas power plant. Heat recovery boiler will also be installed at the biogas power plant to recover and supply heat to CSTR. The installed capacity of the biogas power plant is 1MW. The electricity generated by the project is only use for internal use. The emission reductions from waste heat recovery and electricity generation will not be accounted for. The project activity is expected to have a 20-year operational lifetime.

The project is expected to avoid GHG emission of methane through recovery and destruction of biogas.

The key system involved in the project are as follows:

Anaerobic animal manure management system

The Completely Stirred Tank Reactor (CSTR) type anaerobic digesters are to be applied in the project activity. Four high concentration CSTR digesters with effective volume of 7,000 m³ each and two low concentration CSTR digesters with the same effective volume and 42,000 m³ in total will be installed. The biogas produced from this procedure will be pipelined to biogas pre-treatment system.

Biogas pre-treatment system

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

Digestate advanced treatment unit

⁴ The annual estimated emission reduction is 59,610 tCO₂e. It is covering 104 days from 01-Jan-2033 to 14-Apr-2023, thus the estimated emission reduction is 16,985 tCO₂e, e.g. 16,985 tCO₂e = 59,610 tCO₂e * 104 days / 365 days.

The digestate from the anaerobic digesters will be sent to digestate advanced treatment units, it mainly involved filter press and then return to nearby field.

Biogas power generation system

The biogas electricity generation plant will be installed at the project site. The installed capacity of the project is 1MW (1MW×1). The type of generator is LSA50.2VL10C6S/4. The speed is 1,500rpm. The electricity generated by the project is only use for internal use, no electricity supplied to the grid. A biogas heat boiler will also be installed at the biogas power plant to generate heat for the utilization of the auxiliary equipment of the project.

Emergency flare system

An emergency enclosed flare system was installed to ensure all the biogas was destroyed in case the generator is defected. The power rate is 2 kW, the design discharge is 1,900m³/h.

Table 1-1 Main Equipment Parameter⁵

Parameter	Value	Unit
Completely Stirred Tank Reactor (CSTR) Type Anaerobic Digester		
Number	6	-
Effective Volume	7,000	m ³
Manufacturer	Hangzhou Energy and Environmental Engineering Co., Ltd	-
Double membrane dry gas holder		
Number	2	-
Effective Volume	4,000	m ³
Manufacturer	Hangzhou Energy and Environmental Engineering Co., Ltd	-
Electricity Generation System		
Type	LSA50.2VL10C6S/4	-
Design Capacity	1,000	kW
Speed	1,500	rpm
Number	1	-
Manufacturer	Hangzhou Energy and Environmental Engineering Co., Ltd	-
Boiler		
Type	CWNS4.2-95/70-Y.Q	-

⁵ According to Equipment nameplate.

Rated working pressure	4.2	MW
Number	1	-
Manufacturer	Zhejiang Tefu Development Co., Ltd	-

1.13 Project Location

The Project is located at Hongcunpu Village, Leizu Town, Xiping County, Zhumadian City, Henan Province, P.R China. The coordinates of the project site are 33°25'0"N, 113°42'6"E. The project location is shown in Figure 1.1.



Figure 1.1 Location of the Project

1.14 Conditions Prior to Project Initiation

The baseline scenario is the same as the conditions existing prior to the project initiation. Please refer to Section 3.4 (Baseline Scenario).

In absence of the project, the animal manure waste would be disposed in uncovered anaerobic manure management system (lagoon) and methane is emitted to the atmosphere.

1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project complies with all Chinese relevant laws and regulations. Mainly include:

1. Environmental Protection Law of People's Republic of China⁶;
2. Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution⁷;
3. Regulations on prevention and control of pollution from large scale livestock and poultry breeding⁸
4. Renewable Energy Law of the People's Republic of China⁹;
5. Catalogue for the Guidance of Industrial Structure Adjustment (2019 revision)¹⁰;
6. Livestock Law of the People's Republic of China(Revised in 2022)¹¹

The project has obtained the project approval and EIA approval from local government authorities: Xiping County Development and Reform Commission and Zhumadian Ecological Environment Bureau. The two approvals well demonstrate that local government permits the construction of the project. Consequently, the project is compliance with laws, status and other regulatory frameworks.

1.16 Double Counting and Participation under Other GHG Programs

1.16.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

⁶ http://www.china-npa.org/uploads/1/file/public/201803/20180327160313_j8uwkhdsgn.pdf

⁷ https://www.mee.gov.cn/ywgz/fgbz/fl/202004/t20200430_777580.shtml

⁸ http://www.gov.cn/flfg/2013-11/26/content_2535095.htm

⁹ http://www.nea.gov.cn/2017-11/02/c_136722869.htm

¹⁰ http://www.gov.cn/xinwen/2019-11/06/content_5449193.htm

¹¹ http://www.npc.gov.cn/npc/c2/c30834/202210/t20221030_320096.html

☐ Yes☒ No

1.16.2 Registration in Other GHG Programs

Has the project registered under any other GHG programs?

☐ Yes☒ No

1.16.3 Projects Rejected by Other GHG Programs

Has the project been rejected by any other GHG programs?

☐ Yes☒ No

1.17 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.17.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes☒ No

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

China has a national emissions trading scheme only cover the high-emission industries that emit at least 26,000 tons of (eg. petrochemical, chemical, building materials, iron and steel, non-ferrous, paper, aviation) CO₂e/year, not including renewable project¹². And the project activity is not included the mandatory emission control scheme and there is no emission cap enforced for the project owner according to the enforced company list in public information¹³. The project did not register or applied for registration under the Chinese Pilot Market for Carbon Trading. The Chinese Pilot Market for Carbon Emission Trading built 7 pilot markets for carbon trading in 2011 in Beijing City, Shanghai City, Tianjin City, Chongqing City, Guangdong Province, Hubei Province, and Shenzhen City¹⁴. The project locates in Liaoning Province, which was not part of the pilot markets. Furthermore, the project does not register or applies for registration under the Chinese Carbon Trading Market, which replaces the pilot market since 2021.

¹² https://www.mee.gov.cn/xxgk2018/xxgk/xxgk05/202103/t20210330_826728.html

¹³ http://sthjt.zj.gov.cn/art/2021/12/16/art_1229263559_4843729.html

¹⁴ https://www.gov.cn/xinwen/2021-08/03/content_5629115.htm

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

1.17.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

1.17.3 Supply Chain (Scope 3) Emissions

Do the project activities specified in Section 1.12 affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

1.18 Sustainable Development Contributions

1.18.1 Sustainable Development Contributions Activity Description

The project uses animal manure waste as ferment material to produce biogas for electricity generation. The project achieves significant GHG emission reductions by destroying biogas that would have been vented into the atmosphere directly in the absence of the project activity. The project also provides long-term job opportunities to local people and contributes to the economic prosperity.

The Project contributes to sustainable development in the following ways:

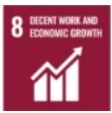
- The project uses dairy cattle manure wastes ferment material to produce biogas for electricity and heat generation, which reducing waste generation through recycling and reuse. Thus, the project will achieve SDG 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”¹⁵.
- The project provides job opportunities and increase tax revenue, which will have a positive effect on the local economy. Thus, the project achieved SDG 8 “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”¹⁶.
- The project will achieve a GHG emission reduction during the crediting period. The project will recover and destroy biogas that would otherwise be released directly into the

¹⁵ <https://sdgs.un.org/goals/goal7>

¹⁶ <https://sdgs.un.org/goals/goal8>

atmosphere, effectively reducing greenhouse gas emissions, which contributes to China's commitment to peak carbon dioxide emissions before 2030. Thus, the project will achieve SDG 13 "Take urgent action to combat climate change and its impacts"¹⁷..

The project contributes to achieving Chinese sustainable development priorities is described as below:

SDG Targets		Chinese Sustainable Development Progress	Project activity contribution
	SDG 7 "Ensure access to affordable, reliable, sustainable and modern energy for all"	By the end of 2015, China had fully solved the problem of providing electricity to all people without electricity, and reached the goal of the Sustainable Development Agenda 15 years ahead of schedule. From 2015 to 2021, the share of non-fossil energy increased from 14.5 % to 20.6%, while the share of raw coal decreased from 72.2 % to 66.7%.	The project is to use the biogas for power generation for the daily use of Zhumadian Youran Xiping Dairy Farm and natural gas upgrading (in the future), accordingly, substitute equivalent electricity from thermal power . This contributes to achieve China's stated sustainable development priorities "By 2030, the proportion of non-fossil energy consumption will reach about 25%".
	SDG 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all".	China is deeply implementing the employment priority strategy, placing the promotion of employment as a top priority for economic and social development, and promoting decent work and comprehensive development for workers. Firstly, the scale of employment continues to expand, while the level of unemployment remains low. From 2015 to 2022, the average annual increase in urban employment was about 13 million, with 733.51 million employed people nationwide in 2022. The second is the	The project activity can provide employment opportunities for local villagers. This contributes to one of China's actions for promoting sustainable developing: "by 2030, achieve full and productive employment and decent work for all women and men, including for young people and persons with disabilities, and equal pay for work of equal value".

¹⁷ <https://sdgs.un.org/goals/goal13>

		continuous optimization of the employment structure, and the employment structure of the "inverted pyramid" of the three industries is gradually forming. Thirdly, the quality of employment continues to improve, and the employment of key groups remains stable.	
	SDG 13 "Take urgent action to combat climate change and its impacts".	China has promoted the clean, low-carbon and efficient use of energy, and made new achievements in the clean and low-carbon transformation of industry, construction, transportation and other fields. In 2022, China's energy consumption per unit of GDP was reduced by 35% compared with 2012.	The project is to utilize the LFG for electricity generation to avoid methane emissions and CO ₂ emissions from the production of the equivalent amount of electricity replaced by the Project that would otherwise have been purchased from the CCPG. This contributes to achieve China's stated sustainable development priorities "China's carbon dioxide emissions would strive to peak by 2030 and strive to achieve carbon neutrality by 2060".

1.18.2 Sustainable Development Contributions Activity Monitoring

The project, located in Hongcunpu Village, Leizu Town, Xiping County, Zhumadian City, Henan Province, P.R China, utilizes biogas to generate power. By utilizing animal manure waste as ferment material to produce biogas, the project achieves significant GHG emission reductions. The project is owned and implemented by Zhumadian Youran Animal Husbandry Co., Ltd. The project also provides long-term job opportunities for local people and contributes to the economic prosperity.

Table 1: Sustainable Development Contributions

Row number	SDG target	SDG indicator	Net impact on SDG indicator	Current project contributions	Contributions over project lifetime
1)	7.2	7.2.1 Renewable energy share in the total final energy consumption Project Level indicator: Renewable energy supplied to the dairy cattle farm	Implemented activities to increase	7,198,080 MWh of electricity generated from the recovered biogas, which is a renewable fuel source, was supplied to the dairy cattle farm during this monitoring period.	From 15-Apr-2023 to 31-Dec-2024, 7,198,080 MWh of electricity generated from the recovered biogas, which is a renewable fuel source, was supplied to the dairy cattle farm during this monitoring period.
2)	8.5	8.5.1 Average hourly earnings of employees, by sex, occupation and persons with disabilities Project Level indicator: The number of long-term jobs by the implementation of the project.	Implemented activities to increase	Provided 21 (including 17 male and 4 female) employment positions for local people. No further changes during the first monitoring period.	Provided 21 (including 17 male and 4 female) employment positions for local people during the first monitoring period.
3)	13.2	13.2.2 Total greenhouse gas emissions per year Project Level indicator: Tonnes of greenhouse gas emissions avoided or removed.	Implemented activities to increase	The project achieved a GHG emission reduction of 91,275 tCO ₂ e during the first monitoring period.	From 15-Apr-2023 to 31-Dec-2024, the project has achieved a GHG emission reduction of 91,275 tCO ₂ e.

1.19 Additional Information Relevant to the Project

Leakage Management

According to the methodology, no leakage effects are accounted for.

Commercially Sensitive Information

There is no commercially sensitive information has been excluded from the public version of the project description.

Further Information

There is no additional relevant legislative, technical, economic, sectoral, social, environmental, geographic, site-specific and/or temporal 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 AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification

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

The following people are considered as the stakeholders of the project during the implementation stage.

	- Residents of the nearby village about 2 km. - Relevant administrative staff of the local government. - Staff of the farm and the project.
Legal or customary tenure/access rights	Applicable legal frameworks govern land and manure use and access rights. The project activity do not involve alterations to the existing legal or customary tenure/access rights of stakeholders, indigenous people (IPs), local communities (LCs), or customary rights holders, as the land is already designated for industrial purposes. And due to the project owner of the farm is the same as the project, thus there is no manure resource conflict.
Stakeholder diversity and changes over time	The social diversity mainly includes the differences of age, education, and occupations. The nearby residents are dominated by farmers, who also have a relatively low level of education. The worker of the plant is in the range of legal enforcement which is between 22 and 60/55 (male/female) years old. From the public recruitment information, workers of the project at least have accepted junior high school education. Experts and management personnel might be people who accept higher education or older. But it's not absolute. The economic sources of the stakeholders mainly come from farming, migrant work, individual enterprises and working in enterprises and governments. There are some disparities in income between different staff members. The project employs some local residents to solve some employment problems and increase their income. The stakeholders involved in the project are all Han, no minority ethnic groups are involved, and no obvious significant cultural diversity identified among Han people. The interactions between the stakeholder groups are mainly collaboratively, involves project information sharing and joint decision-making. Over time, the members of each group will adjust, but their groups does not change much in terms of society, economy, culture, etc.
Expected changes in well-being	The project is expected to improve the local environment. The large amount of manure generated in the project will be disposed to avoid direct exposure to the environment in the open lagoon, thereby reducing the spread of pathogens and the emission of odorous gases, and lowering the risk of pollution to the

	surrounding air, soil, and water bodies, and avoiding the methane emission in the open lagoon. Besides, the project provides numerous employment options for residents, which will subsequently lead to a reduction in the number of impoverished households. By increasing their income, these job opportunities will enable individuals to connect with one another and engage in more social activities, ultimately fostering greater interaction within the community. As a result, the overall welfare of the local communities will witness a substantial improvement.
Location of stakeholders	Stakeholders in this project located at the project site and within a few kilometers of it.
Location of resources	The project is not involved the territories and resources, or customary access of the stakeholders own.

2.1.2 Stakeholder Consultation and Ongoing Communication

Date of stakeholder consultation	11-May-2021
Stakeholder engagement process	Prior to the Project construction, the project owner conducted local stakeholder consultation by meeting and distributing survey questionnaires on 11-May-2021, to get informed of the stakeholders' opinion about the Project in various aspects. The project owner started notifying stakeholders on 04-May-2021 by means of distributing brochures and putting up leaflets on bulletin boards at various locations of the landfill and the village. The brochures and leaflets included general information of the project (purpose, planned location, planned dates of construction and commissioning), the date and the purpose of the upcoming stakeholder consultation as well as the project owner's phone number and email address. On 11-May-2021, 30 people including residents of the nearby village and staff of the farm attended the consultation. Among them, 17 were male and 13 were female, and the age ranged from 22 to 65. The project owner initiated the consultation by giving an introduction of the planned biogas recovery and utilization project. Following the introduction, the project owner had a discussion with the participants on various issues and 30 questionnaires were

	distributed and all questionnaires collected for the survey.
Consultation outcome	No negative feedback was received from the consultation meeting survey and the local community expressed their approval for the project. All surveyed members of the public are aware of the construction of the project and believe that the construction of the project will be beneficial or basically have no impact on their lives, and all in favor of the construction of the project under the premise of taking environmental protection measures to ensure that the emission standards are met.
Ongoing communication	The project owner has set up an on-going communication mechanism to regularly hold stakeholder meetings, distribute questionnaires and give the response to various stakeholders. Communications with Local stakeholders are being carried out at periodic intervals. During the first monitoring period, one stakeholder consultation took place on 23-August-2023 through questionnaire survey. Moreover, local stakeholders can also raise their concerns and opinions directly by making a phone call to the project owner. They can also contact the local government agencies, especially Zhumadian Ecological Environment Bureau, who are responsible for continuously ensuring the project compliance with laws and regulations.
Stakeholder input	During the project operation, feedback from stakeholders through surveys, phone calls, etc., regarding the project were collected and regularly reported to company management. Regarding environmental impact or safety issues, the relevant responsible personnel would be promptly notified for inspection and corrective action upon receiving the feedback, and an immediate report would be submitted to the company management.

2.1.3 Free Prior and Informed Consent

Obtaining consent	The project belongs to the emission reduction project and is supported and encouraged by the government. The project has obtained project approval and EIA approval from local government. Therefore, the project has been approved by the local government. Meanwhile, the project owner of Zhumadian Youran Xiping Dairy
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	Farm is the same with the project, therefore there is no conflict over biogas resources. The project has maintained ongoing communication with the local residents and has secured permission and support for its construction and operation, as detailed in section 2.1.2. There are no ongoing or unresolved conflicts.
Outcome of FPIC	Local stakeholders are supportive of the construction of the project. The project was constructed with the consent of government departments at all levels. The project has not encroached on land, relocated people without consent, and forced physical or economic displacement. Most surveyed stakeholders think the project improves regional economic development without adverse environmental impact. The survey shows that the stakeholders are supportive of the project.

2.1.4 Grievance Redress Procedure

Development process	There is an opinion book about the project at the entrance of the project owner's company. The stakeholders can register any opinions and suggestions on the project in the opinion book at any time, or stakeholders can visit the official website of Zhumadian City Ecological Environment Bureau¹⁸ or call directly to reflect, report problem or give comments at any time. The project owner designates a person responsible for recording and collecting conflicts and grievances of the local community, and the related resolution process is as follows.
Grievance redress procedure	Firstly, once getting the complaints or grievances, project owner shall contact and discuss with relevant community or other stakeholders within 3 days. Then the specific staff of project owner should propose a solution and mediation which is performed by relevant government agency within a week based on all collected information. Thirdly, the project owner will address their complaints or grievances by relevant legal method such as arbitration and courts if necessary. Finally, the entire complaints or grievances redress process shall be dealt within 30 days.

¹⁸<https://sthjj.zhumadian.gov.cn/>

Grievances received	Resolution and outcome
No grievance received during this monitoring period.	Not Applicable.

2.1.5 Public Comments

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

Comments received	Actions taken
Not Applicable.	Not Applicable.

