



BINZHOU TOPIGS NORSVIN BREEDING SWINE CO., LTD. BINHAI SWINE FARM BIOGAS RECOVERY AND UTILIZATION PROJECT



Document Prepared by Climate Bridge (Shanghai) Ltd.

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1 PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

Binzhou Topigs Norsvin Breeding Swine Co., Ltd. Binhai Swine Farm Biogas Recovery and Utilization Project (hereinafter referred to as "the Project") is located in Zhanhua District, Binzhou City, Shandong Province, People's Republic of China. The project is owned and implemented by Binzhou Topigs Norsvin Breeding Swine Co., Ltd. Binhai Branch. The project started construction on 16-Oct-2019 and got commissioned on 05-Aug-2020.

This project is to build an anaerobic animal manure treatment system to dispose manure waste of breeding swine in the Binhai Breeding Swine Farm. The project uses the High Density Polyethylene (HDPE) membrane enclosed anaerobic digesters to treat animal manure waste. During this monitoring period of the project, the biogas produced in this anaerobic process was burnt through the biogas flare system and the residual waste from the digesters was handled aerobically to produce organic fertilizer at the project site.

Prior to the implementation of the project, the animal manure waste was left to decay in anaerobic manure management system (uncovered open lagoon) at the Binhai Breeding Swine Farm and methane was emitted to the atmosphere directly without any methane recovery and destruction facility. The conditions existing prior to project initiation is regarded as the baseline scenario of the project.

The project is expected to avoid GHG emission of methane through recovery and destruction of biogas. The project is expected to achieve an annual emission reduction of 11,795tCO₂e and a total emission reduction of 82,563tCO₂e during the first 7-year renewable crediting period.

This is the first monitoring period of the Project, spanning from 05-Aug-2020 to 31-May-2023 (both days included) and covering a total of 1,030 days. The actual emission reduction of this monitoring period is 20,326tCO₂e.

The audit history of the project is as below:

Audit Type	Period	Program	VVB Name	Number of years
Validation	12-Sept-2022	Verified Carbon Standard	CTI Certification CO.,LTD.	-
Verification (1 st monitoring period)	05-Aug-2020 - 31-May-2023	Verified Carbon Standard	CTI Certification CO.,LTD.	2.8
Total	05-Aug-2020 - 31-May-2023	-	-	2.8

1.2 Sectoral Scope and Project Type

Sectoral Scope 1: Energy (renewable/non-renewable).

Sectoral Scope 13: Waste handling and disposal.

Sectoral Scope 15: Livestock and manure management

The project is not a grouped project.

1.3 Project Proponent

Organization name	Binzhou Topigs Norsvin Breeding Swine Co., Ltd. Binhai Branch
Contact person	Geng Wang
Title	Project Manager
Address	Huaquan Village, Binhai Town, Zhanhua District, Binzhou City, Shandong Province
Telephone	+86 2162462036
Email	3542346576 qq.com

1.4 Other Entities Involved in the Project

Organization name	Climate Bridge (shanghai) Ltd.
Role in the Project	Consultancy
Contact person	Zhiwen Gao
Title	General Manager
Address	Block B, Level 24, Jiangong Mansion, 33 Fushan Road, Pudong New Area, Shanghai, China 200120
Telephone	+86 2162462036
Email	gao.zhiwen@climatebridge.com ; projects@climatebridge.com

1.5 Project Start Date

05-Aug-2020 (operation start date of anaerobic animal manure treatment system).

1.6 Project Crediting Period

This project adopts a 7-year renewable crediting period, from 05-Aug-2020 to 04-Aug-2027 (both days included).

1.7 Project Location

This project is in Huaquan Village, Binhai Town, Zhanhua District, Binzhou City, Shandong Province, People's Republic of China. The project site is located at north latitude $37^{\circ}52'43''$ and east longitude $118^{\circ}10'54''$. The geographic location of the project is depicted in Figure 1.1.