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

The project owner, Zhumadian Youran Animal Husbandry Co., Ltd. has sufficient capacity and experience in project management, and the project has been running since April 2023 without any problems. The technicians of project owner have professional licenses and extensive hands-on experience, and regular training is conducted to further improve the skills of its staff. As the parent company, Inner Mongolia Youran Animal Husbandry Co., Ltd. oversees a vast network of anaerobic fermentation of manure and utilization of biogas projects spread across multiple locations, such as Jinan Pingyin Youran Dairy Cattle Manure Management Project (VCS4443), which was operated by another subsidiary Jlnan Youran Animal Husbandry Co., Ltd., who can provide corresponding technical and management support and training to the project owner.

Climate Bridge (Shanghai) Ltd. has successfully developed emission reductions and/or removals projects under the VCS program and fully understands the requirements of the standard as well as the validation and verification process. Having signed an agreement with the project proponent, Climate Bridge (Shanghai) Ltd. develops the project under the VCS program and participates in various tasks associated with the project development, especially write-up of the project description and monitoring reports, preparation of the monitoring plan, etc.

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

2.2.2 Risk Assessment

	Risks identified	Mitigation or preventative measure(s) taken
Natural and human-induced risks to stakeholders' wellbeing	No risk identified	The project will provide socio-economic and environmental benefits. It will not cause negative impacts on stakeholders' livelihood or employment..The project uses CSTR type anaerobic digesters to treat dairy cattle manure. Its main purpose is to collect and eliminate the biogas produced by anaerobic fermentation for power generation, avoiding direct methane emissions into the atmosphere, reducing the emission of odorous gases, and improving the working environment.
Risks to stakeholder participation	No risk identified	The mechanism for on-going communication with local stakeholders has been set up. Stakeholders are free to reach the reflection portals anytime anywhere and face no barrier or pressure to report the problems without leaving their name or showing face.
Working conditions	No risk identified	According to EIA, the project owner has established and improved the safety production responsibility system; formulated safety production rules and regulations and operating procedures; formulated and implemented the safety production education and training plan. These measures ensure the effective implementation of safety production investment, eliminate safety hazards in time, and carry out the standardization construction of safety production. Moreover, the project uses CSTR type anaerobic digesters to treat dairy cattle manure. Its main purpose is to collect and eliminate the biogas produced by anaerobic fermentation for power generation, avoiding direct methane emissions into the atmosphere, reducing the emission of

		odorous gases, and improving the working environment.
Safety of women and girls	No risk identified	Article 12 of Labour Law of the People's Republic of China enforces: Labourers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. The project owner obeys the anti-discrimination rules set out in the law.
Safety of minority and marginalized groups, including children	No risk identified	Article 12 of Labour Law of the People's Republic of China enforces: Labourers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. And article 15 enforces: The employing units are prohibited from recruiting minors under the age of 16. The project owner strictly obeys the law.
Pollutants (air, noise, discharges to water, generation of waste, and release of hazardous materials and chemical pesticides and fertilizers)	No risk identified	The Project owner entrusted a third party, Henan Guanyu Environmental Protection Technology Co., Ltd to conduct the Environmental Impact Assessment (EIA) of the project. The EIA report was completed in December 2020 and was approved by Yingkou Administrative Approval Bureau on 12-January-2021 (Zhuhuanshen (2021) No.5). The environmental impacts of the project in operation period are summarized as follows. 1 Air pollution The air pollution during the operation mainly includes the exhaust gas of the anaerobic fermentation system, biogas generator, the boiler and the flare. The exhaust gas is to be treated through 2 stage purification equipment before being discharged through exhaust cylinders with with a height of not less than 15m..

		The H₂S, NH₃ and odorous substance in all the exhaust gas by the project can meet the requirements of Table 2 standard limit of the "Odorous Pollutant Emission Standard" (GB14554-1993)..The SO₂, NO_x, and particulate matter in all the exhaust gas by the project meets Grade 2 emission standard of "Integrated Emission Standard of Air Pollutants" (GB16297-1996). 2 Wastewater The wastewater during operation is mainly domestic sewage and biogas slurry from anaerobic digesters. The domestic sewage of the project is pretreated in a septic tank and reused in anaerobic digesters. Biogas slurry will be directly returned to nearby farmland as fertilizer. No wastewater will be discharged to the environment. 3.Noise The high noise equipment of the project mainly consists of various fans and pumps. After sound insulation, vibration reduction, noise elimination, greening and distance attenuation, the noise at the plant boundary can meet the requirements of Class II standard of the "Emission Standard for Industrial Enterprises Noise at Boundary" (GB12348-2008). By taking the measures above, the impact of the project's noises on the surrounding area is small. 4. Solid waste The solid wastes generated in the operation process of this project mainly include filtered sand, waste desulfurizer, waste filter element and domestic waste of employees. All of the filtered sand are supplied to dairy farm as bedding for cattleheds. The project site sets up a hazardous waste collection site,
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		and hazardous waste collected is disposed by the qualified company. The storage and disposal meet the requirements of “Standard for pollution control on hazardous waste storage” (GB18597-2001&2013). Domestic waste will be collected, cleaned and disposed by the local sanitation department. The other general industrial solid wastes are regularly removed by the qualified company, the storage of general industrial solid wastes can meet the requirements of “Standard for pollution on the storage and disposal site for general industrial solid wastes” (GB18599-2001). In conclusion, the environmental impact during the project operation will be minor. The project can reduce greenhouse gas emissions and environmental pollution caused by methane released. The Project owner takes appropriate measures to minimize adverse environmental impacts.
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2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

	Risks identified ¹⁹	Mitigation or preventative measure(s) taken
Discrimination	No risk identified	Article 12 of Labour Law of the People’s Republic of China enforces: Labourers, regardless of their ethnic group, race, sex, or religious belief, shall not be discriminated against in employment. The project owner strictly obeys the anti-discrimination rules set out in the law. No discrimination has occurred or will occur.
Sexual harassment	No risk identified	Article 40 of Law of People’s Republic of China

¹⁹ The identified risks and commensurate mitigation or preventative measure(s) for forced labor, child labor, and human trafficking, must be inclusive of staff and contracted workers employed by third parties.

		for the Protection of Women's Rights and Interests enforces: Sexual harassment of women is prohibited. Women victims have the right to complain to their units and relevant authorities. The project owner strictly obeys the anti-discrimination rules set out in the law. No discrimination or sexual harassment has occurred or will occur.
Equal pay for equal work	No risk identified	Article 46 of the Labour Law of the People's Republic of China stipulates that the distribution of wages shall be based on the principle of distribution according to work, with equal pay for equal work. The project owner strictly obeys the law. 21 employment positions (including 17 male and 4 female) is provided for local people during the first monitoring period.
Gender equity in labor and work	No risk identified	Chapter IV Labor and Social Security Rights and Interests of Law of People's Republic of China for the Protection of Women's Rights and Interests provide the legal enforcement for gender equity in labour and work. The project owner strictly obeys the law.
Forced labor	No risk identified	Article 244 of the Criminal Law of the People's Republic of China [Crime of Forced Labor] Anyone who forces another person to work by means of violence, threat or restriction of personal freedom shall be sentenced to fixed-term imprisonment of not more than three years or detention, and shall be fined; if the circumstances are serious, he shall be sentenced to fixed-term imprisonment of not less than three years but not more than 10 years, and shall be fined. The project owner strictly obeys the law.
Child labor	No risk identified	Article 15 of the Labor Law of the People's Republic of China states: "Employers are prohibited from employing minors under the age of sixteen. The project owner strictly obeys the

		law.
Human trafficking	No risk identified	All the labour is hired from normal paths. Laborers have the right to resign anytime. Article 15 of Labour Law of People's Republic of China enforces: The employing units are prohibited from recruiting minors under the age of 16. The project owner strictly obeys the law.

2.3.2 Human Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	The project strictly follows the Labour Law of in line with People's Republic of China. The legal rights and interests of all employees are protected. The project is committed to upholding the rights of IPs, LCs, and customary rights holders by engaging in ongoing, informed consultations, obtaining their free, prior, and informed consent for any activities, and ensuring that their cultural heritage and traditional knowledge are respected and preserved by "1989 Indigenous and Tribal Peoples Convention (No. 169)", "1992 Declaration on the Rights of Persons Belonging to National or Ethnic, Religious and Linguistic Minorities" and "2007 Declaration on the Rights of Indigenous Peoples".

2.3.3 Indigenous Peoples and Cultural Heritage

Risks identified	Mitigation(s) or preventative measure taken
No risk identified	The purpose of the project is to utilize biogas generated from animal manure waste by anaerobic fermentation, which consists mainly of methane, for electricity and heat generation. The project improve the local environment and encourage employees to preserve and protect cultural heritage as part of project activities.

2.3.4 Property Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	The project prioritizes protecting stakeholders' property rights by engaging in regular consultations, complying with legal standards, documenting rights, offering accessible conflict resolution, and ensuring fair benefit sharing and transparent monitoring.

2.3.5 Benefit Sharing

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

2.4 Ecosystem Health

	Risks identified	Mitigation or preventative measure(s) taken
Impacts on biodiversity and ecosystems	No risk identified	The project activity is renewable electricity generation that avoids direct emissions of methane (CH ₄) emissions from the anaerobic animal manure management system (lagoon) into the atmosphere, which has no negative impact to biodiversity and ecosystems. The project is also not located in the protected area.
Soil degradation and soil erosion	No risk identified	According to EIA of the project, the facilities for storing, transporting, and treating wastewater in this project are equipped with anti leakage measures, and the maintenance and upkeep of the anaerobic fermentation system are strengthened to ensure the normal operation of the equipment. At the same time, taking into

		account the fertilizer requirements, soil conditions, climate environment, and other factors in the project area, the combination and application amount of biogas slurry are determined, and scientific and reasonable fertilization is carried out. After the project is put into operation, it will provide high-quality fertilizers, which can reduce the use of chemical fertilizers and pesticides, and improve the physical and chemical properties of the soil.
Water consumption and stress	No risk identified	Cooling water of biogas power generation system is recycled for reuse, as a way to optimize and minimize the water consumption by the project. The water consumption by the project does not affect local water use and does not lead to increased water stress.

2.4.1 Rare, Threatened, and Endangered species

Is the project located in or adjacent to habitats for rare, threatened, or endangered species?

☐ Yes ☒ No

	Risks identified	Mitigation or preventative measure(s) taken
Habitats for rare, threatened, and endangered species	No risk identified	As per the EIA report, the project's location does not involve any habitats for rare, threatened, or endangered species.
Areas for habitat connectivity	No risk identified	The project's located in Hongcunpu Village, Leizu Town, Xiping County, Zhumadian City, there is no areas for habitat connectivity.

2.4.2 Introduction of species

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

2.4.3 Ecosystem conversion

	Risks identified	Mitigation or preventative measure(s)
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		taken
Ecosystem conversion	No risk identified	Not applicable as the project is a non-AFOLU project.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	AMS-III.D.	Methane recovery in animal manure management systems ²⁰	21.0
Tool	TOOL06	Project emissions from flaring ²¹	04.0
Tool	TOOL14	Project and leakage emissions from anaerobic digesters ²²	03.0

For more detail information about the methodologies and tools, please reference to the following link:

<https://cdm.unfccc.int/methodologies/DB/H9DVSB2407GEZQYLYNWUX23YS6G4RC>

3.2 Applicability of Methodology

The project satisfies all the applicability criteria of the methodology AMS-III.D. (Version 21.0), of which the detailed description is listed in Table 3-1 below:

Table 3-1 Applicability of AMS-III.D.

No.	Applicability conditions of the methodology	The project
1	This methodology covers project activities involving the replacement or modification of	Applicable. The project is a plant treats animal manure

²⁰ <https://cdm.unfccc.int/UserManagement/FileStorage/1AWXEKHVTYF423LCN56Z9GIMQOS8JR>

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

²² <https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-14-v3.pdf>

	anaerobic animal manure management systems in livestock farms to achieve methane recovery and destruction by flaring/combustion or gainful use of the recovered methane. It also covers treatment of manure collected from several farms in a centralized plant	waste collected from Zhumadian Youran Xiping Dairy Farm. The project replaces existing anaerobic animal manure management systems (open lagoon) in livestock farm to achieve methane recovery and destruction by flaring/combustion, gainful use (electricity and heat generation) and natural gas upgrading in the future of the recovered methane.
2	This methodology is only applicable under the following conditions: a) The livestock population in the farm is managed under confined conditions	Applicable. All the livestock population in the Zhumadian Youran Xiping Dairy farm within the project boundary is managed under confined conditions.
	b) Manure or the streams obtained after treatment are not discharged into natural water resources (e.g. river or estuaries), otherwise "AMS-III.H Methane recovery in wastewater treatment" shall be applied	Applicable. As per the FSR and EIA report of the project, manure or the streams obtained after treatment are not discharged into natural water resources (e.g. river or estuaries). The biogas residue (dried part) from the CSTR digesters will be used as cattle bedding material, and biogas slurry (liquid part) will be directly returned to the nearby farmland through a lifting pump station and a pipeline network.
	c) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C	Applicable. The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C. The average temperature in project site of Zhumadian City is 14.7~15.0°C ²³ .
	d) In the baseline scenario the retention time of manure waste in the anaerobic treatment system is greater than one month, and if anaerobic lagoons are used in the baseline, their depths are at least 1 m	Applicable. In the baseline scenario the retention time of manure waste in the anaerobic lagoon of Zhumadian Youran Xiping Dairy farm is 45 days, and the depth is 3 m.
	e) No methane recovery and destruction by flaring or combustion for gainful use takes place in the baseline scenario	Applicable. No methane recovery and destruction by flaring or combustion for gainful use takes place in the baseline scenario for the project.
3	The project activity shall satisfy the following	Applicable.

²³ https://www.zhumadian.gov.cn/mltz/zrdl/202212/t20221209_35645.html

	conditions: (a) The residual waste from the animal manure management system shall be handled aerobically, otherwise the related emissions shall be taken into account as per relevant procedures of "AMS-III.AO Methane recovery through controlled anaerobic digestion". In the case of soil application, proper conditions and procedures (not resulting in methane emissions) must be ensured;	The residual waste (dried part) from the animal manure management system of the project will be used as cattle bedding material, and biogas slurry (liquid part) will be directly returned to the nearby farmland through a lifting pump station and a pipeline network. Digestate will not be stored under anaerobic conditions and will not result in methane emissions.
	(b) Technical measures shall be used (including a flare for exigencies) to ensure that all biogas produced by the digester is used or flared;	Applicable. Biogas generated by the project is used directly for electricity generation, heating and natural gas upgrading in the future, the emergency flare ensures biogas would be destroyed while exigencies happened.
	(c) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the anaerobic digester. If the project proponent can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.	Applicable. For the project, the storage time of the manure after removal from the animal barns, including transportation will be about 7 hours, not exceed 45 days before being fed into the anaerobic digester.
4	Projects that recover methane from landfills shall use "AMS-III.G Landfill methane recovery" and projects for wastewater treatment shall use AMS-III.H. Projects for composting of animal manure shall use "AMS-III.F Avoidance of methane emissions through composting". Project activities involving co-digestion of animal manure and other organic matters shall use the methodology "AMS-III.AO Methane recovery through controlled anaerobic digestion".	Irrelevant. The project does not involve landfill methane recovery, wastewater treatment, composting animal manure, or co-digestion of animal manure and other organic matters.
5	Utilization of the recovered biogas in one of the options detailed in AMS-III.H is also eligible under this methodology. The respective procedures in AMS-III.H shall be followed in this regard. If the recovered biogas is used to power auxiliary equipment of the project activity, it should be taken into account accordingly, using zero as its emission factor; however, energy used for such purposes is not eligible as an SSC CDM Type I project component.	Applicable. The biogas generated from CSTR of the project is for gainful use (electricity, heat generation and natural gas upgrading in the future), which is applicable under paragraph 4(a) of AMS-III.H., i.e. the recovered biogas are utilized for the thermal or mechanical, electrical energy generation directly instead of combustion/flaring. The electricity and heat generated from biogas combustion is used in auxiliary equipment of the project activity and the farm, no electricity delivered to the power grid, zero is used as its

		emission factor, and the project is not eligible as an SSC CDM Type I project component, which means no emission reductions will be claimed for electricity generation. In the future, a plan is made to sell the excess biogas to the third party for natural gas upgrading and accordingly the natural gas will be transported and sold by the third party. According to the project owner, the upgrading natural gas from excess biogas may be used as paragraph 4(c) (i) in the methodology AMS-III.H: Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; For this condition, the upgrading natural gas production (NG_y) has been monitored. The relevant emission reductions from the displacement of the use of natural gas shall be considered in the future.
6	New facilities (Greenfield projects) and project activities involving capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirements in the "General guidelines for SSC CDM methodologies".	Applicable. The project is a Greenfield project. The emission reduction sourced from methane recovery is 59,610 tCO₂e/yr, which is lower than the threshold of 60,000 tCO₂e/yr. Therefore, the Project is in line with "General Guidelines to SSC CDM methodologies".
7	The requirements concerning demonstration of the remaining lifetime of the replaced equipment shall be met as described in the "General guidelines for SSC CDM methodologies".	The project is a Greenfield project, does not involve the replaced equipment; therefore, this is irrelevant.
8	Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO ₂ equivalent annually from all Type III components of the project activity.	Applicable. The emission reductions from the recovery and destruction of methane (viz. Type III components of the project) is 59,610 tCO₂e/yr, which is less than 60 kt CO₂ equivalent.

In addition, the project meets the applicability conditions of the applied tools applied in the PD as follows:

Table 3-2 Applicability of applied tools

Tool	Applicability	The project
Tool 06: Project emissions from	This tool provides procedures to calculate project emissions from flaring of a residual gas. The tool is applicable to	Applicable. According to the FSR, the project

flaring (version 04.0)	enclosed or open flares and project participants should document in the CDM-PDD the type of flare used in the project activity.	uses enclosed flare system.
	This tool is applicable to the flaring of flammable greenhouse gases where: (a) Methane is the component with the highest concentration in the flammable residual gas; and (b) The source of the residual gas is coal mine methane or a gas from a biogenic source (e.g. biogas, landfill gas or wastewater treatment gas).	Applicable. Methane is the component with the highest concentration in the residual gas utilized and flared in the project, and the source of residual gas is from biogas.
	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. In the case of an enclosed flare, there shall be operating specifications provided by the manufacturer of the flare and these shall be followed by the project participant.	Applicable. No auxiliary fuel is required for the combustion of biogas in this project, and the project participants operate in strict accordance with the operational specifications.
Tool 14: Project and leakage emissions from anaerobic digesters (version 03.0)	This tool provides procedures to calculate project and leakage emissions associated with anaerobic digestion in anaerobic digesters. The tool is not applicable to other systems where waste may be decomposed anaerobically, for instances stockpiles, SWDS or unaerated lagoons.	Applicable. The project uses animal manure waste as ferment material to produce biogas in the Completely Stirred Tank Reactor (CSTR) type anaerobic digesters, not involving decomposed anaerobically, for instances stockpiles, SWDS or unaerated lagoons.
	The following sources of project emissions are accounted for in this tool: (a) CO₂ emissions from consumption of electricity associated with the operation of the anaerobic digester; (b) CO₂ emissions from consumption of fossil fuels associated with the operation of the anaerobic digester; (c) CH₄ emissions from the digester (emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety	Applicable. Source (a),(c) and (d) of project emissions have been accounted. The project does not involve fossil fuel consumption, so the emission from consumption of fossil fuels is not included.

	valves due to excess pressure in the digester); and (d) CH ₄ emissions from flaring of biogas.	
	The following sources of leakage emissions are accounted for in this tool: (a) CH ₄ and N ₂ O emission from composting of digestate; (b) CH ₄ emissions from the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage, such as in a stabilization pond.	Irrelevant. The residual waste (dried part) from the animal manure management system of the project will be used as cattle bedding material, and biogas slurry (liquid part) will be directly returned to the nearby farmland through a lifting pump station and a pipeline network. Digestate will not be stored under anaerobic conditions. Thus, there are no CH ₄ and N ₂ O emissions from this procedure.
	Emission sources associated with N ₂ O emissions from physical leakages from the digester, transportation of feed material and digestate or any other on-site transportation, piped distribution of the biogas, aerobic treatment of liquid digestate and land application of the digestate are neglected because these are minor emission sources or because they are accounted in the methodologies referring to this tool.	Applicable. As per the applied methodology, N ₂ O emissions are neglected because these are minor emission sources.

3.3 Project Boundary

According to the methodology AMS-III.D., the project boundary includes the physical, geographical site(s) of (a) The livestock; (b) Animal manure management systems (including centralised manure treatment plant where applicable); (c) Facilities which recover and flare/combust or use methane.

Hence, the project boundary of the Project includes the physical and geographical sites of the livestock, the animal manure management system, the biogas generator, biogas boiler and the emergency flare. Figure 3-1 shows the project boundary of the Project Activity.

The diagram of the project boundary is shown in Figure 3.1.

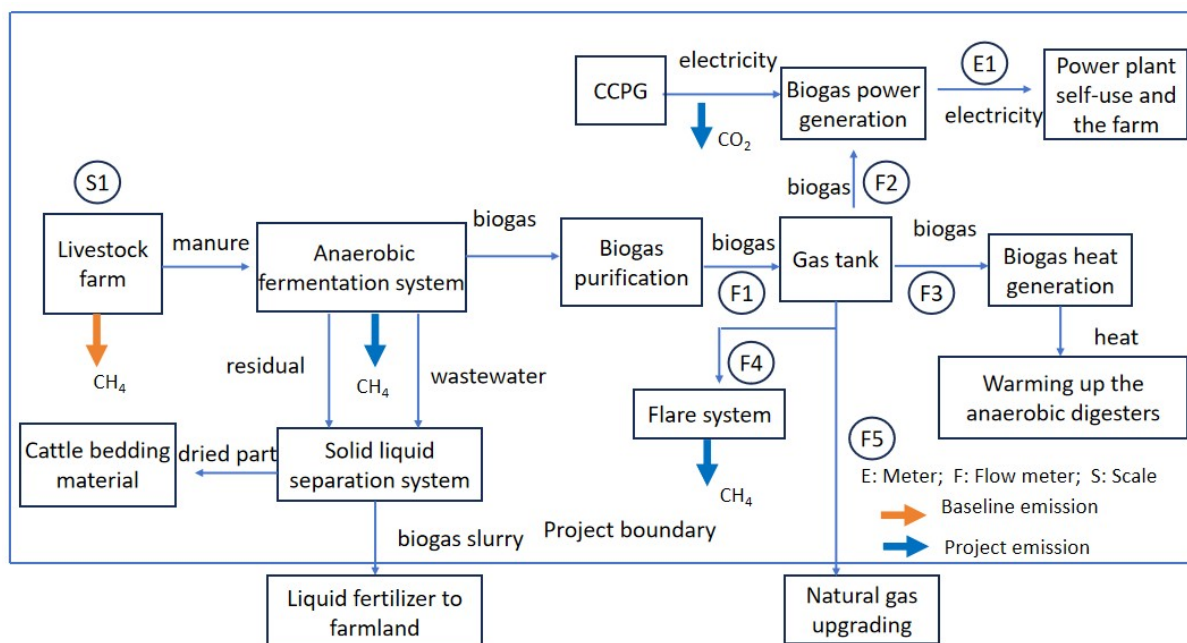


Figure 3.1 Diagram of the project boundary

The main emission sources and gases included in the project boundary are listed in table below:

Source	Gas	Included?	Justification/Explanation
Baseline	CO ₂	No	Excluded for simplification.
	CH ₄	Yes	The major source of emissions in the baseline
	N ₂ O	No	Excluded for simplification.
	CO ₂	No	Excluded for simplification.
	CH ₄	No	Excluded for simplification.
	N ₂ O	No	Excluded for simplification.
Project	CO ₂	No	Excluded for simplification.
	CH ₄	Yes	Main emission source.
	N ₂ O	No	Excluded for simplification.
	CO ₂	No	Excluded for simplification.
	CH ₄	Yes	The enclosed flare has been installed to flare the excess biogas from biogas generator when exigencies happened. The emission from flaring is

Source	Gas	Included?	Justification/Explanation
			included. ²⁴ .
	N ₂ O	No	Excluded for simplification.
Emissions from use of fossil fuels or electricity	CO ₂	Yes	The project consumes electricity during operation, so Emission from use of electricity is the main emission source. The project does not involve fossil fuel consumption, so the emission from use of fossil fuels is not included.
	CH ₄	No	Excluded for simplification.
	N ₂ O	No	Excluded for simplification.
Emissions from incremental transportation distances	CO ₂	No	The CSTR type anaerobic digesters is installed within the farm. The project has no incremental transportation compared to the baseline scenario, so the emission from incremental transportation is not accounted for.
	CH ₄	No	Excluded for simplification.
	N ₂ O	No	Excluded for simplification.
Emissions from the storage of manure	CO ₂	No	Excluded for simplification.
	CH ₄	No	The storage time of the manure after removal from the animal barns, including transportation, is about 7 hours before being fed into the anaerobic digester, hence Emissions from the storage of manure is not accounted for.
	N ₂ O	No	Excluded for simplification.

3.4 Baseline Scenario

As per para. 17 of AMS-III.D, the baseline scenario is the situation where, in the absence of the project activity, animal manure is left to decay anaerobically within the project boundary and methane is emitted to the atmosphere.

Hence, the baseline scenario of the project is the animal manure waste was left to decay in anaerobic manure management system (open lagoon) at the livestock farms and methane is emitted to the atmosphere directly without any methane recovery and destruction facility.

²⁴ Only when emergency occurs or the biogas is residual besides used for energy use, the emergency flare system will be used and the biogas will be flared. In this situation, there will be project emission from flaring.

3.5 Additionality

The project uses the following steps to demonstrate additionality. The project meets the additionality criteria as outlined in the VCS methodology as:

Step 1: Regulatory Surplus: the project is not mandated by any legal requirements. Please refer to section 3.5.1 below for details.

3.5.1 Regulatory Surplus

Is the project registered or seeking registration in an UNFCCC Annex 1 or Non-Annex 1 country?

☐ Annex 1 country

☒ Non-Annex 1 country

Are the project activities mandated by any law, statute, or other regulatory framework?

☐ Yes

☒ No

If the project is located inside a Non-Annex 1 country and the project activities are mandated by a law, statute, or other regulatory framework, are such laws, statutes, or regulatory frameworks systematically enforced?

☐ Yes

☒ No

According to the relevant applicable laws and regulations at the time of submission of registration, i.e. Renewable Energy Law of the People's Republic of China which came into effect on 01-Jan-2006, Agenda for China's 14th Five-Year Plan (2021-2025), there are no new national and/or sectoral policies that could affect the baseline scenario during the crediting period. Therefore, the project is surplus to regulatory requirements.

3.5.2 Additionality Methods

As per para. 15-16 of applied methodology AMS-III.D, project activities may demonstrate the additionality by showing that there is no regulation in the host country, applicable to the project site, that requires the collection and destruction of methane from livestock manure. If so, it is not required to apply the "Guidelines on the demonstration of additionality of small-scale project activities". This additionality condition also applies to Greenfield project activities. Furthermore, for project activities applying this methodology in combination with a Type I methodology, that has an energy component whose installed capacity is less than 5 MW, this procedure for additionality demonstration also applies to that component.

In line with AMS-III.D, the project recovers biogas to generate electricity with a total installed capacity of 1MW, which is lower than 5MW. The regulations relative to the project in China are identified as below.

- a) Law of the People's Republic of China on Environment Protection;

- b) Law of the People's Republic of China on the Prevention and Control of Solid Waste Pollution;
- c) Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution;
- d) Regulations on prevention and control of pollution from large scale livestock and poultry breeding;
- e) Discharge standard of pollutants for livestock and poultry breeding (GB/T 18596);
- f) Technical standard of pollution prevention for livestock and poultry breeding (HJ/T 81).

It has been identified that all the above laws and regulations in China **do not** require the collection and destruction of methane from livestock manure. In line with AMS-III.D, the project is deemed automatically additional.

The additionality of the Project has thus been demonstrated.

3.6 Methodology Deviations

There is no methodology deviation for the project.

4 IMPLEMENTATION STATUS

4.1 Implementation Status of the Project Activity

The project is implemented in accordance with the description of this PD&MR in the former sections. The key system involved in the project are as follows:

Anaerobic animal manure management system

The Completely Stirred Tank Reactor (CSTR) type anaerobic digesters are to be applied in the project activity. Four high concentration CSTR digesters with effective volume of 7,000 m³ each and two low concentration CSTR digesters with the same effective volume and 42,000 m³ in total will be installed. The biogas produced from this procedure will be pipelined to biogas pre-treatment system.

Biogas pre-treatment system

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

Digestate advanced treatment unit

The digestate from the anaerobic digesters will be sent to digestate advanced treatment units, it mainly involved filter press and then return to nearby field.

Biogas power generation system

The biogas electricity generation plant will be installed at the project site. The installed capacity of the project is 1MW (1MW×1). The type of generator is LSA50.2VL10C6S/4. The speed is 1,500rpm. The electricity generated by the project is only use for internal use, no electricity supplied to the grid. Waste heat recovery boiler will also be installed at the biogas power plant to recover and supply waste heat to the auxiliary equipment of the project.

Emergency flare system

An emergency enclosed flare system was installed to ensure all the biogas was destroyed in case the generator is defected. The power rate is 2 kW, the design discharge is 1,900m³/h.

The timeline of the project is as below:

Start date of construction	25-Nov-2021
Start date of operation	15-Apr-2023
Start date of the crediting period	

The biogas from anaerobic animal manure management system is used for generating electricity and waste heat for onsite usage, the excess biogas is flared in this monitoring period. During this monitoring period, the project run continuously. No events or situations, which may impact the applicability of the applied methodology occurred.

5 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

According to the methodology AMS-III.D., Baseline Emissions (BE_y) are calculated by using one of the following two options:

- Using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC Tier 2 approach (please refer to the chapter 10 'Emissions from Livestock and Manure Management' under the volume 4 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse

Gas Inventories). For this calculation, information about the characteristics of the manure and of the management systems in the baseline is required. Manure characteristics include the amount of volatile solids (VS) produced by the livestock and the maximum amount of methane that can be potentially produced from that manure (B_0);

(b) Using the amount of manure that would decay anaerobically in the absence of the project activity based on direct measurement of the quantity of manure treated together with its specific volatile solids (SVS) content.

The project applies option (a) to calculate baseline emissions from the manure management (BE_y), and baseline emissions are determined as follows:

$$BE_y = GWP_{CH_4} \times D_{CH_4} \times UF_b \times \sum_{j,LT} MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{BL,j} \quad (1)$$

Where:

BE_y	=	Baseline emissions in year y (tCO ₂ e)
GWP_{CH_4}	=	Global Warming Potential (GWP) of CH ₄ applicable to the crediting period (tCO ₂ e/tCH ₄)
D_{CH_4}	=	CH ₄ density (0.67kg/m ³ at room temperature (20°C) and 1 atm pressure)
LT	=	Index for all types of livestock
j	=	Index for animal manure management system
MCF_j	=	Annual methane conversion factor (MCF) for the baseline animal manure management system j
$B_{0,LT}$	=	Maximum methane producing potential of the volatile solid generated for animal type LT (m ³ CH ₄ /kg-dm)
$N_{LT,y}$	=	Annual average number of animals of type LT in year y (numbers)
$VS_{LT,y}$	=	Volatile solids production/excretion per animal of livestock LT in year y (on a dry matter weight basis, kg-dm/animal/year)
$MS\%_{BL,j}$	=	Fraction of manure handled in baseline animal manure management system j
UF_b	=	Model correction factor to account for model uncertainties (0.94)

a) Maximum methane producing potential of the manure (B_0):

As per the paragraph 18(a) of AMS-III.D (Version 21.0), the maximum methane-producing capacity of the manure ($B_{0,LT}$) varies by species and diet. The preferred method to obtain $B_{0,LT}$ measurement values is to use data from country-specific published sources, measured with a standardised method ($B_{0,LT}$ shall be based on total as-excreted VS). These values shall be compared to IPCC default values and any significant differences shall be explained. If country

specific B_0 values are not available, default values from table 10.16A (UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be used, provided that the project participants assess the suitability of those data to the specific situation of the treatment site.

As per table 10.16 (UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10, the maximum methane producing potential (B_0) for dairy cattle from other regions with high productivity systems is $0.24 \text{ m}^3\text{CH}_4/\text{kg-dm}$.

b) Volatile solids production/excretion per dairy cattle in year y ($VS_{LT,y}$):

As per the paragraph 18 (b) (iii) of AMS-III.D (Version 21.0), if country specific VS values are not available, IPCC default values from 2019 Refinement to the 2006 IPCC Guidelines Volume 4 Chapter 10 table 10.13A (NEW) can be used provided that the project participants assess the suitability of those data to the specific situation of the treatment site particularly with reference to feed intake levels. According to the FSR of the project, dairy cattle purchase contracts, feed purchase contracts and the breeding contracts, the Zhumadian Youran Xiping Dairy Farm is 100 percent market oriented with high level of capital input and high level of overall herd (flock) performance. Most of the feed is purchased from local and other provinces in China, with a small amount purchased internationally, cattle are improved through breeding practices for commercial production. In the process of dairy farming, through scientific feeding management, excellent genetic breeding, and efficient disease prevention and control measures, outstanding performance of the dairy herd in terms of milk production, health status, and reproductive ability has been achieved. Therefore, the project site is deemed as high productivity systems in Asia. The default VS value of a dairy cattle from Asia with high productivity systems is $8.1 \text{ kg-VS}/1000\text{kg-mass}/\text{day}$. Since this default value is based on a daily basis, we convert it to an annual value using the following equation.

According to the equation 10.22A (UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10, the volatile solids production/excretion per dairy cattle in year y ($VS_{LT,y}$) can be determined as follows:

$$VS_{LT,y} = VS_{(T,P)} = VS_{rate(T,P)} \times \left(\frac{TAM_{T,P}}{1000} \right) \times 365 \quad (2)$$

Where:

$VS_{(T,P)}$ = annual VS excretion for livestock category T, for productivity system P (when applicable), $\text{kg-VS}/\text{animal}/\text{yr}$

$VS_{rate(T,P)}$ = default VS excretion rate, for productivity system P (when applicable), $\text{kg-VS}/1000 \text{ kg animal-mass}/\text{day}$

$TAM_{(T,P)}$ = typical animal mass for livestock category T, for productivity system P (when applicable), kg/animal

As per the paragraph 17 (c) of AMS III.D version 21, Project participants may adjust default IPCC values for VS for a site-specific average animal weight. If so, it shall be well explained and documented.

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}} \right) \times VS_{default} \times nd_y \quad (3)$$

Where:

- 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, this data is sourced from IPCC 2006 (kg)
- $VS_{default}$ = Default value for the volatile solid excretion rate 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

According to Dairy Weight Record Table of the project, the average weight of dairy cattle of the project in 2023 and 2024 is respectively 520 kg and 513kg, more than the default value from the table 10A.5(New) of 2019 Refinement to the 2006 IPCC, i.e.485kg animal⁻¹. Thus, it is more conservative to apply directly IPCC default value of dairy cattle weight in calculating $VS_{LT,y}$, other than adjusting default IPCC values for VS for a site-specific average animal weight using equation (3) above. The default VS value of a dairy cattle from Asia with high productivity systems is 8.1 kg-VS/1000kg-mass/day from the table 10.13A (NEW) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10. Based on equation (2), the default VS value of a dairy cattle is also equal to 1,433.90 kg-dm/animal/year²⁵.

c) Methane Conversion Factors (MCF):

As per the paragraph 18 (f) of AMS-III.D (Version 21.0), Methane Conversion Factors (MCF) values are determined for a specific manure management system and represent the degree to which B_0 is achieved. Where available country-specific MCF values that reflect the specific management systems used in particular countries or regions shall be used. Alternatively, the IPCC default values provided in table 10.17(UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 can be used. The site annual average temperature is taken from official data at the nearest meteorological station, or from data available from historical on site observations.