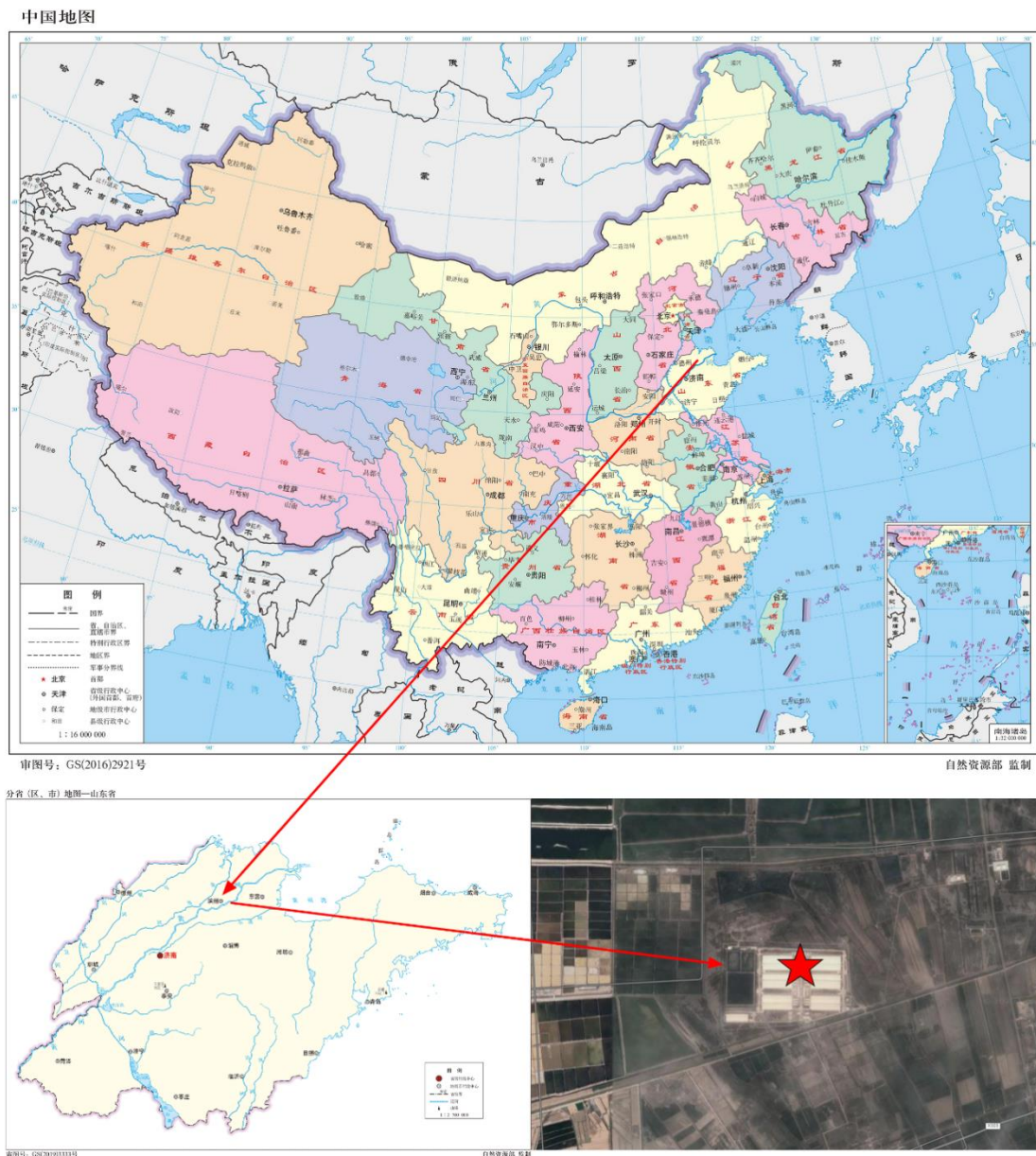


Figure 1.1 Location of the Project

1.8 Title and Reference of Methodology

The methodology applied:

“AMS-III.D Methane recovery in animal manure management systems” (version 21.0)

CDM tools applied:

“Project and leakage emissions from anaerobic digesters” (version 02.0)

“Project emissions from flaring” (version 03.0)

For more detail information about the methodology and tools, please reference to the following link: <https://cdm.unfccc.int/methodologies/DB/H9DVSB2407GEZQYLYNWUX23YS6G4RC>.

1.9 Participation under other GHG Programs

The Project has neither been registered nor seeking registration under any other GHG programs. The Project was registered as a VCS project on 28-Dec-2022, and the VCS ID is 2880.

1.10 Other Forms of Credit and Supply Chain (Scope 3) Emissions

- Emissions Trading Programs and Other Binding Limits

The project is not included in an emissions trading program or any other mechanism that includes GHG allowance trading. China has a national emissions trading scheme that only covers high-emission industries, such as thermal power generation, petrochemicals, chemicals, building materials, iron and steel, non-ferrous metals, paper, aviation and other key emission industries with emissions of at least 26,000 tons of CO_{2e} per year, while renewable projects are not included¹. And the project activity is not included in the mandatory emission control scheme and the project owner has not enforced the emission cap according to the list of enforcement companies² in public information. Hence, it is confirmed that the net GHG emission reductions or removals generated over this monitoring period have not been and will not be used for compliance under such programs or mechanisms.

- Other Forms of Environmental Credit

The project has not sought or received any other form of GHG-related environmental credits, including renewable energy certificates.

- Supply Chain (Scope 3) Emissions

¹ http://www.mee.gov.cn/xxgk/xxgk/xxgk05/202103/t20210330_826728.html

² <http://www.mee.gov.cn/xxgk/xxgk/xxgk03/202012/W020201230736907682380.pdf>

According to VERRA's latest announcement on the effective date of VCS scope 3 requirements dated 31-May-2023, projects are not required to complete this section until the effective date of the revised requirements of 01-Jan-2024³, and as such, it does not yet apply to this MR.

1.11 Sustainable Development Contributions

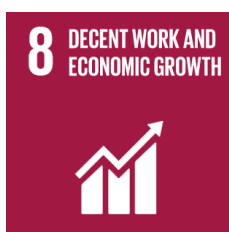
The Project contributes to sustainable development in the following ways:



SDG 6 “Ensure availability and sustainable management of water and sanitation for all”.⁴

The Chinese government promotes water control, and promotes the conservation, protection and management of water resources. The urban and rural water supply and environmental sanitation conditions have been significantly improved, and the people feel happy. It is of great significance to promote the comprehensive green transformation of economic and social development.

The project will avoid waste of animals discharging into the farm and underground water system through capturing waste of animals. The project will enhance the quality of the water and improve the working environment of the workers of the livestock farm. This contributes to one of China's actions for promoting sustainable developing: "Continue to implement water pollution prevention and control. Coordinate the development of high-quality protection and high levels of development and continuously improve the ecological environment of the basin.



SDG 8 “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”⁵.

China continuously improves the quality and efficiency of development. In-depth implementation of the innovation-driven development strategy, the rapid development of small and medium-sized enterprises. Adhering to the policy of giving priority to employment, the unemployment rate has remained at a low level. By coordinating epidemic prevention and control and economic and social development, it has become the only major economy to achieve positive growth in 2020 and has made positive contributions to the recovery of the global economy.

The project will provide new job opportunities and increase tax revenue, which will have a positive effect on the local economy. This contributes to

³ <https://verra.org/wp-content/uploads/2023/06/VCS-Clarification-on-Scope-3-Emissions-Double-Claiming-Requirements-31-May-2023.pdf>

⁴ <https://sdgs.un.org/goals/goal6>

⁵ <https://sdgs.un.org/goals/goal8>

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".