²⁵ 1,433.90 kg-dm/animal/year = 8.1 (kg-VS/1000kg-mass/day) * (485 / 1000) * 365

For the MCF, the project applies the IPCC default values provided in table 10.17(UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10. The mean annual temperature (MAT) of Zhumadian City is 14.7 - 15°C, the mean annual precipitation (MAP) and potential evapotranspiration (PET) is respectively 850 - 980 mm²⁶ and 1,314.15 mm²⁷ (MAP:PET<1). According to figure 3A.5.1-3A.5.2 in 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 03, the climate zone of Xiping County, Zhumadian City belongs to Warm Temperate Dry, so the MCF of the project should apply 76%.

d) The annual average number of animals ($N_{LT,y}$):

The annual average number of animals ($N_{LT,y}$) is determined as follows:

$$N_{LT,y} = N_{da,y} \times \left(\frac{N_{p,y}}{365} \right) \quad (4)$$

Where:

$N_{da,y}$ = Number of days animal is alive in the farm in the year y (numbers)

$N_{p,y}$ = Number of animals produced annually of type LT for the year y (numbers)

5.2 Project Emissions

According to the methodology AMS-III.D, project emissions consist of:

- (a) Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use ($PE_{PL,y}$);
- (b) Emissions from flaring or combustion of the gas stream ($PE_{flare,y}$);
- (c) CO₂ emissions from use of fossil fuels or electricity for the operation of all the installed facilities ($PE_{power,y}$);
- (d) CO₂ emissions from incremental transportation distances;
- (e) Emissions from the storage of manure before being fed into the anaerobic digester ($PE_{storage,y}$).

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y} \quad (5)$$

²⁶ https://www.zhumadian.gov.cn/mltz/zrdl/202212/t20221209_35645.html

²⁷ <https://sthjj.zhumadian.gov.cn/>

Where:

PE_y = Project emissions in year y (t CO₂e)

$PE_{PL,y}$ = Emissions due to physical leakage of biogas in year y (t CO₂e)

$PE_{flare,y}$ = Emissions from flaring or combustion of the biogas stream in the year y (t CO₂e)

$PE_{power,y}$ = Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year y (t CO₂e)

$PE_{transp,y}$ = Emissions from incremental transportation in the year y (t CO₂e), as per relevant paragraph in AMS-III.AO

$PE_{storage,y}$ = Emissions from the storage of manure (t CO₂e)

1. Project emissions due to physical leakage of biogas in year y

Project emissions due to physical leakage of biogas from the animal manure management systems used to produce, collect and transport the biogas to the point of flaring or gainful use are estimated as:

$$PE_{PL,y} = 0.10 \times GWP_{CH_4} \times D_{CH_4} \times \sum_{i,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y} \quad (6)$$

Where:

GWP_{CH_4} = Global Warming Potential (GWP) of CH₄ applicable to the crediting period (t CO₂e/t CH₄)

D_{CH_4} = CH₄ density (0.00067 t/m³ at room temperature (20 °C) and 1 atm pressure)

LT = Index for all types of livestock

j = Index for animal manure management system

$N_{LT,y}$ = Annual average number of animals of type LT in year y (numbers)

$VS_{LT,y}$ = Volatile solids production/excretion per animal of livestock LT in year y (on a dry matter weight basis, kg-dm/animal/year)

$MS\%_{i,y}$ = Fraction of manure handled in system i in year y. If the project activity involves sequential manure management systems, the procedure specified in paragraph 18(e) of AMS-III.D shall be used to estimate the

project emissions due to physical leakage of biogas in each stage

$B_{0,LT}$ = Maximum methane producing potential of the volatile solid generated for animal type LT ($m^3 CH_4/kg\text{-VS}$), as per paragraph 18 of AMS-III.D

2. Project emissions from flaring or combustion of the biogas stream in the year y

According to methodology, in the case of flaring of the recovered biogas, project emissions are estimated using the procedures described in the methodological tool “Project emissions from flaring” (version 04.0).

If the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. Therefore, the biogas flared by the project will be included in this calculation, while the biogas used for electricity will not be accounted for Emissions from flaring or combustion of the biogas stream in the year y since the methane destruction efficiency is 100%.

As per the methodological TOOL06 “Project emissions from flaring” (version 04.0), emissions from flaring ($PE_{flare,y}$) should be calculated as below:

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad (7)$$

Where:

$PE_{flare,y}$ = Project emissions from flaring of the residual gas in year y (tCO₂e)

GWP_{CH_4} = Global Warming Potential (GWP) of CH₄ applicable to the crediting period (t CO₂e/t CH₄)

$F_{CH_4,RG,m}$ = Mass flow of methane in the residual gas in the minute m (kg)

$\eta_{flare,m}$ = Flare efficiency in the minute m

For the mass flow of methane in the residual gas ($F_{CH_4,RG,m}$), the project can choose paragraph 17 option 2 to determine $\sum_{m=1}^{525600} F_{CH_4,RG,m}$ according to the tool 14 “Project and leakage emissions from anaerobic digesters (version 03.0)”, as follows:

$$\sum_{m=1}^{525600} F_{CH_4,RG,m} = Q_{biogas,flare,y} \times f_{CH_4,default} \times \rho_{CH_4} \quad (8)$$

Where:

$Q_{biogas,flare,y}$ = Amount of biogas monitored at the inlet of the flaring system in year y (Nm³ biogas)

$f_{CH_4,default}$ = Default value for the fraction of methane in the biogas ($m^3 CH_4/m^3$ biogas)

ρ_{CH_4} = Density of methane at normal conditions (kgCH₄/Nm³CH₄)

Based on the FSR, the methane generated by the project will be used as energy supply and the surplus will be flared, and the methane destruction efficiency for energy supply is considered as 100%. The value of parameter $\eta_{flare,m}$ was ex-ante assumed to be 90% (default value for enclosed flares in "Project emissions from flaring (versio 04.0)"). The parameters $T_{EG,m}$, $F_{RG,m}$ and $Flame_m$ will be monitored ex-post to determine whether the 90% default value can be applied for $\eta_{flare,m}$ (refer to "Parameters determined ex-post" for details). The details are described in the FE determination for Equation (13) in Section 5.4.

In order to ensure no biogas is released under any case, an enclosed flare is installed at the project site, The actual biogas flared ($Q_{biogas,flare,y}$) is ex ante determined as 3,500,000 m³ ²⁸ in the FSR and will be monitored ex post in the verification period.

3. Project emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year y

Project emissions from electricity and fossil fuel consumption are determined by following the methodological tool "Project and leakage emissions from anaerobic digesters" (version 03.0), where $PE_{Power,y}$ is the sum of $PE_{EC,y}$ and $PE_{FC,y}$ in the tool.

The project does not use any fossil fuel, so $PE_{FC,y}$ is not included in the project. Thus, $PE_{FC,y} = 0$ tCO₂e.

According to methodological tool "Project and leakage emissions from anaerobic digesters (version 03.0)", the project participants can use monitored data or default value to calculate $PE_{EC,y}$. For this project, we choose using default value to calculate $PE_{EC,y}$:

$$PE_{Power,y} = PE_{EC,y} + PE_{FC,y}$$

$$PE_{EC,y} = Q_{CH_4,y} \times F_{EC,default} \times EF_{EL,default} \quad (9)$$

Where:

$PE_{EC,y}$ = Project emissions from electricity consumption associated with the anaerobic digester in year y (t CO₂/ yr)

$Q_{CH_4,y}$ = Quantity of methane produced in the anaerobic digester in year y (t CH₄)

$F_{EC,default}$ = Default factor for the electricity consumption associated with the anaerobic digester per ton of methane generated (MWh/t CH₄)
(use default value: 1.02 MWh/t CH₄)

$EF_{EL,default}$ = Default emission factor for the electricity consumed in year y (t CO₂/MWh) (use default value: 1.3 t CO₂/MWh)

²⁸ According to FSR

According to the tool “Project and leakage emissions from anaerobic digesters (version 03.0)”, the project can choose paragraph 15 option 2 to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$):

$$Q_{CH4,y} = Q_{biogas,y} \times f_{CH4,default} \times \rho_{CH4} \quad (10)$$

Where:

$Q_{CH4,y}$	=	Quantity of methane produced in the digester in year y (t CH ₄)
$Q_{biogas,y}$	=	Amount of biogas collected at the digester outlet in year y (Nm ³ biogas)
$f_{CH4,default}$	=	Default value for the fraction of methane in the biogas (m ³ CH ₄ /m ³ biogas) (use default value: 0.6 m ³ CH ₄ /m ³ biogas)
ρ_{CH4}	=	Density of methane at normal conditions (t CH ₄ /Nm ³ CH ₄) (0.00067t CH ₄ /m ³ CH ₄ at room temperature (20°C) and 1 atm pressure)

$Q_{biogas,y}$ is ex ante determined as 11,000,000m³ ²⁹ in the FSR and will be monitored ex post in the verification period.

4. Project emissions from incremental transportation in the year y

According to AMS-III.D, emission from transportation of animal manure between livestock farms and the project site is calculated using relevant paragraph in AMS-III.AO as below:

$$PE_{transp,y} = (Q_y/CT_y) * DAF_w * EF_{CO2,transport} + (Q_{res-waste,y}/CT_{res-waste,y}) * DAF_{res-waste} * EF_{CO2,transport} \quad (11)$$

Where:

Q_y	=	Quantity of raw waste/manure treated and/or wastewater co-digested in the year y(tonnes)
CT_y	=	Average truck capacity for transportation (tonnes/truck)
DAF_w	=	Average incremental distance for raw solid waste/manure and/or wastewater transportation (km/truck)
$EF_{CO2, transport}$	=	CO ₂ emission factor from fuel use due to transportation (kgCO ₂ /km, IPCC default values or local values may be used)
$Q_{res-waste,y}$	=	Quantity of residual waste produced in year y (tonnes)
$CT_{res,waste,y}$	=	Average truck capacity for residual waste transportation (tonnes/truck)

²⁹ According to FSR

$DAF_{res, waste}$ = Average distance for residual waste transportation (km/truck)

The CSTR type anaerobic digesters is installed within the farm. The project has no incremental transportation compared to the baseline scenario, and the manure from Zhumadian Youran Xiping Dairy Farm will all enter the receiving tank of the pre-treatment system through tight pipeline, thus there is no emission from transportation of animal manure between livestock farm and the project site. $PE_{transp,y} = 0$.

5. Emissions from the storage of manure

Project emissions on account of storage of manure before being fed into the anaerobic digester shall be accounted for if both condition (a) and condition (b) below are satisfied:

- (a) The storage time of the manure after removal from the animal barns, including transportation, exceeds 24 hours before being fed into the anaerobic digester;
- (b) The dry matter content of the manure when removed from the animal barns is less than 20%.

According to the EIA report and actual operation log, the manure from Daming farm is sent to anaerobic digester through pipeline and enter into digester with 24 hours, normally 12 hours, but not exceed 24 hours, hence emissions from the storage of manure is not accounted for, $PE_{storage,y} = 0 \text{ tCO}_2\text{e}$.

5.3 Leakage Emissions

According to AMS-III.D Methane recovery in animal manure management systems (version 21.0): Leakage is determined by following the relevant procedure in the methodological tool “Project and leakage emissions from anaerobic digesters”.

As per “Project and leakage emissions from anaerobic digesters” (version 02.0): The following sources of leakage emissions are accounted for in this tool:

- (a) CH_4 and N_2O emission from composting of digestate;
- (b) CH_4 emissions from the anaerobic decay of digestate disposed in a SWDS or subjected to anaerobic storage, such as in a stabilization pond.

The leakage emissions associated with the anaerobic digester depend on how the digestate is managed. The leakage emissions include emissions associated with storage of digestate and emissions associated with composting of the digestate.

The digestate produced after anaerobic fermentation is separated by solid-liquid separation, and the solid part is squeezed twice before entering the drying drum. The dried part is used as cattle bedding material, and the biogas slurry (liquid part) is returned to the nearby farmland through a lifting pump station and a pipeline network. Digestate will not be stored under

anaerobic conditions. In addition, the project does not involve composting of digestate. Therefore, leakage emissions of the project associated with the anaerobic digester is not accounted for, leakage emission is 0.

5.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals

The emission reductions achieved by the project activity will be determined ex post through direct measurement of the amount of methane fueled, flared or gainfully used. It is likely that the project activity involves manure treatment steps with higher methane conversion factors (MCF) than the MCF for the manure treatment systems used in the baseline situation, therefore the emission reductions achieved by the project activity are limited to the ex post calculated baseline emissions minus the project emissions using the actual monitored data for the project activity (i.e. $N_{LT,y}$, $MS\%_{i,y}$, as well as $VS_{LT,y}$ in cases where adjusted values for animal weight are used). The emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\ post} = \min[(BE_{y,ex\ post} - PE_{y,ex\ post}), (MD_y - PE_{power,y,ex\ post})] \quad (12)$$

Where:

$ER_{y,ex\ post}$	=	Emission reductions achieved by the project activity based on monitored values for year y (tCO ₂ e)
$BE_{y,ex\ post}$	=	Baseline emissions calculated using equation 1. For projects using option in paragraph 17(a) using ex post monitored values of $N_{LT,y}$ and if applicable $VS_{LT,y}$. For projects using option in paragraph 17(b), the ex post monitored values for $Q_{manure,j,LT,y}$ and $SVS_{j,LT,y}$ are used
$PE_{y,ex\ post}$	=	Project emissions calculated using equation 11 using ex post monitored values of $N_{LT,y}$, $MS\%_{i,y}$, and if applicable $VS_{LT,y}$
MD_y	=	Methane captured and destroyed or used gainfully by the project activity in year y (tCO ₂ e)
$PE_{power,y,ex\ post}$	=	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year y (tCO ₂ e)

As per para.28 of AMS-III.D (Version 21.0), biogas flared or combusted, (MD_y) shall be determined using the flare efficiency and methane content of biogas:

$$MD_y = BG_{burnt,y} \times W_{CH4,y} \times D_{CH4} \times FE \times GWP_{CH4} \quad (13)$$

Where:

$BG_{burnt,y}$	=	Biogas flared or combusted in year y (m ³) Equals to $Q_{biogas,y}$ in "Project and leakage emissions from anaerobic digesters" (version 03.0)
$W_{CH4,y}$	=	Methane content in biogas in the year y (volume fraction) (use default value: 60 %)
FE	=	Flare efficiency in the year y (fraction)

As per para.30 of AMS-III.D, if project activities utilize the recovered methane for power generation, methane captured and destroyed or used gainfully by the project activity may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration:

$$MD_y = \frac{EG_y \times 3600}{NCV_{CH_4} \times EE_y} \times D_{CH_4} \times GWP_{CH_4} \quad (14)$$

Where:

- EG_y = Total electricity generated from the recovered biogas in year y (MWh)
- 3600 = Conversion factor (1 MWh = 3600 MJ)
- NCV_{CH_4} = NCV of methane (MJ/Nm³) (use default value: 35.9 MJ/Nm³)
- EE_y = Energy conversion efficiency of the project equipment, which is determined by adopting one of the following criteria:
- Specification provided by the equipment manufacture. The equipment shall be designed to utilize biogas as fuel, and efficiency specification is for this fuel. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation;
- Default efficiency of 40 %.

1. Calculation of baseline emissions:

Table 4-1: Ex-ante value of parameters to calculate BE_y

Parameter	Value	Data sources
GWP_{CH_4}	28 tCO ₂ e/tCH ₄	IPCC Fifth Assessment Report (AR5)
D_{CH_4}	0.67 kg/m ³	AMS-III.D
UF_b	0.94	AMS-III.D
MCF_j	76%	Table 10.17 of 2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10
$B_{o,LT}$	Dairy cattle: 0.24 m ³ CH ₄ /kg-VS	Table 10.16 (UPDATED) of 2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10
VS_{rate}	Dairy cattle: 8.1 kg-VS/1000kg-mass/day	Table 10.13A (NEW) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10
$MS\%_{BI,j}$	100%	FSR
nd_y	365 days	FSR

$N_{da,y}$	365 days	FSR
$N_{p,y}$	17,500	FSR

As per equations (1), the result of the ex-ante calculated baseline emissions of methane from the manure treatment processes of the project is:

Table 4-2: Ex-ante Baseline Emissions BE_y

Index for all types of livestock (LT)	The annual average number of animals ($N_{LT,y}$)	Volatile solids production of livestock LT in year y ($VS_{LT,y}$) (kg-dm/animal/year)	Baseline Emissions (BE_y) tCO ₂ e
-	$N_{LT,y} = N_{da,y} \times \left(\frac{N_{p,y}}{365}\right)$	$VS_{LT,y} = VS_{(T,P)} = VS_{rate(T,P)} \times \left(\frac{TAM_{T,P}}{1000}\right) \times 365$	$BE_y = GWP_{CH_4} \times D_{CH_4} \times UF_b \times \sum_{j,LT} MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{BL,j}$
Dairy cattle	17,500	1,433.90	80,712
Total	-	-	80,712

2. Calculation of project emissions

Table 4-3: Ex-ante value of parameters to calculate project emissions

Parameter	Value	Data sources
GWP_{CH_4}	28 tCO ₂ e/tCH ₄	IPCC Fifth Assessment Report (AR5)
D_{CH_4} (ρ_{CH_4})	0.67 kg/m ³	AMS-III.D.
$B_{0,LT}$	Dairy cattle: 0.24 m ³ CH ₄ /kg-VS	Table 10.16 (UPDATED) of 2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10
VS_{rate}	Dairy cattle: 8.1 kg-VS/1000kg-mass/day	Table 10.13A (NEW) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10
$MS\%_{i,y}$	100%	FSR
$N_{da,y}$	365 days	FSR
$N_{p,y}$	17,500	FSR
$Q_{biogas,y}$	11,000,000 Nm ³	FSR
$F_{CH_4, RG, m} = BG_{flare,y}$	3,500,000 Nm ³	FSR
$\eta_{flare,m}$	100% (biogas used for power usage)	Tool 06 "project emission from flaring"

	and natural upgrading)	(Version 04.0)
	90% (biogas used for enclosed flare system and for heat usage for conservative)	Tool 06 “project emission from flaring” (Version 04.0)
$f_{CH_4, default}$	0.6 m ³ CH ₄ /m ³ biogas	Tool 14 “Project and leakage emissions from anaerobic digesters” (Version03.0)
$EF_{EL, default}$	1.3 tCO ₂ /MWh	Tool 14 “Project and leakage emissions from anaerobic digesters” (Version03.0)
$F_{EC, default}$	1.02MWh/t CH ₄	Tool 14 “Project and leakage emissions from anaerobic digesters” (Version03.0)

2.1 Emissions due to physical leakage of biogas in year y

As described in 4.2, project emissions from physical leakage of biogas are calculated as per equations (6).

Table 4-4: Ex-ante calculate physical leakage of biogas ($PE_{PL,y}$)

Index for all types of livestock (LT)	The annual average number of animals ($N_{LT,y}$)	Volatile solids production of livestock LT in year y ($VS_{LT,y}$) (kg-dm/animal/year)	Physical leakage of biogas ($PE_{PL,y}$) tCO ₂ e
-	$N_{LT,y} = N_{da,y} \times \left(\frac{N_{p,y}}{365}\right)$	$VS_{LT,y} = VS_{(T,P)} = VS_{rate(T,P)} \times \left(\frac{TAM_{T,P}}{1000}\right) \times 365$	$PE_{PL,y} = 0.10 \times GWP_{CH_4} \times D_{CH_4} \times \sum_{j,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$
Dairy cattle	17,500	1,433.90	11,298
Total	-	-	11,298

So, the ex-ante calculated result of the project’s Physical leakage of biogas is 11,298 tCO₂e.

2.2 Emissions from flaring or combustion of the biogas stream in the year y

As described in 4.2, project emissions from flaring or combustion of the biogas stream are calculated as per equations (7)~(8).

Table 4-5: Ex-ante calculate emissions from flaring or combustion of the biogas stream ($PE_{flare,y}$)

Parameter	Unit	Value
G_{WPCH_4}	tCO ₂ e/tCH ₄	28

DC_{CH_4}	tCH_4/Nm^3CH_4	0.00067
$F_{CH_4, RG, m} = BG_{flare, y}$	Nm^3	3,500,000
$f_{CH_4, default}$	$m^3 CH_4/m^3 biogas$	0.6
$\eta_{flare, m}$	%	90%
$PE_{flare, y}$	tCO_2e	3,940

As described above, in case this emergency flare system operated, the estimated $PE_{flare, y}$ is 3,940 tCO_2e ex ante and will be monitored and calculated ex post.

2.3 Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year y

As described in 4.2, the project does not use any fossil fuel, so $PE_{FC, y}$ is not included in the project emission.

As described in 4.2, the electricity consumption of the project site is ex ante determined as per equations (9)~(10) ,

Table 4-6: Ex-ante calculate emissions from use of electricity for the operation of all the installed facilities ($PE_{EC, y}$)

Parameter	Unit	Value
$Q_{CH_4, y}$	$t CH_4$	4,422
$EF_{EL, default}$	$t CO_2/MWh$	1.3
$FE_{C, default}$	$MWh/t CH_4$	1.02
$PE_{EC, y}$	tCO_2e	5,864

$PE_{EC, y}$ is calculated as 5,864 tCO_2e ex ante and will be monitored ex post in the verification period. Thus, $PE_{power, y} = PE_{EC, y} = 5,864 tCO_2e$.

2.4 Emissions from incremental transportation in the year y

As described above, $PE_{transp, y}$ is excluded, hence $PE_{transp, y} = 0$ for the project.

2.5 Emissions from the storage of manure

As described above, $PE_{storage, y}$ is excluded, hence emissions from the storage of manure are not accounted for, $PE_{storage, y} = 0 tCO_2e$.

So, the ex-ante estimated project emission shall calculate as per equation (5):

$$PE_y = PE_{PL, y} + PE_{flare, y} + PE_{power, y} + PE_{transp, y} + PE_{storage, y} = PE_{PL, y} + PE_{flare, y} + PE_{power, y} = 21,102 tCO_2e$$

3. Calculation of leakage

As per “Project and leakage emissions from anaerobic digesters” (version 02.0), the leakage emissions associated with the anaerobic digester depend on how the digestate is managed. The leakage emissions include emissions associated with storage of digestate and composting of the digestate.

Digestate from the anaerobic digesters of the project will be used to produce fertilizer as soon as digestate is removed from the digesters. Digestate will not be stored under anaerobic conditions. In addition, the project does not involve composting of digestate. Therefore, leakage emissions of the project associated with the anaerobic digester is not accounted for.

Thus, $LE_y = 0$.

4. Calculation of the emission reductions

The estimated emission reductions of the 10-year crediting period are calculated as follows:

Vintage period	Estimated baseline emissions (tCO ₂ e)	Estimated project emissions (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated reduction VCU (tCO ₂ e)	Estimated removal VCU (tCO ₂ e)	Estimated total VCUs (tCO ₂ e)
15-April-2023 to 31-Dec-2023	57,715	15,089	0	42,625	0	42,625
01-Jan-2024 to 31-Dec-2024	80,712	21,102	0	59,610	0	59,610
01-Jan-2025 to 31-Dec-2025	80,712	21,102	0	59,610	0	59,610
01-Jan-2026 to 31-Dec-2026	80,712	21,102	0	59,610	0	59,610
01-Jan-2027 to 31-Dec-2027	80,712	21,102	0	59,610	0	59,610
01-Jan-2028 to 31-Dec-2028	80,712	21,102	0	59,610	0	59,610
01-Jan-2029 to 31-Dec-2029	80,712	21,102	0	59,610	0	59,610
01-Jan-2030 to 31-Dec-2030	80,712	21,102	0	59,610	0	59,610
01-Jan-2031 to 31-Dec-2031	80,712	21,102	0	59,610	0	59,610
01-Jan-2032 to 31-Dec-2032	80,712	21,102	0	59,610	0	59,610

01-Jan-2033 to 14-April-2033	22,997	6,013	0	16,985	0	16,985
Total	807,120	211,020	0	596,100	0	596,100

6 MONITORING

6.1 Data and Parameters Available at Validation

Data / Parameter	GWP_{CH_4}
Data unit	t CO ₂ e/t CH ₄
Description	Global warming potential of CH ₄
Source of data	IPCC Fifth Assessment Report (AR5)
Value applied	28
Justification of choice of data or description of measurement methods and procedures applied	Default value of 28 from IPCC Fifth Assessment Report (AR5). Shall be updated according to any future revision to VCS standard by VERRA.
Purpose of Data	Calculation of baseline emissions
Comments	The parameter will be updated according to the latest requirement of VCS Standard as well as the IPCC report.

Data / Parameter	D _{CH₄}
Data unit	kg/m ³
Description	CH ₄ density
Source of data	AMS-III.D (Version 21.0)
Value applied	0.67 (at 20 °C and 1 atm pressure)
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions and project emissions

Comments	-
Data / Parameter	UF _b
Data unit	-
Description	Model correction factor to account for model uncertainties
Source of data	AMS-III.D. (Version 21.0)
Value applied	0.94
Justification of choice of data or description of measurement methods and procedures applied	-
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	-
Data / Parameter	MCF _j
Data unit	-
Description	Annual methane conversion factor (MCF) for the baseline animal manure management system j
Source of data	2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value applied	76%
Justification of choice of data or description of measurement methods and procedures applied	No country or regional specific value is available. Default value from table 10.17(UPDATED) of 2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 is applied. The mean annual temperature (MAT) of Xipingxian County where anaerobic manure treatment facility is located is around 15 °C³⁰, and the mean annual precipitation (MAP) and potential evapotranspiration (PET) is respectively 846.1 mm and 1263 mm³¹, thus ratio of potential evapotranspiration to precipitation is less than 1. The climate zone is warm temperature dry. Thus,

³⁰ <http://www.xiping.gov.cn/portal/zjxp/dlhj/webinfo/2018/11/phone1542930947908336.htm>

³¹ <http://xiping.gov.cn/portal/jrxp/xzxx/webinfo/2024/11/phone1735504616272863.htm>

	the corresponding annual methane conversion factor (MCF) is 76%.
Purpose of Data	Calculation of baseline emissions and project emissions
Comments	-

Data / Parameter	B _{0,LT}				
Data unit	m ³ CH ₄ /kg-VS				
Description	Maximum methane producing potential of the volatile solid generated for animal type LT				
Source of data	Table 10.16A (UPDATED) of 2019 refinement to 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10				
Value applied	<table border="1"> <tr> <td>Animal type</td><td>B_{0,LT}</td></tr> <tr> <td>Dairy cattle</td><td>0.24</td></tr> </table>	Animal type	B _{0,LT}	Dairy cattle	0.24
Animal type	B _{0,LT}				
Dairy cattle	0.24				
Justification of choice of data or description of measurement methods and procedures applied	No country or regional specific value is available. Default values from table 10.16 (UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 is applied. The project adopts data from other regions with high productivity systems.				
Purpose of Data	Calculation of baseline emissions and project emissions				
Comments	-				

Data / Parameter	MS% _{BL,i}
Data unit	-
Description	Fraction of manure handled in baseline animal manure management system j
Source of data	FSR
Value applied	100%
Justification of choice of data or description of measurement methods and procedures applied	-

Purpose of Data	Calculation of baseline emissions and project emissions
Comments	-

Data / Parameter	$F_{EC,default}$
Data unit	MWh/t CH ₄
Description	Default factor for the electricity consumption associated with the anaerobic digester per ton of CH ₄ generated
Source of data	Project and leakage emissions from anaerobic digesters (version 03.0)
Value applied	1.02
Justification of choice of data or description of measurement methods and procedures applied	The digesters this project use belongs to conventional digesters with continuously stirred tank reactor type for wastewater, default value of 1.02 tCO ₂ /MWh can be applied
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$EF_{EL,default}$
Data unit	t CO ₂ /MWh
Description	Default emission factor for the electricity consumed in year y
Source of data	Project and leakage emissions from anaerobic digesters (version 03.0)
Value applied	1.3
Justification of choice of data or description of measurement methods and procedures applied	Default value of 1.3 tCO ₂ /MWh is applied
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$f_{CH_4, default}$
Data unit	$m^3 CH_4/m^3$ biogas
Description	Default value for the fraction of methane in the biogas
Source of data	Project and leakage emissions from anaerobic digesters (version 03.0)
Value applied	Default value of $0.6 m^3 CH_4/m^3$ biogas is applied
Justification of choice of data or description of measurement methods and procedures applied	There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH_4, y}$). For small scale projects, project participants may choose between Option 1 or Option 2. (i) Option 1: Procedure using monitored data; (ii) Option 2: Procedure using a default value. This project chooses Option 2 and applies the default value for the fraction of methane in the biogas, which is $0.6 m^3 CH_4/m^3$ biogas.
Purpose of Data	Calculation of project emissions
Comments	-

Data / Parameter	$SPEC_{flare}$
Data unit	Temperature - °C Flow rate or heat flux - kg/h or m^3/h Maintenance schedule - number of days
Description	Manufacturer's flare operating specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value applied	Minimum and maximum operating Temperature: $600^\circ C^{32}$ ~ $1260^\circ C$ Minimum and maximum inlet Flow rate: $0 \sim 1900 m^3/h$ Maintenance schedule: every 12-24 months (around 365days – 730 days) based on operating conditions
Justification of choice of data or description of measurement methods and procedures applied	Determined from Operation Specification of the flare. The enclosed flare that is not defined as low height flare based on the Operation Specification of the flare.
Purpose of Data	Confirmation that flow/heat flux meets manufacturer's

³² GB T41191-2021: Flare for biogas engineering

	specifications
Comments	Only applicable in case of enclosed flares. The maintenance schedule is not required if Option A is selected to determine flare efficiency of an enclosed flare

6.2 Data and Parameters Monitored

Data / Parameter	$MS\%_{i,y}$
Data unit	-
Description	Fraction of manure handled in system i in year y
Source of data	FSR
Description of measurement methods and procedures to be applied	All manure would be handled in this project, 100% is applied for $MS\%_{i,y}$ in ex-ante estimation. This parameter will be monitored in verification period. As per AMS-III.D. version 21.0, if animal manure is treated in different treatment systems manure weight delivered to each system shall be directly measured or alternatively manure volume can be measured together with the density determined from representative sample (90/10 precision). The quantity of animal manure from different farms and different animal types shall be recorded separately for cross-check. Recording of the baseline animal manure management system where the animal manure would have been treated anaerobically is also required. For the project activity, only dairy cattle manure from Zhumadian Youran Xiping Dairy farm is involved. The manure of the project will be cleaned by scrapers to the closed transportation pipeline and finally to the anaerobic digesters for anaerobic fermentation.
Frequency of monitoring/recording	Annually, based on daily measurement and monthly aggregation
Value applied	100%
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions and project emissions

Calculation method	-
Comments	-

Data / Parameter	$N_{da,y}$
Data unit	number
Description	Number of days animal is alive in the farm in year y.
Source of data	Records of dairy cattle farm production from Project proponents
Description of measurement methods and procedures to be applied	365 days used for ex-ante estimation. The actual number of days animal is alive in the farm in the monitoring periods will be monitored and recorded by staff. The project owner will establish a unique identification tag for each dairy cattle, which is an electronic ear tag. Through electronic ear tags, the system can count the alive condition and number of dairy cattle. In addition, the project owner will conduct monthly on-site inventory of the cattle herd, to check the ear tag numbers and system records, and confirm whether the cattle is alive.
Frequency of monitoring/recording	Annually, based on monthly records
Value applied	365
Monitoring equipment	-
QA/QC procedures to be applied	The consistency between the value and indirect information (records of sales, records of food purchases) should be assessed.-
Purpose of data	To estimate the annual volatile solid excretions for livestock LT entering all animal waste management systems on a dry matter weight basis ($VS_{LT,y}$).
Calculation method	-
Comments	-

Data / Parameter	$N_{p,y}$
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Data unit	Number
Description	Number of animals produced annually of type LT for the year y
Source of data	Records of dairy cattle farm production from Project proponents
Description of measurement methods and procedures to be applied	The project owner will establish a unique identification tag for each dairy cattle, which is an electronic ear tag. Through electronic ear tags, the system can count the alive condition and number of dairy cattle. In addition, the project owner will conduct monthly on-site inventory of the cattle herd, to check the ear tag numbers and system records, and confirm whether the cattle is alive.
Frequency of monitoring/recording	Annually, based on monthly records
Value applied	17,500 (estimated ex ante and will be monitored ex post)
Monitoring equipment	-
QA/QC procedures to be applied	The consistency between the value and indirect information (records of sales, records of food purchases) should be assessed.
Purpose of data	To calculate the annual average number of animals ($N_{LT,y}$)
Calculation method	-
Comments	The $N_{p,y}$ for the project is the number of adult dairy cattle and breeding cattle, not including the number of calves. According to the project approval and EIA approval of the project, the total number of dairy cattle of the project is 24,000 heads, comprising 14,400 adult dairy cattle, 3,100 breeding cattle and 6,500 calves per year. the number of calves is not included in the calculation of the emission reduction of the project..

Data / Parameter	$VS_{LT,y}$
Data unit	Kg dry matter/animal/year
Description	Volatile solids production/excretion per animal of livestock LT in

	year y				
Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories				
Description of measurement methods and procedures to be applied	Default value from table 10.13A (NEW) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 is applied. According to equation 10.22A from 2019 Refinement to the 2006 IPCC Guidelines, VS can be calculated as follows $VS_{LT,y} = VS_{rate} * TAM / 1000 * 365$ VS_{rate} is 8.1 kg VS (1000kg animal mass)/day for dairy cattle from Asia with high productivity systems, which is default value from 2019 Refinement to the 2006 IPCC Guidelines Volume 4 Chapter 10 table 10.13A. The default value for weight of Dairy cattle is 485 kg from Asia with high productivity systems from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10A.5(NEW), which will be compared with the actual weight of dairy cattle. The actual weight of Dairy cattle is 520 kg and 513 kg in 2023 and 2024 which is higher than the default value, thus the default value is conservative.				
Frequency of monitoring/recording	Annually				
Value applied	<table border="1"> <thead> <tr> <th>Animal type</th><th>$VS_{LT,y}$</th></tr> </thead> <tbody> <tr> <td>Dairy cattle</td><td>1,433.90</td></tr> </tbody> </table>	Animal type	$VS_{LT,y}$	Dairy cattle	1,433.90
Animal type	$VS_{LT,y}$				
Dairy cattle	1,433.90				
Monitoring equipment	-				
QA/QC procedures to be applied	The default value for weight of dairy cattle applied by the project is more conservative and the actual weight will be monitored to compared with the default value..				
Purpose of data	Calculation of baseline emissions and project emissions				
Calculation method	-				
Comments	-				

Data / Parameter	$W_{site}(TAM_{T,P})$
Data unit	kg
Description	Average animal weight of a defined livestock population at the project site
Source of data	Records of dairy cattle farm production from Project proponents
Description of measurement methods and procedures to be applied	When IPCC default values are to be adjusted for site specific average animal weight as per paragraph 18(c) and equation 3 of the methodology, sampling procedures can be used to estimate this variable as per the “Standard for sampling and surveys for CDM project activities and Programmes of Activities”. For the project, W_{site} is ex-ante determined as 485kg from the IPCC default value. For the calculation of actual emission reductions in monitoring period, the average animal weight (W_{site}) will be measured randomly, and a conservative value will be applied for the calculation (i.e.the smaller value of the actual average animal weight and the default weight).
Frequency of monitoring/recording	Monthly
Value applied	485 (estimated ex ante, the default value of Asia with high productivity systems from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10A.5(NEW)
Monitoring equipment	-
QA/QC procedures to be applied	The scale will calibrated once every year by a qualified third party in accordance with the “Digital Indicating Weighing Instruments” (JJG539-2016).
Purpose of Data	Project participants may adjust default IPCC values for VS for a site-specific average animal weight.
Calculation method	-
Comments	-

Data / Parameter	$Q_{\text{biogas},y} (BG_{\text{burnt},y}), BG_{\text{elec},y}, BG_{\text{heat},y}, Q_{\text{biogas,flare},y} (BG_{\text{flare},y})$								
Data unit	Nm ³								
Description	Amount of biogas collected at the digester outlet in year y; Biogas volume for power generation in year y; Biogas volume for heat generation in year y; Biogas volume for flare in year y								
Source of data	Flow meters								
Description of measurement methods and procedures to be applied	The amount of biogas recovered and flared or combusted shall be monitored by four mass flow meters. The meter readings are automatically converted to value at normal conditions of temperature (20 °C) and 1 atm pressure in volumetric flow from mass flow through the built-in gas density at normal condition from mass flow. The total generated biogas, the biogas used for energy and the biogas flared is continuously monitored separately. The recovered biogas is prioritized for energy use, and the excess amount is flared. The system should be built and operated to ensure that there is no air ingress into the biogas pipeline.								
Frequency of monitoring/recording	Annually, based on continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)								
Value applied	11,000,000 (Ex-ante estimation), of which about 3,500,000 Nm³ will be used for flaring system. <table border="1"> <thead> <tr> <th>Parameter</th><th>Value (Nm³)</th></tr> </thead> <tbody> <tr> <td>$Q_{\text{biogas},y} (BG_{\text{burnt},y})$</td><td>11,000,000</td></tr> <tr> <td>$Q_{\text{biogas,flare},y} (BG_{\text{flare},y})$</td><td>3,500,000</td></tr> <tr> <td>$BG_{\text{energy},y} (BG_{\text{elec},y} + BG_{\text{heat},y})$</td><td>7,500,000</td></tr> </tbody> </table>	Parameter	Value (Nm ³)	$Q_{\text{biogas},y} (BG_{\text{burnt},y})$	11,000,000	$Q_{\text{biogas,flare},y} (BG_{\text{flare},y})$	3,500,000	$BG_{\text{energy},y} (BG_{\text{elec},y} + BG_{\text{heat},y})$	7,500,000
Parameter	Value (Nm ³)								
$Q_{\text{biogas},y} (BG_{\text{burnt},y})$	11,000,000								
$Q_{\text{biogas,flare},y} (BG_{\text{flare},y})$	3,500,000								
$BG_{\text{energy},y} (BG_{\text{elec},y} + BG_{\text{heat},y})$	7,500,000								
Monitoring equipment	The total biogas generated by the anaerobic animal manure treatment system is monitored by flow meter F1 installed at the outlet of the pre-treatment system. The second one F2 is installed at the inlet of power generation system—for the biogas flow to power generation system. The third one F3 is installed at the inlet of heat generation system—for the biogas flow to heat generation system. The fourth one F4 is installed at the inlet of								

	the emergency flare---for the biogas flow to emergency flare. In the future a plan is made to sell the excess biogas to the third party for natural gas upgrading, and the fifth one F5 may be installed to monitor the amount of upgrading natural gas.
QA/QC procedures to be applied	The flow meters are to be calibrated once every two years by a qualified third party in accordance with the “Verification Regulation of Thermal Mass Gas Flowmeters” (JJG-1132-2017).
Purpose of data	Calculation of project emissions or emission reductions
Calculation method	-
Comments	The amount of $Q_{biogas,y}$ ($BG_{burnt,y}$), $BG_{elec,y}$, $BG_{heat,y}$, $Q_{biogas,flare,y}$ ($BG_{flare,y}$) are originated from the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. When calculating the parameter of MD_y , the data of these parameters will be deducted the biogas generated from calves’ manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions. While calculating the project emissions, the actual monitored values of these parameters (without deducting the calf fraction) will be directly applied, which is considered to be more conservative.