SDG 13 “Take urgent action to combat climate change and its impacts”⁶.

In 2020, China's energy consumption per unit of GDP was reduced by 24.4% compared with 2012; carbon dioxide emissions per unit of GDP was reduced by 18.8% compared with 2015 and 48.4% compared with 2005, all of which have already fulfilled China's commitment to the international community in 2020 ahead of schedule.

The project will reduce CH₄ emissions from animal wastes through biogas digesters with methane capture and flare. This contributes to achieve one of China's stated sustainable development priorities "Actively adapt to climate change and strengthen resistance capacity to climate risks in agriculture, forestry, water resources and other key fields, as well as cities, coastal regions and ecologically vulnerable areas".

⁶ <https://sdgs.un.org/goals/goal13>

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	6.3	Amount of livestock manure discharged into the farm and groundwater system	Implemented activities to decrease	Avoided the discharge of at least 4,639.0882 ⁷ tonnes of livestock manure into the farm and groundwater system.	From 05-Aug-2020 onwards, the project has avoided the discharge of at least 4,639.0882 tons of livestock manure into the farm and groundwater system.
2)	8.5	Number of job opportunities created by implementation of the project	Implemented activities to be stable or increase	Provided 30 employment positions for local people in this monitoring period.	From 05-Aug-2020 onwards, the project has provided 30 employment positions for local villagers in this monitoring period.
3)	13.0	Tonnes of greenhouse gas emissions avoided or removed	Implemented activities to increase	Achieved a GHG emission reduction of 20,326tCO ₂ e during this monitoring period.	From 05-Aug-2020 onwards, the project has achieved a GHG emission reduction of 20,326tCO ₂ e during this monitoring period.

⁷ Calculated by Annual average number of animals of type LT ($N_{LT,y}$) × Volatile solids production/excretion per animal of livestock LT ($VS_{LT,y}$)

2 SAFEGUARDS

2.1 No Net Harm

The Environmental Impact Assessment (EIA) of the project has been conducted, and EIA report has been approved by Environmental Protection Bureau of Zhanhua District, Binzhou City on 29-11-2018 (Approval No. “Zhanhuanzi [2018] No.76”). This EIA report has assessed every possible aspect of environmental impact of the project and recommended corresponding mitigation measures, where applicable. During this monitoring period, all mitigation measures were properly implemented by the project, and no significant impact on the surrounding environment was found. Meanwhile, the implementation of the project improved local socio-economic development through creating career opportunities and paying taxes. The project also contributed to the sustainable development of local community as described in Section 1.11 above.

To conclude, the project did not bring negative impacts to local environment and socio-economy during this monitoring period. No net harm on local environment and social community was detected for the project.

2.2 Local Stakeholder Consultation

The ongoing communications with local stakeholders have been carried out at periodic intervals. Key implementation schedules or changes of the project were conveyed to local authorities, neighbourhood committees, and residents during this monitoring period. Comments and suggestions from any of these entities were collected and considered by the project owner.

A total of two local stakeholder consultations (LSC) were conducted during the monitoring period. The LSC meetings were held at the office building on the project site in Nov-2020 and Oct-2022. During the meeting, project information and corresponding environmental and social impacts of the project were communicated thoroughly to the local stakeholders. For each LSC, 30 copies of questionnaire were distributed to stakeholder representatives, taking full account of different ages, genders and occupations. Questionnaire focused on following issues:

1. Do you know the construction and operation of the project?
2. What impacts would the project have on your environment of living, studying and working?
3. What impacts would the project have on local economic development?
4. What impacts would the project have on the ecosystem?
5. Do you agree with the development and construction of the project?
6. Do you have any suggestions about the project?

Both surveys received a 100% response rate. No negative comments were received for the project from LSC meetings.

Besides questionnaires surveys conducted in Nov-2020 and Oct-2022, the project proponent also maintained a direct line of communication with community members and relevant stakeholders regularly, where stakeholders could raise their opinions, suggestions and concerns directly. A commitment was established to keep stakeholders informed of the processes of project activities including implementation, production, maintenance, monitoring and VCS verification process. The local government agencies and competent authorities also conducted spot checks on the implementation of the project at periodic intervals and provided suggestions on the involved rectification problems if needed. No negative comments were received for the project during this monitoring period, stakeholders generally expressed their support to the project.

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

2.3 AFOLU-Specific Safeguards

The project is a non-AFOLU project and thus is not applicable.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The Project started construction on 16-Oct-2019 and operated since 05-Aug-2020. This is the first monitoring period of this Project spanning from 05-Aug-2020 to 31-May-2023 with both days include.

During this monitoring period, the project was operating with no major changes in project design, no malfunctions or technical failures, apart from some minor deviations detailed in Section 3.2.2 that did not significantly affect greenhouse gas emission reductions and monitoring. Animal manure waste were collected and transmitted to the HDPE membrane enclosed anaerobic digesters, and the biogas produced in this process was burnt year-round through the biogas flare system. The residual waste from the digesters were handled aerobically to produce organic fertilizer on the project site. The operation of key systems involved in the project during this monitoring period are described more specifically as below.

- Anaerobic animal manure management system

Two HDPE membrane enclosed anaerobic digesters were installed on site. The ferment process took place in the HDPE membrane enclosed anaerobic digesters with the temperature between 15°C and 25°C.

- Biogas pre-treatment system

Before combustion or flaring, the biogas was pre-treated by removing sulphide, moisture and so on to prevent biogas pipelines from corrosion. Biogas was contained in a continuously stable condition before it was transmitted into gas engine or flare. This pre-treatment consisted of desulfurization and dehumidification.