Data / Parameter	$W_{CH4,y}$
Data unit	-
Description	Methane content in biogas in the year y (volume fraction)
Source of data	AMS-III.D. (Version 21.0)
Description of measurement methods and procedures to be applied	Default value from methodology is applied
Frequency of monitoring/recording	-
Value applied	60%

Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of Data	Calculation of emission reductions
Calculation method	-
Comments	-

Data / Parameter	$FE (\eta_{flare,m})$
Data unit	-
Description	Flare efficiency in the year y (fraction)
Source of data	AMS-III.D. (Version 21.0) Project emissions from flaring (version 04.0)
Description of measurement methods and procedures to be applied	As per para. 22 of the applied methodology, if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. Therefore, the methane destruction efficiency of biogas used for power generation is 100%. Due to there is no monitoring equipment to monitor the heat generation for the biogas boiler to warming up the anaerobic digesters of the project, thus it is assumed these amount of biogas used for heat generated were flared and included these amount of biogas when calculating PE_{flare}, which is conservative, therefore, the efficiency of biogas boiler is selected to be 90% (the same as flare efficiency). As per Tool 06, the low height flare is defined as an enclosed flare for which the flame enclosure has a height between two and ten times the diameter of the combustion enclosure. According to the operating specification of biogas flare, the combustion chamber has an inner diameter of 1.5 meters and a height of 20 meters, the height is 13.3 times the diameter of the combustion enclosure, and accordingly the flare of the project is not low height flare. As for flaring, the project uses the enclosed flare, and the project chose option A of Project emissions from flaring (version 04.0)

	for the determination of flare efficiency. The flare efficiency of the project is determined as 90% since the enclosed flare applied by the project is not low height flare and the project meets the following two conditions when in operating: • The temperature of the flare ($T_{EG,m}$) and the flow rate of the residual gas to the flare ($F_{RG,m}$) is within the manufacturer's specification for the flare; and • The flame is detected in minute m.
Frequency of monitoring/recording	-
Value applied	90% for flaring 90% for heat generation 100% for power generation 100% for upgrading natural gas
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of Data	Calculation of emission reductions and project emissions
Calculation method	-
Comments	This parameter was determined ex post and was used to calculate MD_y (biogas flared or combusted), as per para 28 and equation 11 of methodology AMS-III.D. FE in equation 11 includes flare efficiency (when biogas is flared) and methane destruction efficiency (when biogas is combusted). As per para 22 of AMS-III.D., if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. Total electricity generated from the recovered biogas in year y (EG_y) is continuously monitored and total nature gas upgraded from the recovered biogas in year y (NG_y) will be continuously monitored in the future. During this monitoring period, the data is confirmed by the staff of the project. The metering instruments

	have been calibrated annually in accordance with the latest version “Technical administrative code of electric energy metering”. For biogas flaring, please refer to $T_{EG,m}$, $F_{RG,m}$ and $Flame_m$ for details on monitoring the temperature, flow rate and the presence or absence of flame.
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Data / Parameter	$T_{EG,m}$
Data unit	°C
Description	Temperature in the exhaust gas of the enclosed flare in the minute m
Source of data	Records by project participants
Description of measurement methods and procedures to be applied	The temperature in the exhaust gas of the enclosed flare shall be monitored ex-post, using monitoring port in the flare to ensure that the flare is functioning correctly.
Frequency of monitoring/recording	Once per minute
Value applied	Monitored ex-post
Monitoring equipment	Monitoring port in the flare
QA/QC procedures to be applied	Temperature measurement equipment should be replaced or calibrated once every year in accordance with the “Calibration Specification of the Temperature Transmitter” (JJF 1183-2007).
Purpose of Data	To confirm that the flare operates within the manufacturer’s operating specification
Calculation method	-
Comments	Unexpected changes such as a sudden increase/drop in temperature can occur for different reasons. These events should be noted in the site records along with any corrective action that was implemented to correct.

Data / Parameter	$F_{RG,m} (BG_{flare,y})$
Data unit	Nm ³
Description	Flow rate of the residual gas on a dry basis at reference

	conditions in the minute m
Source of data	Records by project participants
Description of measurement methods and procedures to be applied	The flow rate of the residual gas to the flare shall be monitored ex-post, using mass flow meters. Continuously measured by flow meter at the inlet of the flare system. The meter readings will be automatically converted to value at room temperature (20 °C) and 1 atm pressure.
Frequency of monitoring/recording	Continuously. Values to be averaged on a minute basis
Value applied	3,500,000 (Ex-ante estimation), monitored ex-post
Monitoring equipment	Flow meter F4
QA/QC procedures to be applied	Flow meter is to be calibrated once every two years by a qualified third party in accordance with the “Verification Regulation of Thermal Mass Gas Flowmeters” (JJG-1132-2017).
Purpose of Data	To confirm that the flare operates within the manufacturer’s operating specification
Calculation method	-
Comments	The amount of $F_{RG,m}$ ($BG_{flare,y}$) is originated from the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. When calculating the parameter of MD_y , the data of these parameters will be deducted the biogas generated from calves’ manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions. While calculating the project emissions, the actual monitored value of this parameter (without deducting the calf fraction) will be directly applied, which is considered to be more conservative.

Data / Parameter	$Flame_m$
Data unit	Flame on or Flame
Description	Flame detection of flare in the minute m
Source of data	Records by project participants
Description of measurement methods and procedures to be applied	This parameter is determined based on parameter $T_{EG,m}$ if manufacturer's flare specifications for operating temperature are met detection of flame recorded as a minute that the flame was

	on, otherwise recorded as a minute that the flame was off.
Frequency of monitoring/recording	Once per minute. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off
Value applied	Monitored ex-post
Monitoring equipment	Optical flame detector
QA/QC procedures to be applied	Equipment shall be maintained and calibrated once every year in accordance with the "Calibration Specification of the Temperature Transmitter" (JJF 1183-2007).
Purpose of Data	To monitor if the flare is operating
Calculation method	-
Comments	-

Data / Parameter	EG _y
Data unit	MWh
Description	Total electricity generated from the recovered biogas in year y
Source of data	Records of electricity generation by project proponents
Description of measurement methods and procedures applied	Measured by an electricity meter inner generator
Frequency of monitoring/recording	Continuously measured and monthly recorded
Value applied:	Monitored ex-post
Monitoring equipment	Electricity meter inner generator
QA/QC procedures applied	The project owner will provide capability training for the operation and maintenance personnel, conduct daily inspection, record relevant information such as power generation, and investigate abnormal situations,etc.
Purpose of data	The output of the recovered biogas shall be monitored to ensure that the recovered biogas is actually destroyed, in order to claim

	100% of FE for power generation and natural gas upgrading.
Calculation method	-
Comments	As per para 22 of AMS-III.D (Version 21.0), if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. This project will monitor power generation production (EG_y). A description of the power generation monitoring is described in Section 7.1. Moreover, the amount of EG_y will be generated from the biogas by the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. Thus, the data of this parameter will be deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution.

Data / Parameter	NG_y
Data unit	Nm ³
Description	Total nature gas upgraded from the recovered biogas in year y
Source of data	Records of natural gas upgrading by project proponents
Description of measurement methods and procedures applied	Measured by a flow meter.
Frequency of monitoring/recording	Continuously measured and monthly recorded
Value applied:	Monitored ex-post
Monitoring equipment	Flow meter

QA/QC procedures applied	-
Purpose of data	The output of the recovered biogas shall be monitored to ensure that the recovered biogas is actually destroyed, in order to claim 100% of FE for power generation and natural gas upgrading.
Calculation method	-
Comments	As per para 22 of AMS-III.D. (Version 21.0), if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. This project will monitor upgrading natural gas (NG_y) production. The purified natural gas system has not yet been constructed and its monitoring equipment will be updated in the subsequent monitoring period. Moreover, the amount of NG_y will be generated from the biogas by the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. Thus, the data of this parameter will be deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions.

Data / Parameter	Soil application
Data unit	-
Description	Soil application of residual waste
Source of data	Records by project participants
Description of measurement methods and procedures applied	The residual waste from the animal manure management system is handled aerobically.

Frequency of monitoring/recording	Annually
Value applied:	Monitored ex-post
Monitoring equipment	-
QA/QC procedures applied	-
Purpose of data	To ensure that the residual waste from the animal manure management system is handled aerobically.
Calculation method	-
Comments	-

6.3 Monitoring Plan

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

The Project owner organizes a specific VCS team in project development department to be responsible for data collection, supervision and witness the whole process of data measuring and recording.

(A) Management structure

The Project owner organizes a specific VCS team in 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 of extracted gas, electricity generation and consumption etc. are carried out by a few designated monitoring officers. In addition, the Project developer appoints internal verifiers who is 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.

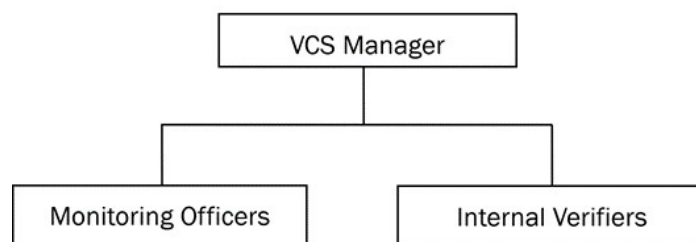


Figure 5.1 Operation and management structure of the project

(B) Data and Parameters to be monitored

Figure 5.1 shows the parameters to be monitored as well as the positions of the monitoring instruments; Table 5.1 further explains each of the monitored parameters.

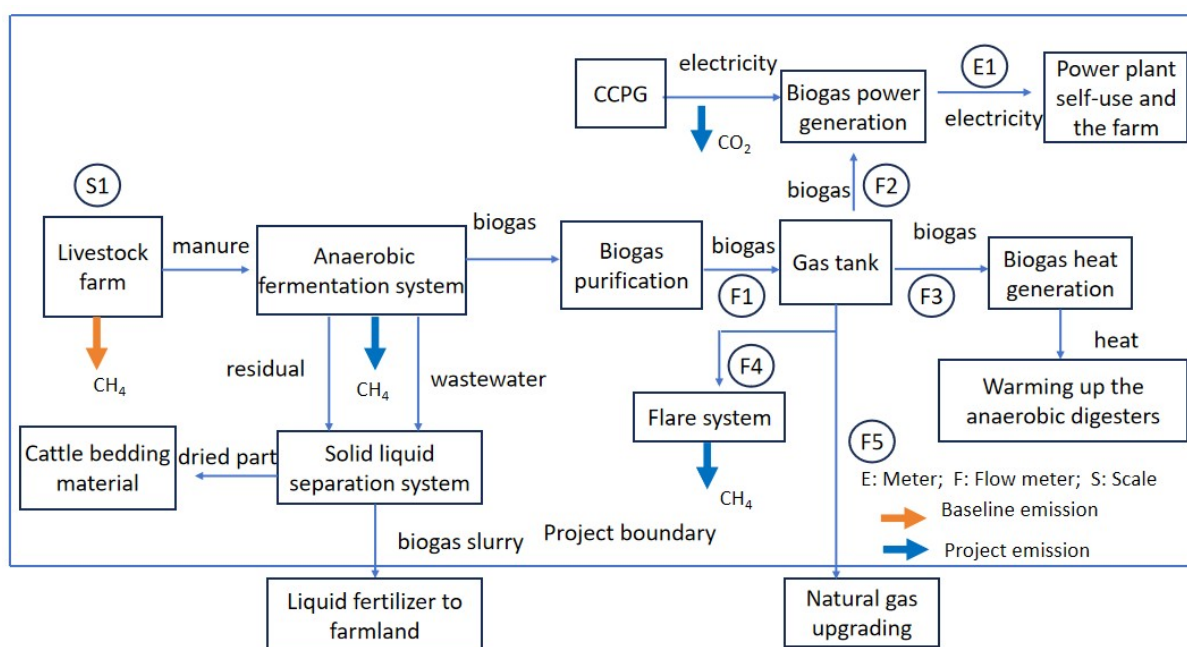


Figure 5.2 Project monitoring diagram

Table 5.1 Description of the monitored parameters

Parameter to be Monitored	Description
$MS\%_{i,y}$	Fraction of manure handled in system i in year y is 100%.
$N_{p,y}$	The actual number of Dairy cattle produced in the farm will be recorded manually by the responsible staff.
$N_{da,y}$	The actual number of days animal is alive in the farm in the monitoring periods will be monitored and recorded by staff.

$VS_{LT,y}$	Volatile solids for Dairy cattle entering the animal manure management system in year y is 1,433.90 Kg-dm/animal/year.
$Q_{biogas,y}$ ($BG_{burnt,y}$), $BG_{elec,y}$, $BG_{heat,y}$, $Q_{biogas,flare,y}$ ($BG_{flare,y}$)	Amount of biogas collected at the digester outlet in year y; Biogas volume for power generation in year y; Biogas volume for heat generation in year y; Biogas volume for flare in year y is continuously measured by flow meter installed at the outlet of the biogas pre-treatment system, the inlet of power generation system, the inlet of heat generation system, and the inlet of the emergency flare and all of them will be recorded.
FE ($\eta_{flare,m}$)	The flare efficiency applies default value of 90% for biogas flared and heat generation, and 100% for biogas for power generation and natural gas upgrading. This project will monitor power generation (EG_y) and upgrading natural gas (NG_y) production.
$T_{EG,m}$	Temperature in the exhaust gas of the enclosed flare in the minute m. It is continuously measured by monitoring port in the flare.
$F_{RG,m}$ ($BG_{flare,y}$)	Flow rate of the residual gas on a dry basis at reference conditions in the minute m. It is continuously measured by flow meter with temperature sensor and pressure sensor at the inlet of the flare system.
$Flame_m$	Flame detection of flare in the minute m. It is determined based on parameter $T_{EG,m}$.
EG_y	Total electricity generated from the recovered biogas in year y.
NG_y	Total nature gas upgraded from the recovered biogas in year y
W_{site} ($TAM_{T,p}$)	Average animal weight of a defined livestock population at the project site.
<i>Soil application</i>	Soil application of residual waste. To ensure that the residual waste from the animal manure management system is handled aerobically

(C) 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. Automatic records will serve as the main data source for emission reductions calculation. All data files, relevant purchase invoices and sales receipts will be collected by a designated monitoring officer, who will prepare backup in time and archive all documents properly.

(D) Quality assurance

All the monitoring instruments are chosen in compliance with VCS requirements, and will be calibrated regularly for accuracy by qualified third-party organizations according to the national regulations during the entire crediting period. To assist in future verifications, the project owner preserves the calibration records, along with the files of monitored data.

Error-checking is carried out regularly on site and at the point of data storage to detect data measuring/transmission failures as well as malfunctions. In case of malfunction of any measuring instrument, the instrument supplier will provide technical support to solve the problem promptly, and the emission reductions during the troubleshooting period will be calculated conservatively.

The installation of the electricity metering equipment will fulfill the requirements of “DL/T448–2016 Technical Administrative Code of Electric Energy Metering”. The accuracy should not be less than 0.5S. All the meters will be checked and maintained periodically.

(E) Data file management

All the monitored data are electronically files at the end of each month and the electronic data files are archived in both disk copy and printed hard copy. All data collected as part of the monitoring must be archived electronically and be kept at least for two years after the end of the crediting period. The project owner will provide original records and documents if necessary.

7 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

7.1 Data and Parameters Monitored

Data / Parameter	$MS_{i,y}$
Data unit	-
Description	Fraction of manure handled in system i in year y
Value applied:	During this monitoring period, there was no sequential manure management system and thus 100% is applied.
Comments	Based on the monthly report from Zhumadian Youran Xiping Dairy farm, on-site inspection and the actual situation of the project.

Data / Parameter	$N_{p,y}$						
Data unit	number						
Description	Number of animals produced annually of type LT for the year y						
Value applied:	<table border="1"> <thead> <tr> <th>Period</th><th>Value (head)</th></tr> </thead> <tbody> <tr> <td>15-Apr-2023~31-Dec-2023</td><td>14,418</td></tr> <tr> <td>01-Jan-2024~31-Dec-2024</td><td>16,611</td></tr> </tbody> </table>	Period	Value (head)	15-Apr-2023~31-Dec-2023	14,418	01-Jan-2024~31-Dec-2024	16,611
Period	Value (head)						
15-Apr-2023~31-Dec-2023	14,418						
01-Jan-2024~31-Dec-2024	16,611						
Comments	This parameter was recorded monthly according to daily report of cattle dynamics from Zhumadian Youran Xiping Dairy Farm and aggregated annually. The consistency between the value and indirect information (records of sales, records of food purchases) was assessed. The $N_{p,y}$ for the project is the number of adult dairy cattle and breeding cattle, not including the number of calves. In this monitoring period, the number of calves is respectively 2,129 and 2,455 heads, which is not included in the calculation of emission reduction.						

Data / Parameter	$N_{da,y}$	
Data unit	number	
Description	Number of days animal is alive in the farm in the year y	
Value applied:	Period	Value(day)
	15-Apr-2023~31-Dec-2023	261
	01-Jan-2024~31-Dec-2024	366
Comments	The project owner establishes a unique identification tag for each dairy cattle, e.g. an ear tag. And conducts monthly on-site inventory of the cattle herd, to check the ear tag numbers and system records, and confirm whether the dairy cattle are alive. The actual number of days animal was alive in the farm in the monitoring periods was monitored and monthly recorded by staff. The consistency between the value and indirect information (records of sales, records of food purchases) was assessed.	

Data / Parameter	$VS_{LT,y}$	
Data unit	Kg-dm/animal/year	
Description	Volatile solids production/excretion per animal of livestock LT in year y	
Value applied:	1,433.90	
Comments	This parameter was calculated from equation 10.22A(UPDATED) of 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10, and the parameters in this equation were default values from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10.	

Data / Parameter	$W_{site}(TAM_{T,P})$	
Data unit	kg	
Description	Average animal weight of a defined livestock population at the	

	project site														
Source of data	Records of dairy cattle farm production from Project proponents														
Description of measurement methods and procedures to be applied	When IPCC default values are to be adjusted for site specific average animal weight as per paragraph 18(c) and equation 3 of the methodology, sampling procedures can be used to estimate this variable as per the “Standard for sampling and surveys for CDM project activities and Programmes of Activities”. For the project, W_{site} is ex-ante determined as 485kg from the IPCC default value. For the calculation of actual emission reductions in monitoring period, the average animal weight (W_{site}) will be measured randomly, and a conservative value will be applied for the calculation (i.e. the smaller value of the actual average animal weight and the default weight).														
Frequency of monitoring/recording	Monthly														
Value applied	Monitored ex-post. Please refer to the ER sheet for monthly records. <table> <tr> <th>Period</th> <th>W_{site}(Kg)- Monitoring value</th> <th>W_{site}(Kg)- Conservative value</th> </tr> <tr> <td>15-Apr-2023~31-Dec-2023</td> <td>521</td> <td>520</td> </tr> <tr> <td>01-Jan-2024~31-Dec-2024</td> <td>518</td> <td>513</td> </tr> </table>			Period	W_{site} (Kg)- Monitoring value	W_{site} (Kg)- Conservative value	15-Apr-2023~31-Dec-2023	521	520	01-Jan-2024~31-Dec-2024	518	513			
Period	W_{site} (Kg)- Monitoring value	W_{site} (Kg)- Conservative value													
15-Apr-2023~31-Dec-2023	521	520													
01-Jan-2024~31-Dec-2024	518	513													
Monitoring equipment	One scale installed at the farm. The key information of the monitoring equipment is shown as below: <table> <tr> <th>Monitoring equipment</th> <th>Scale</th> </tr> <tr> <td>type</td> <td>BW-CT110</td> </tr> <tr> <td>Serial No.</td> <td>BWCT110220060</td> </tr> <tr> <td>Accuracy</td> <td>III</td> </tr> <tr> <td>Calibration date</td> <td>30-December-2022</td> </tr> <tr> <td>Validity date</td> <td>29-December-2023</td> </tr> </table>			Monitoring equipment	Scale	type	BW-CT110	Serial No.	BWCT110220060	Accuracy	III	Calibration date	30-December-2022	Validity date	29-December-2023
Monitoring equipment	Scale														
type	BW-CT110														
Serial No.	BWCT110220060														
Accuracy	III														
Calibration date	30-December-2022														
Validity date	29-December-2023														
QA/QC procedures to be applied	The scale is calibrated once every year by a qualified third party in accordance with the “Digital Indicating Weighing Instruments” (JJG539-2016). In this monitoring period, the scale has been calibrated dated on 30-December-2022. From 30-December-2023, the scale was not timely calibrated by the project owner, thus the conservative														

	value deducted the maximum permission error of the equipment is applied to correct the weight of the dairy cattle. The maximum permission error of the scale is 1%, and the error in the calibration report was less than the maximum permission error, thus the conservative value = The monitored value * (1-1%) is reasonable. For conservative, the data for the whole month (December, 2023) was corrected.																		
Purpose of Data	Project participants may adjust default IPCC values for VS for a site-specific average animal weight.																		
Calculation method	During this monitoring period, project participants carried out simple random sampling (SRS) procedures as per the “Standard for sampling and surveys for CDM project activities and Programmes of Activities (Version 09.0)”³³ to randomly select 300 dairy cattle with 90/10 confidence/precision level and monitored their weights monthly. The sample size was determined using the CDM sample size calculator (Version 03.1)³⁴ with the following inputs and outputs: <table border="1"> <thead> <tr> <th>Input</th><th>Value</th></tr> </thead> <tbody> <tr> <td>Expected mean</td><td>485</td></tr> <tr> <td>Expected standard deviation</td><td>485</td></tr> <tr> <td>Confidence level</td><td>90%</td></tr> <tr> <td>z multiplier</td><td>1.645</td></tr> <tr> <td>Relative precision</td><td>1%</td></tr> <tr> <td>Population size, N</td><td>17,500</td></tr> <tr> <th>Output</th><th>Value</th></tr> <tr> <td>Predicted sample size, n</td><td>267</td></tr> </tbody> </table> The target population was the 17,500 adult and breeding swine expected to be in the farm as described in the registered VCS PD. For conservativeness, a coefficient of variation (V) of 1 was used, and the sample size was calculated as 267. To compensate for any attrition, outliers or non-response associated with the sample, and to prevent a situation at the analysis stage where the required	Input	Value	Expected mean	485	Expected standard deviation	485	Confidence level	90%	z multiplier	1.645	Relative precision	1%	Population size, N	17,500	Output	Value	Predicted sample size, n	267
Input	Value																		
Expected mean	485																		
Expected standard deviation	485																		
Confidence level	90%																		
z multiplier	1.645																		
Relative precision	1%																		
Population size, N	17,500																		
Output	Value																		
Predicted sample size, n	267																		

³³ https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20210531160756223/Meth_Stan05.pdf

³⁴ <https://cdm.unfccc.int/Reference/Guidclarif/index.html>

	reliability was not achieved and additional sampling efforts would be required, oversampling was employed and the sample size was rounded up to 300. The precision was calculated after the sample survey to check whether the target precision was achieved. During this monitoring period, the relative standard error of the monthly sample mean of each month was below 1%, thus achieving the target precision level of 1%. CDM sample size calculator (Version 03.1) was also used for double-check.
Comments	It is ensured that the average weights were over the default value as per 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which is 485kg. The corrected average weight of swine of this project is 520 kg and 513 kg in 2023 and 2024. Thus, choosing to use the default value is more conservative.

Data / Parameter	$Q_{biogas,y}$ ($BG_{burnt,y}$), $BG_{elec,y}$, $BG_{heat,y}$, $Q_{biogas,flare,y}$ ($BG_{flare,y}$)				
Data unit	Nm^3				
Description	Amount of biogas collected at the digester outlet in year y; Biogas volume for power generation in year y; Biogas volume for heat generation in year y; Biogas volume for flare in year y				
Value applied:	Period	$Q_{biogas,y}(BG_{burnt,y})$ (Nm^3)	$BG_{elec,y}$ (Nm^3)	$BG_{heat,y}$ (Nm^3)	$Q_{biogas,flare,y}(BG_{flare,y})$ (Nm^3)
	15-Apr-2023~31-Dec-2023	4,002,234	704,114	518,301	2,779,820
	01-Jan-2024~31-Dec-2024	7,566,244	2,412,672	2,040,536	3,113,037
	Total	11,568,478	3,116,786	2,558,837	5,892,857
	The amount of $Q_{biogas,y}$ ($BG_{burnt,y}$), $BG_{elec,y}$, $BG_{heat,y}$, $Q_{biogas,flare,y}$ ($BG_{flare,y}$) are originated from the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. when calculating the project emissions, the actual monitored values of these parameters (without deducting the calf fraction) are directly applied, which is considered to be more conservative. While calculating the parameter of MD_y , the data of these				

parameters is deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions. Value of these parameters after deducting the calf fraction is listed as follows:

Period	$Q_{biogas,y}(BG_{burnt,y})$ for conservative to calculate MD_y (Nm^3)	$BG_{elec,y}$ for conservative to calculate MD_y (Nm^3)	$BG_{heat,y}$ for conservative to calculate MD_y (Nm^3)	$Q_{biogas,flare,y}(BG_{flare,y})$ for conservative to calculate MD_y (Nm^3)
15-Apr-2023~31-Dec-2023	3,884,725	685,320	505,710	2,693,696
01-Jan-2024~31-Dec-2024	7,359,658	2,355,146	1,994,316	3,010,196
Total	11,244,383	3,040,466	2,500,026	5,703,892

Comments

The amount of biogas recovered and flared or combusted shall be monitored by four mass flow meters. The first One F1 is installed at the outlet of the biogas pre-treatment system—for the biogas flow from the anaerobic digester system after pre-treatment. The second one F2 is installed at the inlet of power generation system—for the biogas flow to power generation system. The third one F3 is installed at the inlet of heat generation system—for the biogas flow to heat generation system. The fourth one F4 is installed at the inlet of the emergency flare—for the biogas flow to emergency flare. The meters readings are automatically converted to value at normal conditions of temperature (20 °C) and 1 atm pressure in volumetric flow from mass flow through the built-in gas density at normal condition from mass flow.

The total generated biogas, the biogas used for electricity generation, heat generation and flared is continuously monitored separately. The recovered biogas is prioritized for energy use, and the excess amount is flared.

Flow meters were calibrated at periodic interval as per national regulation "Verification Regulation of Thermal Mass Gas Flowmeters".

Position	Type	Serial number	Accuracy	Date of calibration	Validity
Outlet of the biogas pre-treatment system	Proline t-mass 65	SB02E3 02000	1%	13-April-2023	12-April-2025

	Inlet of the generator	Proline t-mass 65	SB02E4 02000	1%	13-April-2023	12-April-2025
	Inlet of the boiler	Proline t-mass 65	SB02E2 02000	1%	13-April-2023	12-April-2025
	Inlet of the emergency flare	Proline t-mass 65	SB02E5 02000	1%	13-April-2023	12-April-2025

Data / Parameter	$W_{CH_4,y}$
Data unit	-
Description	Methane content in biogas in the year y (volume fraction)
Value applied:	60%
Comments	This parameter applied default value of AMS-III.D (Version 21.0)

Data / Parameter	$FE (\eta_{flare,m})$
Data unit	-
Description	Flare efficiency in the year y (fraction)
Value applied:	90% for flaring 90% for heat generation 100% for power generation 100% for upgrading natural gas
Comments	As per para 22 of AMS-III.D, if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. The output EG_y is monitored and NG_y will be monitored by the project owner. Due to there is no monitoring equipment to monitor the heat generation for the biogas boiler to warming up the anaerobic

digesters of the project, thus it is assumed these amount of biogas used for heat generated were flared and included these amount of biogas when calculating PE_{flare} , which is conservative, therefore, the efficiency of biogas boiler is selected to be 90% (the same as flare efficiency).

As per Tool 06, the low height flare is defined as an enclosed flare for which the flame enclosure has a height between two and ten times the diameter of the combustion enclosure. According to the operating specification of biogas flare, the combustion chamber has an inner diameter of 1.5 meters and a height of 20 meters, the height is 13.3 times the diameter of the combustion enclosure, and accordingly the flare of the project is not low height flare.

As for flaring, the project uses enclosed flares, and the project chose option A of Project emissions from flaring (version 04.0) for the determination of flare efficiency. The flare efficiency of the project is determined as 90% since the enclosed flare applied by the project is not low height flare. Meanwhile, the temperature of flare (687°C in 2023 and 712°C 2024) and flow rate of the residual gas ($560.43 \text{ Nm}^3/\text{h}$ and $514.96 \text{ Nm}^3/\text{h}$) were within the manufacturer's operation specification in this monitoring period.

Data / Parameter	$T_{GE,m}$							
Data unit	$^{\circ}\text{C}$							
Description	Temperature in the exhaust gas of the enclosed flare in the minute m.							
Value applied:	Monitored ex-post. <table border="1"> <thead> <tr> <th rowspan="2">Period</th><th>E₅</th></tr> <tr> <th>$T_{EG,m} (^{\circ}\text{C})$</th></tr> </thead> <tbody> <tr> <td>15-Apr-2023~31-Dec-2023</td><td>687</td></tr> <tr> <td>01-Jan-2024~31-Dec-2024</td><td>712</td></tr> </tbody> </table>	Period	E ₅	$T_{EG,m} (^{\circ}\text{C})$	15-Apr-2023~31-Dec-2023	687	01-Jan-2024~31-Dec-2024	712
Period	E ₅							
	$T_{EG,m} (^{\circ}\text{C})$							
15-Apr-2023~31-Dec-2023	687							
01-Jan-2024~31-Dec-2024	712							
Comments	Description of measurement methods and procedures to be applied. The temperature in the exhaust gas of the enclosed flare shall be monitored ex post, using monitoring port in the flare to ensure that the flare is functioning correctly. The							

monitoring frequency is once per minute.

The flare monitoring port is equipped with a temperature transmitter. The temperature transmitter is calibrated annually according to the manufacturer's recommendations. Key information of the temperature transmitter. is shown as below:

Monitoring equipment	Temperature transmitter.
Position	Monitoring port in the flare
Type	WRNK-346
Serial number	22K201K13327
Accuracy	II
Date of calibration	14-March-2023; 13-March-2024
Calibration Validity	13-March-2024;12-March-2025

The flare operates within the manufacturer's operating specification, which is no less than 600°C.

Data / Parameter	$F_{RG,m} (BG_{flare,y})$														
Data unit	Nm ³														
Description	Flow rate of the residual gas on a dry basis at reference conditions in the minute m.														
Value applied:	Monitored ex-post, aggregated by year. <table><tr><th>Period</th><th>Flow rate (Nm³/h)</th><th>$F_{RG,m} (BG_{flare,y})$ (Nm³)</th></tr><tr><td>15-Apr-2023~31-Dec-2023</td><td>560.43</td><td>2,779,820</td></tr><tr><td>01-Jan-2024~31-Dec-2024</td><td>514.96</td><td>3,113,037</td></tr><tr><td>Average/Total</td><td>534.45</td><td>5,892,857</td></tr></table> The amount of $F_{RG,m} (BG_{flare,y})$ is originated from the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. when calculating the project emissions, the actual monitored value of this parameter (without deducting the calf fraction) is directly applied, which is considered to be more conservative. While calculating the parameter of MD_y, the data of this parameter is deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions.			Period	Flow rate (Nm ³ /h)	$F_{RG,m} (BG_{flare,y})$ (Nm ³)	15-Apr-2023~31-Dec-2023	560.43	2,779,820	01-Jan-2024~31-Dec-2024	514.96	3,113,037	Average/Total	534.45	5,892,857
Period	Flow rate (Nm ³ /h)	$F_{RG,m} (BG_{flare,y})$ (Nm ³)													
15-Apr-2023~31-Dec-2023	560.43	2,779,820													
01-Jan-2024~31-Dec-2024	514.96	3,113,037													
Average/Total	534.45	5,892,857													

	Value of these parameters after deducting the calf fraction were listed as follows:														
	<table><tr><td>Period</td><td>$F_{RG,m}(BG_{flare,y})$ for conservative to calculate MD_y (Nm³)</td></tr><tr><td>15-Apr-2023~31-Dec-2023</td><td>2,693,696</td></tr><tr><td>01-Jan-2024~31-Dec-2024</td><td>3,010,196</td></tr><tr><td>Total</td><td>5,703,892</td></tr></table>	Period	$F_{RG,m}(BG_{flare,y})$ for conservative to calculate MD_y (Nm ³)	15-Apr-2023~31-Dec-2023	2,693,696	01-Jan-2024~31-Dec-2024	3,010,196	Total	5,703,892						
Period	$F_{RG,m}(BG_{flare,y})$ for conservative to calculate MD_y (Nm ³)														
15-Apr-2023~31-Dec-2023	2,693,696														
01-Jan-2024~31-Dec-2024	3,010,196														
Total	5,703,892														
Comments	The flow meter installed at the inlet of the emergency flare monitors the biogas volume for flaring ($BG_{flare,y}$). The flow meter were read by project staff and recorded monthly based on continuous flow measurement with daily accumulated volume recording. The meter readings were automatically converted to value at normal condition of temperature (20 °C) and 1 atm pressure in volumetric flow from mass flow through the built-in gas density at normal condition from mass flow. Flow meters were calibrated at periodic interval as per national regulation “Verification Regulation of Thermal Mass Gas Flow meters”. <table><tr><td>Monitoring equipment</td><td>Flow meter</td></tr><tr><td>Position</td><td>Inlet of the emergency flare</td></tr><tr><td>Type</td><td>Proline t-mass 65</td></tr><tr><td>Serial number</td><td>SB02E502000</td></tr><tr><td>Accuracy</td><td>1%</td></tr><tr><td>Date of calibration</td><td>13-April-2023</td></tr><tr><td>Calibration Validity</td><td>12-April-2025</td></tr></table> The flare operates within the manufacturer’s operating specification, which is no more than 16,644,000 m³/year (1,900m³/h).	Monitoring equipment	Flow meter	Position	Inlet of the emergency flare	Type	Proline t-mass 65	Serial number	SB02E502000	Accuracy	1%	Date of calibration	13-April-2023	Calibration Validity	12-April-2025
Monitoring equipment	Flow meter														
Position	Inlet of the emergency flare														
Type	Proline t-mass 65														
Serial number	SB02E502000														
Accuracy	1%														
Date of calibration	13-April-2023														
Calibration Validity	12-April-2025														

Data / Parameter	Flame _m
Data unit	Flame on/Flame off
Description	Flame detection of flare in the minute m.
Value applied:	Monitored ex-post. During this monitoring period, the flame was continuously detected to ensure that the biogas flare system has

	been working properly.
Comments	The flare monitoring port is equipped with a temperature transmitter, which continuously measure temperature of the flaring system, and therefore allow the detection of the presence and absence of flame. Detection of flame recorded as a minute that the flame was on, otherwise recorded as a minute that the flame was off. Flame detection of flare in the minute m , and "on" is indicated when the temperature is above flame temperature for flaring. It is determined based on parameter $T_{EG,m}$. Please refer to $T_{EG,m}$ for key information about the temperature transmitter.