- Biogas flare system

The flare combustion system installed on site is HJ-200 with a rated capacity of 2.2KW/H. The recovery methane was transmitted to flare instead of directly emitting to the atmosphere.

- Wastewater treatment system

The outlet wastewater from the anaerobic digesters was disposed in an open tank. Wastewater treatment system was handled aerobically and the treated wastewater was reused for nearby farm irrigation.

- Residual waste treatment system

The residual waste from HDPE membrane enclosed anaerobic digesters and wastewater treatment were disposed aerobically to produce organic fertilizer on site.

3.2 Deviations

3.2.1 Methodology Deviations

There is no methodology deviation in this monitoring period.

3.2.2 Project Description Deviations

Deviation 1:

In the registered VCS PD, the biogas produced from the anaerobic process should be burnt through the biogas flare system during the non-heating period (May to September) and should be utilized by the biogas heating system for heat supply during the heating period (October to April next year).

In this monitoring period, as there was no additional heating demand requiring biogas combustion, the biogas heating system was not yet put into operation. The biogas produced during the heating period was also transmitted to the biogas flare system and burnt out, instead of being recovered for thermal energy production. Therefore, from 05-Aug-2020 to 31-May-2023, biogas was all burnt through the biogas flare system.

This deviation does not affect the additionality of the project, as the host country does not have any regulations requiring the collection and destruction of methane from livestock manure and thus the project is deemed automatically additional. This deviation does not affect the conservativeness of the project either, as the project emission from flaring or combustion of the

gas stream ($PE_{flare,y}$) was consistently based on a 90% flare efficiency, regardless of combustion for electrical/thermal energy production or for other gainful use (100% methane destruction efficiency), resulting in an increase in $PE_{flare,y}$. Meanwhile, the amount of methane captured and destroyed or used gainfully by the project activity (MD_y) was also reduced due to this deviation, leading to more conservative results.

This deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

Deviation 2:

In the registered VCS PD, the parameter $BG_{burnt,y}$ described in Section 5.2 as “Biogas flared in year y” & “(measured by flow meter) at the inlet of the flare system” were typos, while the accurate descriptions could be retrieved from Table 5-1 of the registered VCS PD.

In this monitoring report, the descriptions of $BG_{burnt,y}$ throughout the text has been unified to “Biogas volume in year y”, measuring by the flow meter installed at the outlet of the biogas pre-treatment system to monitor the total amount of biogas produced.

This deviation in wording does not affect the accuracy of the calculation of emission reductions, as the data sources and monitoring methods were accurate and precise, strictly following AMS-III.D (version 21.0).

This deviation does not impact the applicability of the methodology, additionality or the appropriateness of the baseline scenario.

3.3 Grouped Projects

This is not a grouped project.

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

As per Section 1.1 of the latest released VCS Standard (v4.5), when external documents are referenced, and when such documents are updated, the most recent version of the document shall be used.

In the registered VCS PD, a number of parameters (MCF_j , $B_{O,LT}$, $VS_{default}$ and default live weights) applied default values from the 2006 IPCC Guidelines for National GHG Inventories.

In this monitoring report, values applied have been updated to the 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories. Please refer to Section 4 of this monitoring report for details.

Data / Parameter	GWP _{CH4}
Data unit	tCO ₂ e/tCH ₄
Description	Global Warming Potential (GWP) of CH ₄ applicable to the crediting period.
Source of data	IPCC
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) as per VCS Standard, v4.5. Shall be updated according to any future revision to VCS standard by VERRA.
Purpose of Data	Calculation of baseline emissions and project emissions.
Comments	-

Data / Parameter	D _{CH4}
Data unit	kgCH ₄ /Nm ³ CH ₄
Description	CH ₄ density
Source of data	AMS-III.D (version 21.0)
Value applied	0.67 ⁸ (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.

⁸ Unit conversion conducted: 0.00067tCH₄/Nm³CH₄ = 0.67kgCH₄/Nm³CH₄

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 the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Value applied	73%
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 of Chapter 10, Volume 4, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories is applied. The project falls within warm, temperate, moist climate zone based off Figure 10A.1 of the same chapter. And according to Table 10.17, the corresponding annual MCF of uncovered anaerobic lagoons in this climate zone is 73%.
Purpose of Data	Calculation of baseline emissions and project emissions.
Comments	The value of this parameter in VCS PD (version 3.0 dated 06/12/2022) was sourced from Table 10.17, Chapter 10, Volume 4, IPCC 2006 Guidelines. In this monitoring report, value of this parameter was sourced from 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories.

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	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	
Value applied	Animal type	B _{0,LT}
	Western Europe Swine	0.450
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 of Chapter 10, Volume 4, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories is applied. B₀ values applicable to developed countries are used for the project as the following conditions are satisfied: i. According to the animal purchase contract, the genetic source for all types of swine originates from UK and Denmark; ii. The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics; iii. The use of FFR can be validated through on-farm record keeping; iv. The project specific animal weights are similar to developed country IPCC default values as per on-farm record keeping.	
Purpose of Data	Calculation of baseline emissions and project emissions.	
Comments	The value of this parameter was ex-ante determined in VCS PD (version 3.0 dated 06/12/2022), which was sourced from Tables 10 A-4 to 10 A-9, Chapter 10, Volume 4, 2006 IPCC Guidelines. In this monitoring report, value of this parameter was sourced from 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories.	