Data / Parameter	EG_y								
Data unit	MWh								
Description	Total electricity generated from the recovered biogas in year y								
Value applied:	Total electricity generated from the recovered biogas in year y (EG_y) was continuously monitored by a built-in power monitoring meter and recorded monthly. During this monitoring period, the data was confirmed by the staff of the project. <table border="1"> <thead> <tr> <th>Period</th><th>EG_y (MWh)</th></tr> </thead> <tbody> <tr> <td>15-Apr-2023~31-Dec-2023</td><td>1,548,716</td></tr> <tr> <td>01-Jan-2024~31-Dec-2024</td><td>5,649,364</td></tr> <tr> <td>Total</td><td>7,198,080</td></tr> </tbody> </table>	Period	EG_y (MWh)	15-Apr-2023~31-Dec-2023	1,548,716	01-Jan-2024~31-Dec-2024	5,649,364	Total	7,198,080
Period	EG_y (MWh)								
15-Apr-2023~31-Dec-2023	1,548,716								
01-Jan-2024~31-Dec-2024	5,649,364								
Total	7,198,080								
Comments	As per para 22 of AMS-III.D. (Version 21.0), if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. There is a built-in power monitoring meter (E_1) in the generator of the project, and the power generation can be accessed directly in the control system, so there is no need to install a separate meter, but it can also be proved that the recovered biogas is destroyed. The project generates electricity for self-consumption and the farm								

which is operated by the same owner with the project, and does not involve trade settlement, so the meter is not included in the catalog of measuring instruments issued by the General Administration of Market Supervision on the implementation of mandatory management³⁵. The generator's manual and other relevant materials has been submitted to VVB.

As per para.30 of AMS-III.D. (Version 21.0), MD_y can be calculated as follows, based on the amount of monitored electricity generation.

$$MD_y = \frac{EG_y \times 3600}{NCV_{CH_4} \times EE_y} \times D_{CH_4} \times GWP_{CH_4}$$

Where:

EG_y = Total electricity generated from the recovered biogas in year y (MWh)

3600 = Conversion factor (1 MWh = 3600 MJ)

NCV_{CH_4} = NCV of methane (MJ/Nm³) (use default value: 35.9 MJ/Nm³)

EE_y = Energy conversion efficiency of the project equipment (use the default efficiency of 40%)

D_{CH_4} = CH₄ density (0.67kg/m³ at room temperature (20°C) and 1 atm pressure)

GWP_{CH_4} = Global Warming Potential (GWP) of CH₄ applicable to the crediting period (tCO_{2e}/tCH₄) (use 28 tCO_{2e}/tCH₄ from IPCC Fifth Assessment Report (AR5))

The amount of EG_y is generated from the biogas by the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. Thus, the data of this parameter will be deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions.

The calculation results are shown in the table below.

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total
EG_y (MWh)	1,548.716	5,649.364	7,198.008
EG_y (MWh) for	1,508.866	5,524.777	7,033.644

³⁵ https://scj.sxxz.gov.cn/zljcssyzsfw/jlfw/202107/t20210726_3659463.html

conservative (Subtracted the amount of biogas generated from calf manure)			
NCV _{CH4} (MJ/Nm ³)	35.9	35.9	/
EE _y	40%	40%	/
D _{CH4} (t/m ³)	0.00067	0.00067	/
GWP _{CH4} (tCO ₂ e/tCH ₄)	28	28	/
The amount of biogas combusted for electricity generation (tCO ₂ e)	7,096	25,983	33,070

By comparing the amount of biogas combusted for electricity generation calculated posted above using the generated electricity with the MD_y of $BG_{elec,y}^{36}$ calculated using the flare efficiency and methane content of biogas, it is concluded that essentially all the recovered biogas was actually destroyed by electricity generation.

Data / Parameter	NG _y								
Data unit	Nm ³								
Description	Total nature gas upgraded from the recovered biogas in year y								
Value applied:	In this monitoring period it does not involve nature gas upgrading, therefore only power monitoring data is provided. The flow meter F5 information for natural gas (NG_y) will be updated for the subsequent monitoring period. <table> <tr> <th>Period</th><th>NG_y (Nm³)</th></tr> <tr> <td>15-Apr-2023~31-Dec-2023</td><td>0</td></tr> <tr> <td>01-Jan-2024~31-Dec-2024</td><td>0</td></tr> <tr> <td>Total</td><td>0</td></tr> </table>	Period	NG _y (Nm ³)	15-Apr-2023~31-Dec-2023	0	01-Jan-2024~31-Dec-2024	0	Total	0
Period	NG _y (Nm ³)								
15-Apr-2023~31-Dec-2023	0								
01-Jan-2024~31-Dec-2024	0								
Total	0								

³⁶

$$34,222 = 7,713 + 26,509 = 685,320 \text{ m}^3 * 60\% * 0.00067 \text{ t/m}^3 * 100\% * 28 \text{ tCO}_2\text{e/tCH}_4 + 2,355,146 \text{ m}^3 * 60\% * 0.00067 \text{ t/m}^3 * 100\% * 28 \text{ tCO}_2\text{e/tCH}_4$$

MD_y for power generation is calculated following Equation (14).

Comments	As per para 22 of AMS-III.D. (Version 21.0), if the recovered biogas is combusted for electrical/thermal energy production or for other gainful use, the methane destruction efficiency can be considered as 100%. However, this use of the recovered biogas shall be included in the project boundary and its output shall be monitored in order to ensure that the recovered biogas is actually destroyed, even if the emission reductions from this component are not claimed. The amount of NG_y will be generated from the biogas by the mixed manure (calves included), no physical or analytical basis exists to isolate the fraction derived from calves. Thus, the data of this parameter will be deducted the biogas generated from calves' manure by the calf fraction (the number of calves/the total number of dairy cattle), thereby excluding the calves contribution from the baseline emissions.
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Data / Parameter	Soil application
Data unit	-
Description	Soil application of residual waste
Source of data	Records by project participants
Description of measurement methods and procedures applied	The residual waste from the animal manure management system is handled aerobically.
Frequency of monitoring/recording	Annually
Value applied:	During this monitoring period, the residual waste from the CSTR is passed through a solid-liquid separation system, and then the dried part was used as cattle bedding material, the liquid digestate used to the nearby farmland as liquid fertilizer. The digestate will not be stored under anaerobic conditions.
Monitoring equipment	-
QA/QC procedures applied	-

Purpose of data	To ensure that the residual waste from the animal manure management system is handled aerobically.
Calculation method	-
Comments	-

7.2 Baseline Emissions

As per section 5.1 of this report, baseline emission is calculated as the equation below:

$$BE_y = GWP_{CH_4} \times D_{CH_4} \times UF_b \times \sum_{j,LT} MCF_j \times B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$$

The value of $BE_{y, \text{ex post}}$ monitored during this monitoring period is shown in the table 7-1

Table 7-1 The value of BE_y (i.e. $BE_{y, \text{ex post}}$) during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
GWP_{CH_4}	28	28	-	tCO ₂ e/tCH ₄
D_{CH_4}	0.00067	0.00067	-	t/Nm ³
UF_b	0.94	0.94	-	-
MCF_j	76%	76%	-	%
$B_{0,LT}$	0.24	0.24	-	m ³ CH ₄ /kg-VS
$N_{LT,y}$	10,309	16,656	-	hd
$VS_{LT,y}$	1,433.90	1,433.90	-	Kg-dm/animal/year
$MS\%_{i,y}$	100%	100%	-	%
$BE_{y, \text{ex post}}$	47,546	76,820	124,366	tCO ₂ e

7.3 Project Emissions

As per section 5.1 of this report, the $PE_{y, \text{ex post}}$ is calculated as the equation below:

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y}$$

Since $PE_{transp,y}$ and $PE_{storage,y}$ equals to 0 tCO₂e, project emission is calculated as below:

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} = PE_{PL,y} + PE_{flare,y} + PE_{EC,y}$$

1. Emissions due to physical leakage of biogas

$$PE_{PL,y} = 0.10 \times GWP_{CH_4} \times D_{CH_4} \times \sum_{i,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$$

The value of $PE_{PL,y}$ monitored during this monitoring period is shown in the table 7-2.

Table 7-2 The value of $PE_{PL,y}$ monitored during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
GWP_{CH_4}	28	28	-	tCO ₂ e/tCH ₄
D_{CH_4}	0.00067	0.00067	-	t/Nm ³
$B_{O,LT}$	0.24	0.24	-	m ³ CH ₄ /kg-VS
$N_{LT,y}$	10,309	16,656	-	hd
$VS_{LT,y}$	1,433.90	1,433.90	-	kg-dm/animal/year
$MS\%_{i,y}$	100%	100%	-	%
$PE_{PL,y}$	6,656	10,753	17,409	tCO ₂ e

2. Emissions from flaring or combustion of the biogas stream

Emissions from flaring or combustion of the biogas stream in the year y is calculated as per equation below, details as Table 7-3.

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3}$$

$$\sum_{m=1}^{525600} F_{CH_4,RG,m} = Q_{biogas,flare,y} \times f_{CH_4,default} \times \rho_{CH_4}$$

Table 7-3 The value of $PE_{flare,y}$ monitored during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
GWP_{CH_4}	28	28	28	tCO ₂ e/tCH ₄
ρ_{CH_4}	0.67	0.67	0.67	kg/m ³
$Q_{biogas,flare,y}$	2,779,820	3,113,037	5,892,857	Nm ³
$B_{G,heat,y}$	518,301	2,040,536	2,558,837	Nm ³
$f_{CH_4,default}$	60%	60%	60%	m ³ CH ₄ /m ³ biogas
$\eta_{flare,m}$	90%	90%	90%	-
$PE_{flare,y}$	3,713	5,801	9,514	tCO ₂ e

3. Emissions from electricity consumption

$$PE_{EC,y} = Q_{CH_4,y} \times F_{EC,default} \times EF_{EL,default}$$

$$Q_{CH_4,y} = Q_{biogas,y} \times f_{CH_4,default} \times \rho_{CH_4}$$

The value of $Q_{CH_4,y}$ monitored during this monitoring period is shown in the table 7-4.

Table 7-4 The value of $Q_{CH_4,y}$ monitored during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
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$Q_{\text{biogas},y}$	4,002,234	7,566,244	11,568,478	Nm ³
$f_{\text{CH}_4,\text{default}}$	0.6	0.6	0.6	m ³ CH ₄ /m ³ biogas
ρ_{CH_4}	0.00067	0.00067	0.00067	t CH ₄ /m ³ CH ₄
$Q_{\text{CH}_4,y}$	1,609	3,042	4,651	t CH ₄

The value of $PE_{\text{EC},y}$ monitored during this monitoring period is shown in the table 7-5.

Table 7-5 The value of $PE_{\text{EC},y}$ (i.e. $PE_{\text{power},y,\text{ex post}}$) monitored during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
$Q_{\text{CH}_4,y}$	1,609	3,042	4,651	t CH ₄
$F_{\text{EC},\text{default}}$	1.02	1.02	1.02	MWh/t CH ₄
$EF_{\text{EL},\text{default}}$	1.3	1.3	1.3	tCO ₂ /MWh
$PE_{\text{power},y,\text{ex post}}$	2,134	4,034	6,168	tCO ₂ e

Hence the project emission is calculated as below:

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
$PE_{\text{PL},y}$	6,656	10,753	17,409	tCO ₂ e
$PE_{\text{flare},y}$	3,713	5,801	9,514	tCO ₂ e
$PE_{\text{power},y,\text{ex post}}$	2,134	4,034	6,168	tCO ₂ e
Total $PE_{y,\text{ex post}}$	12,503	20,588	33,091	tCO ₂ e

7.4 Leakage Emissions

Digestate from the anaerobic digesters of the project is directly returned to nearby farm as fertilizer. Digestate is not stored under anaerobic conditions. In addition, the project does not involve anaerobic soil application. Therefore, leakage emissions of the project associated with the anaerobic digester is not accounted for, leakage for this project is 0.

7.5 GHG Emission Reductions and Carbon Dioxide Removals

As per section 5.4 of this project, net GHG emission reduction is calculated as:

$$ER_{y,\text{ex post}} = \min[(BE_{y,\text{ex post}} - PE_{y,\text{ex post}}), (MD_y - PE_{\text{power},y,\text{ex post}})]$$

MD_y is calculated using the equation below:

$$MD_y = BG_{\text{burnt},y} \times W_{\text{CH}_4,y} \times D_{\text{CH}_4} \times FE \times GWP_{\text{CH}_4}$$

The value of MD_y monitored during this monitoring period is shown in the table 7-6 and 7-7.

Table 7-6 The value of MD_y during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
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BG _{burnt,y}	4,002,234	7,566,244	11,568,478	Nm ³
BG _{flare,y}	2,779,820	3,113,037	5,892,857	Nm ³
BG _{heat,y}	518,301	2,040,536	2,558,837	Nm ³
BG _{elec,y}	704,114	2,412,672	3,116,786	Nm ³
W _{CH4,y}	60%	60%	60%	%
D _{CH4}	0.00067	0.00067	0.00067	t/Nm ³
FE for flaring and heat generation	90%	90%	90%	%
FE for power generation	100%	100%	100%	%
GWP _{CH4}	28	28	28	tCO ₂ e/tCH ₄
MD _y	41,336	79,364	120,700	tCO ₂ e

Table 7-7 The value of MD_y (Subtracted the amount of biogas generated from calf manure) during this monitoring period

Period	15-Apr-2023~31-Dec-2023	01-Jan-2024~31-Dec-2024	Total	Unit
BG _{burnt,y} for conservative to calculate MD _y (Subtracted the amount of biogas generated from calf manure)	3,884,725	7,359,658	11,244,383	Nm ³
BG _{flare,y} for conservative to calculate MD _y (Subtracted the amount of biogas generated from calf manure)	2,693,696	3,010,196	5,703,892	Nm ³
BG _{heat,y} for conservative to calculate MD _y (Subtracted the amount of biogas generated from calf manure)	505,710	1,994,316	2,500,026	Nm ³
BG _{elec,y} for conservative to calculate MD _y (Subtracted the amount of biogas generated from calf manure)	685,320	2,355,672	3,040,466	Nm ³
W _{CH4,y}	60%	60%	60%	%
D _{CH4}	0.00067	0.00067	0.00067	t/Nm ³
FE for flaring and heat generation	90%	90%	90%	%
FE for power generation	100%	100%	100%	%
GWP _{CH4}	28	28	28	tCO ₂ e/tCH ₄
MD _y (Subtracted the amount of biogas generated from calf manure)	40,125	77,207	117,332	tCO ₂ e

Hence emission reduction of the project is calculated as follows:

Table 7-8 The value of ER_{y, ex post} during this monitoring period (Unit: tCO₂e)

Period	BE _{y,ex post}	PE _{y, ex post}	BE _{y,ex post} - PE _{y, ex post}	MD _y	PE _{power,y,ex post}	MD _y - PE _{power,y,ex post}	ER _{y,ex post}
	A	B	C=A-B	D	E	F=D-E	G=min(C,F)

15-Apr-2023~31-Dec-2023	47,546	12,503	35,043	40,125	2,134	37,991	35,043
01-Jan-2024~31-Dec-2024	76,820	20,588	56,232	77,207	4,034	73,173	56,232
Total	124,366	33,091	91,275	117,332	6,168	111,164	91,275

Vintage period	Baseline emissions (tCO ₂ e)	Project emissions (tCO ₂ e)	Leakage emissions (tCO ₂ e)	Reduction VCUs (tCO ₂ e)	Removal VCUs (tCO ₂ e)	Total VCUs (tCO ₂ e)
15-Apr-2023~31-Dec-2023	47,546	12,503	0	35,043	0	35,043
01-Jan-2024~31-Dec-2024	76,820	20,588	0	56,232	0	56,232
Total	124,366	33,091	0	91,275	0	91,275

Vintage period	Ex-ante emissions reductions / removals	Achieved emissions reductions / removals	Percent difference	Justification for the difference
15-Apr-2023~31-Dec-2023	42,625	35,043	-17.79%	This monitoring period is from 15-Apr-2023 to 31-Dec-2024, with totally 603 days (261 days in year 2023, and 366 days in 2024 totally 627 days). Based on the annual estimated emission reductions, the amount of emission reductions for this monitoring period would be 102,235 tCO ₂ e. The actual emission reductions achieved in this monitoring period (603 days) are 91,275 tCO ₂ e, which is 10.72% ³⁷ lower than the estimated emission reductions, which is in the reasonable fluctuation range.
01-Jan-2024~31-Dec-2024	59,610	56,232	-5.67%	
Total	102,235	91,275	-10.72%	

³⁷-10.72% = 91,275 tCO₂e / 102,235 tCO₂e - 1

APPENDIX 1: COMMERCIALLY SENSITIVE INFORMATION

Not applicable.

APPENDIX 2: SUPPORTING EVIDENCE

Evidence for SDG 13: From project operation date onwards, the emission reduction achieved in each monitoring period have been listed in below table. Please refer to following links for details.

<https://registry.terra.org/app/projectDetail/VCS/5366>

Period		Emission Reductions achieved
Start Date	End Date	ER _y (tCO ₂ e)
15-Apr-2023	31-Dec-2023	35,043
01-Jan-2024	31-Dec-2024	56,232
Total		91,275

Please refer to section 7 of this Joint PD-MR for the evidence of the detail of the project's contribution to SDG 7 and SDG 13.

Evidence for SDG 8: The employee list of the project has been submitted as a separate document to VVB for validation.