Data / Parameter	VS _{default}	
Data unit	kg-dm/hd/day	
Description	Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population.	
Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	
Value applied	Animal type	VS _{default}

	Western European Breeding Swine	0.456
Justification of choice of data or description of measurement methods and procedures applied	The genetic sources of breeding swine originate from the UK and Denmark. No country or regional specific value is available. VS_{default} values applicable to developed countries are used for the project as the following conditions are satisfied: - According to the animal purchase contract, the genetic source for all types of swine originates from UK and Denmark; - The farm uses formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics; - The use of FFR can be validated through on-farm record keeping; - The project specific animal weights are similar to developed country IPCC default values as per on-farm record keeping. According to Table 10.13A of Chapter 10, Volume 4, 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, the default value for volatile solid excretion rate (VS_{default}) is 2.4kg/1000kg animal mass/day. Table 10A.5 provides the default value for live weights for adult breeding swine in Western Europe, which is 190kg. Therefore, VS_{default} is recalculated as: 190kg animal mass/hd * 2.4kg/1000kg animal mass/day = 0.456kg/hd/day.	
Purpose of Data	Calculation of baseline emissions and project emissions.	
Comments	The value of this parameter was ex-ante determined in VCS PD (version 3.0 dated 06/12/2022), which was sourced from Table 10A-8, Chapter 10, Volume 4, 2006 IPCC Guidelines. In this monitoring report, value of this parameter was sourced from 2019 Refinement to the 2006 IPCC Guidelines for National GHG Inventories.	

Data / Parameter	MS% _{BI,j}
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	$f_{CH_4, default} (w_{CH_4, y})$
Data unit	$m^3CH_4/m^3biogas$
Description	Default value for the fraction of methane in the biogas.
Source of data	CDM Methodological tool: Project and leakage emissions from anaerobic digesters (version 02.0).
Value applied	0.6
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 MR took Option 2 and applied the default value for the fraction of methane in the biogas, which is $0.6m^3CH_4/m^3biogas$. This default value was derived based on reported values from registered projects and research papers (Davidsson, 2007).
Purpose of Data	Calculate the quantity of methane produced in the digester in year y .
Comments	-

4.2 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	AMS-III.D (version 21.0)
Description of measurement methods and procedures to be applied	The project did not involve sequential manure management system during this monitoring period, hence all manure would be handled in system I and 100% was applied for $MS\%_{i, y}$.

Frequency of monitoring/recording	-
Value applied	During this monitoring period, there was no sequential manure management system and thus 100% is applied.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of baseline emissions and project emissions.
Calculation method	-
Comments	-

Data / Parameter	$N_{p,y}$										
Data unit	Numbers (head)										
Description	Number of animals produced annually of type LT for the year y.										
Source of data	Ex-ante values were sourced from the FSR of the project. Ex-post values were from the operation records.										
Description of measurement methods and procedures to be applied	The number of breeding swine on the farm has been recorded monthly in the operation records.										
Frequency of monitoring/recording	Monthly										
Value applied	The annual weighted mean of adult breeding swine is calculated based on monthly operation records: <table border="1"> <thead> <tr> <th>Vintage</th><th>Adult breeding swine (head)</th></tr> </thead> <tbody> <tr> <td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>13,243</td></tr> <tr> <td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>8,280</td></tr> <tr> <td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>12,595</td></tr> <tr> <td>2023 (01-Jan-2023 to 31-May-2023)</td><td>16,522</td></tr> </tbody> </table>	Vintage	Adult breeding swine (head)	2020 (05-Aug-2020 to 31-Dec-2020)	13,243	2021 (01-Jan-2021 to 31-Dec-2021)	8,280	2022 (01-Jan-2022 to 31-Dec-2022)	12,595	2023 (01-Jan-2023 to 31-May-2023)	16,522
Vintage	Adult breeding swine (head)										
2020 (05-Aug-2020 to 31-Dec-2020)	13,243										
2021 (01-Jan-2021 to 31-Dec-2021)	8,280										
2022 (01-Jan-2022 to 31-Dec-2022)	12,595										
2023 (01-Jan-2023 to 31-May-2023)	16,522										
Monitoring equipment	-										
QA/QC procedures to be applied	-										
Purpose of data	To calculate the annual average number of animals ($N_{LT,y}$)										

Calculation method	-
Comments	The farm carried out regular operations from 01-Jan-2021 to 30-June-2021, but from 01-July-2021 to 31-Jan-2022, no adult breeding swine appeared on-site as they were transferred out due to swine fever. Therefore, the annual weighted average based on the first six months of 2021 (181 days) and the last 11 months of 2022 (334 days) was 8,280 and 12,595 heads in 2021 and 2022, respectively. The project has resumed operation since early 2022 when the procurement and rearing of breeding swine returned to normal.

Data / Parameter	$N_{da,y}$										
Data unit	Numbers (day)										
Description	Number of days animal is alive in the farm in the year y.										
Source of data	Ex-ante values were sourced from the FSR of the project. Ex-post values were from the operation records.										
Description of measurement methods and procedures to be applied	To collect the alive days of breeding swine in the livestock farms, the number of alive days of swine on the livestock farm has been recorded monthly in the operation records.										
Frequency of monitoring/recording	Monthly										
Value applied	The alive days of adult breeding swine in the livestock farms is accumulated based on monthly operation records: <table border="1"> <thead> <tr> <th>Vintage</th><th>Day</th></tr> </thead> <tbody> <tr> <td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>365</td></tr> <tr> <td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>181</td></tr> <tr> <td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>334</td></tr> <tr> <td>2023 (01-Jan-2023 to 31-May-2023)</td><td>365</td></tr> </tbody> </table>	Vintage	Day	2020 (05-Aug-2020 to 31-Dec-2020)	365	2021 (01-Jan-2021 to 31-Dec-2021)	181	2022 (01-Jan-2022 to 31-Dec-2022)	334	2023 (01-Jan-2023 to 31-May-2023)	365
Vintage	Day										
2020 (05-Aug-2020 to 31-Dec-2020)	365										
2021 (01-Jan-2021 to 31-Dec-2021)	181										
2022 (01-Jan-2022 to 31-Dec-2022)	334										
2023 (01-Jan-2023 to 31-May-2023)	365										
Monitoring equipment	-										
QA/QC procedures to be applied	-										
Purpose of data	To calculate the annual average number of animals ($N_{LT,y}$).										
Calculation method	-										
Comments	The farm carried out regular operations from 01-Jan-2021 to 30-June-2021, but from 01-July-2021 to 31-Jan-2022, no adult breeding swine appeared on-site as they were transferred out due										

	to swine fever. Therefore, the annual weighted average based on the first six months of 2021 (181 days) and the last 11 months of 2022 (334 days) was 8,280 and 12,595 heads in 2021 and 2022, respectively. And for the rest of the days, the farm was operated in accordance with the registered VCS PD, without any accidental events that might significantly affect the number of adult breeding swine in the farm.
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Data / Parameter	nd_y										
Data unit	Numbers (day)										
Description	The number of days the treatment plant was operational in year y.										
Source of data	Ex-ante values were sourced from the FSR of the project. Ex-post values were from the operation records.										
Description of measurement methods and procedures to be applied	365 days used for ex-ante estimation. The actual number of days the treatment plant was operational was monitored and recorded by staff.										
Frequency of monitoring/recording	Daily										
Value applied	The number of days the treatment plant was operational in each year is accumulated based on monthly operation records: <table border="1"> <thead> <tr> <th>Vintage</th><th>Day</th></tr> </thead> <tbody> <tr> <td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>149</td></tr> <tr> <td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>365</td></tr> <tr> <td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>365</td></tr> <tr> <td>2023 (01-Jan-2023 to 31-May-2023)</td><td>151</td></tr> </tbody> </table>	Vintage	Day	2020 (05-Aug-2020 to 31-Dec-2020)	149	2021 (01-Jan-2021 to 31-Dec-2021)	365	2022 (01-Jan-2022 to 31-Dec-2022)	365	2023 (01-Jan-2023 to 31-May-2023)	151
Vintage	Day										
2020 (05-Aug-2020 to 31-Dec-2020)	149										
2021 (01-Jan-2021 to 31-Dec-2021)	365										
2022 (01-Jan-2022 to 31-Dec-2022)	365										
2023 (01-Jan-2023 to 31-May-2023)	151										
Monitoring equipment	-										
QA/QC procedures to be applied	-										
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	$FE (\eta_{flare,m})$
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Data unit	%
Description	The flare efficiency for the minute m.
Source of data	CDM Methodological tool: Project emissions from flaring (version 03.0).
Description of measurement methods and procedures to be applied	The project activity utilized an enclosed flare. 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%. This is not applicable to this monitoring period, as the biogas was only recovered and combusted through the biogas flare system. As for flaring, the project has been using the enclosed flare, and adopted option A of Project emissions from flaring (version 03.0) for the determination of flare efficiency. The project took a 90% flare efficiency since the project meet the following two conditions while operating: (i) 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 (ii) The flame is detected in minute m.
Frequency of monitoring/recording	Annually
Value applied	90%
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Calculation of emission reductions
Calculation method	-
Comments	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.

Data / Parameter	$BG_{burnt,y}$
Data unit	Nm ³ biogas
Description	Biogas volume in year y.
Source of data	Records by project participants.

Description of measurement methods and procedures to be applied	The amount of biogas recovered and flared or used gainfully shall be monitored ex post, using flow meters. Continuously measured by flow meter with temperature sensor and pressure sensor at the outlet of biogas pre-treatment system. The meter readings have been automatically converted to value at room temperature (20°C) and 1 atm pressure.																				
Frequency of monitoring/recording	Monthly, based on continuous flow measurement with daily accumulated volume recording.																				
Value applied	Monitored ex-post. <table><tr><th>Vintage</th><th>Nm³biogas</th></tr><tr><td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>399,255</td></tr><tr><td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>508,968</td></tr><tr><td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>924,411</td></tr><tr><td>2023 (01-Jan-2023 to 31-May-2023)</td><td>500,425</td></tr><tr><td>Total</td><td>2,333,059</td></tr></table>			Vintage	Nm³biogas	2020 (05-Aug-2020 to 31-Dec-2020)	399,255	2021 (01-Jan-2021 to 31-Dec-2021)	508,968	2022 (01-Jan-2022 to 31-Dec-2022)	924,411	2023 (01-Jan-2023 to 31-May-2023)	500,425	Total	2,333,059						
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Total	2,333,059																				
Monitoring equipment	Flow meter. Key information of the flow meter is shown as below: <table><tr><th>Monitoring equipment</th><td>Flow meter Retired (05-Aug-2020 to 05-Oct-2022)</td><td>Flow meter In-use (Since 05-Oct-2022)</td></tr><tr><td>Type</td><td>KQ-HGM100C</td><td>KQ-HGM100C</td></tr><tr><td>Serial No</td><td>18103217</td><td>22093327</td></tr><tr><td>Accuracy</td><td>1.5S</td><td>1.5S</td></tr><tr><td>Calibration date</td><td>30-May-2020 31-Dec-2020 30-Dec-2021</td><td>05-Oct-2022</td></tr><tr><td>Validity date</td><td>29-May-2021 30-Dec-2021 29-Dec-2022</td><td>04-Oct-2023</td></tr></table>			Monitoring equipment	Flow meter Retired (05-Aug-2020 to 05-Oct-2022)	Flow meter In-use (Since 05-Oct-2022)	Type	KQ-HGM100C	KQ-HGM100C	Serial No	18103217	22093327	Accuracy	1.5S	1.5S	Calibration date	30-May-2020 31-Dec-2020 30-Dec-2021	05-Oct-2022	Validity date	29-May-2021 30-Dec-2021 29-Dec-2022	04-Oct-2023
Monitoring equipment	Flow meter Retired (05-Aug-2020 to 05-Oct-2022)	Flow meter In-use (Since 05-Oct-2022)																			
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Validity date	29-May-2021 30-Dec-2021 29-Dec-2022	04-Oct-2023																			
QA/QC procedures to be applied	The flow meter has been calibrated at the periodic interval according to the manufacturer’s recommendation.																				
Purpose of data	Calculation of emission reductions.																				
Calculation method	-																				
Comments	During this monitoring period from 05-Aug-2020 to 31-May-2023, biogas was all burnt through the biogas flare system, while heating system was not involved. The biogas flow meter employed continuously measures flow, pressure and temperature, displays or outputs the normalized flow of biogas, hence there is no need for separate monitoring of pressure and temperature of the biogas.																				

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. <table><tr><th rowspan="2">Vintage</th><th>T_{EG.m}</th></tr><tr><th>°C</th></tr><tr><td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>699</td></tr><tr><td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>695</td></tr><tr><td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>707</td></tr><tr><td>2023 (01-Jan-2023 to 31-May-2023)</td><td>708</td></tr></table>			Vintage	T _{EG.m}	°C	2020 (05-Aug-2020 to 31-Dec-2020)	699	2021 (01-Jan-2021 to 31-Dec-2021)	695	2022 (01-Jan-2022 to 31-Dec-2022)	707	2023 (01-Jan-2023 to 31-May-2023)	708													
Vintage	T _{EG.m}																										
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2023 (01-Jan-2023 to 31-May-2023)	708																										
Monitoring equipment	The flare monitoring port is equipped with a thermocouple. Key information of the thermocouple is shown as below: <table><tr><th>Monitoring equipment</th><td>Thermocouple Retired (05-Aug-2020 to 03-July-2021)</td><td>Thermocouple Retired (03-July-2021 to 02-July-2022)</td><td>Thermocouple In-use (Since 02-July-2022)</td></tr><tr><td>Type</td><td>WRMK-331</td><td>WRMK-331</td><td>WRMK-331</td></tr><tr><td>Serial No</td><td>20-05</td><td>21-09</td><td>22-16</td></tr><tr><td>Accuracy</td><td>II</td><td>II</td><td>II</td></tr><tr><td>Calibration date</td><td>09-July-2020</td><td>03-July-2021</td><td>02-July-2022</td></tr><tr><td>Validity date</td><td>08-July-2021</td><td>02-July-2022</td><td>01-July-2023</td></tr></table>			Monitoring equipment	Thermocouple Retired (05-Aug-2020 to 03-July-2021)	Thermocouple Retired (03-July-2021 to 02-July-2022)	Thermocouple In-use (Since 02-July-2022)	Type	WRMK-331	WRMK-331	WRMK-331	Serial No	20-05	21-09	22-16	Accuracy	II	II	II	Calibration date	09-July-2020	03-July-2021	02-July-2022	Validity date	08-July-2021	02-July-2022	01-July-2023
Monitoring equipment	Thermocouple Retired (05-Aug-2020 to 03-July-2021)	Thermocouple Retired (03-July-2021 to 02-July-2022)	Thermocouple In-use (Since 02-July-2022)																								
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Calibration date	09-July-2020	03-July-2021	02-July-2022																								
Validity date	08-July-2021	02-July-2022	01-July-2023																								
QA/QC procedures to be applied	The thermocouple has been replaced annually considering the service lifetime of the equipment, to ensure the accuracy and stability of the monitoring process. It has been periodically calibrated according to the manufacturer’s recommendation.																										

Purpose of data	To confirm that the flare operates within the manufacturer's operating specification, which is no less than 600 degrees Celsius ⁹ .
Calculation method	-
Comments	-

Data / Parameter	$F_{RG,m}$												
Data unit	Nm ³ /min												
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 has been monitored ex post, using flow meters. Continuously measured by flow meter with temperature sensor and pressure sensor at the inlet of the flare system. The meter readings has been 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	Monitored ex-post, aggregated by year. <table border="1"> <thead> <tr> <th>Vintage</th><th>Nm³/year</th></tr> </thead> <tbody> <tr> <td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>399,255</td></tr> <tr> <td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>508,968</td></tr> <tr> <td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>924,411</td></tr> <tr> <td>2023 (01-Jan-2023 to 31-May-2023)</td><td>500,425</td></tr> <tr> <td>Total</td><td>2,333,059</td></tr> </tbody> </table>	Vintage	Nm ³ /year	2020 (05-Aug-2020 to 31-Dec-2020)	399,255	2021 (01-Jan-2021 to 31-Dec-2021)	508,968	2022 (01-Jan-2022 to 31-Dec-2022)	924,411	2023 (01-Jan-2023 to 31-May-2023)	500,425	Total	2,333,059
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Total	2,333,059												
Monitoring equipment	Flow meter. Key information of the flow meter is shown as below: <table border="1"> <tbody> <tr> <td>Monitoring equipment</td><td>Flow meter</td></tr> <tr> <td>Type</td><td>KQ-HGM100C</td></tr> <tr> <td>Serial No</td><td>20123710</td></tr> <tr> <td>Accuracy</td><td>1.5S</td></tr> <tr> <td>Calibration date</td><td>30-May-2020 31-Dec-2020 30-Dec-2021</td></tr> </tbody> </table>	Monitoring equipment	Flow meter	Type	KQ-HGM100C	Serial No	20123710	Accuracy	1.5S	Calibration date	30-May-2020 31-Dec-2020 30-Dec-2021		
Monitoring equipment	Flow meter												
Type	KQ-HGM100C												
Serial No	20123710												
Accuracy	1.5S												
Calibration date	30-May-2020 31-Dec-2020 30-Dec-2021												

⁹ Flare for biogas engineering, China National Standard (GB/T 41191-2021) , retrieved from http://www.environtec.com.cn/upload/image/20220303/20220303164000_69491.pdf

		05-Oct-2022
	Validity date	29-May-2021 30-Dec-2021 29-Dec-2022 04-Oct-2023
QA/QC procedures to be applied	The flow meter has been periodically calibrated according to the manufacturer's recommendation.	
Purpose of data	To confirm that the flare operates within the manufacturer's operating specification, which is no more than 1,752,000 m ³ /year (200m ³ /h)	
Calculation method	-	
Comments	-	

Data / Parameter	Flame _m
Data unit	Flame on/Flame off
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	Measure using a fixed installation optical flame detector.
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. During this monitoring period, the flame was continuously detected to ensure that the biogas flare system has been working properly.
Monitoring equipment	The flare monitoring port is equipped with a thermocouple, which continuously measure temperature of the flaring system, and therefore allow the detection of the presence and absence of flame. Please refer to T _{EG,m} for key information on the thermocouple.
QA/QC procedures to be applied	The thermocouple has been replaced annually considering the service lifetime of the equipment, to ensure the accuracy and stability of the monitoring process. It has been periodically calibrated according to the manufacturer's recommendation.
Purpose of data	To monitor if the flare is operating.

Calculation method	-
Comments	-

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 to be applied	Project participants has referred to the original design of the soil application to ensure that the residual waste from the animal manure management system was handled aerobically. Any change in the soil application of residual waste after the implementation of the project activity should be justified.
Frequency of monitoring/recording	Annually
Value applied	During this monitoring period, the residual waste from the animal manure management system were handled aerobically to product organic fertilizer at the project site, which was in accordance with the registered VCS PD.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	To ensure that the residual waste from the animal manure management system is handled aerobically.
Calculation method	-
Comments	-

Data / Parameter	Genetic Source of Swine
Data unit	-
Description	Genetic source of the production operations swine.
Source of data	Records by project participants.

Description of measurement methods and procedures to be applied	Project participants should ensure that genetic source of production operations swine originates from Annex I Party.
Frequency of monitoring/recording	Annually
Value applied	During this monitoring period, the genetic source of breeding swine originated from UK and Denmark, which was in accordance with the registered VCS PD.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	Project participants should ensure that genetic source of production operations swine originates from Annex I Party.
Calculation method	-
Comments	-

Data / Parameter	Formulated Feed Rations (FFR)
Data unit	-
Description	Formulated feed rations.
Source of data	Records by project participants.
Description of measurement methods and procedures to be applied	Project participants should use FFR for the production operations swine, stage of growth, category, weight gain/productivity and/or genetics.
Frequency of monitoring/recording	Monthly
Value applied	During this monitoring period, project participants used FFR that are optimized for breeding swine.
Monitoring equipment	-
QA/QC procedures to be applied	-
Purpose of data	To ensure the use of FFR is validated.

Calculation method	-
Comments	-

Data / Parameter	Swine Weight												
Data unit	kg												
Description	The project specific animal weights at project site.												
Source of data	Records by project participants.												
Description of measurement methods and procedures to be applied	Project participants should record the project specific animal weights to ensure that they were similar to developed country IPCC default values.												
Frequency of monitoring/recording	Monthly												
Value applied	Monitored ex-post. Please refer to the ER sheet for monthly records. <table border="1"> <thead> <tr> <th>Vintage</th><th>Weight (kg)</th></tr> </thead> <tbody> <tr> <td>2020 (05-Aug-2020 to 31-Dec-2020)</td><td>192</td></tr> <tr> <td>2021 (01-Jan-2021 to 31-Dec-2021)</td><td>195</td></tr> <tr> <td>2022 (01-Jan-2022 to 31-Dec-2022)</td><td>197</td></tr> <tr> <td>2023 (01-Jan-2023 to 31-May-2023)</td><td>196</td></tr> </tbody> </table>	Vintage	Weight (kg)	2020 (05-Aug-2020 to 31-Dec-2020)	192	2021 (01-Jan-2021 to 31-Dec-2021)	195	2022 (01-Jan-2022 to 31-Dec-2022)	197	2023 (01-Jan-2023 to 31-May-2023)	196		
Vintage	Weight (kg)												
2020 (05-Aug-2020 to 31-Dec-2020)	192												
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2022 (01-Jan-2022 to 31-Dec-2022)	197												
2023 (01-Jan-2023 to 31-May-2023)	196												
Monitoring equipment	Scale installed at the farm. The key information of the monitoring equipment is shown as below: <table border="1"> <thead> <tr> <th>Monitoring equipment</th><th>Scale</th></tr> </thead> <tbody> <tr> <td>Equipment type</td><td>XK3190-A12+E</td></tr> <tr> <td>Serial No.</td><td>2010200852</td></tr> <tr> <td>Accuracy</td><td>III</td></tr> <tr> <td>Calibration date</td><td>28-Aug-2020 28-Aug-2021 28-Aug-2022</td></tr> <tr> <td>Validity date</td><td>27-Aug-2021 27-Aug-2022 27-Aug-2023</td></tr> </tbody> </table>	Monitoring equipment	Scale	Equipment type	XK3190-A12+E	Serial No.	2010200852	Accuracy	III	Calibration date	28-Aug-2020 28-Aug-2021 28-Aug-2022	Validity date	27-Aug-2021 27-Aug-2022 27-Aug-2023
Monitoring equipment	Scale												
Equipment type	XK3190-A12+E												
Serial No.	2010200852												
Accuracy	III												
Calibration date	28-Aug-2020 28-Aug-2021 28-Aug-2022												
Validity date	27-Aug-2021 27-Aug-2022 27-Aug-2023												
QA/QC procedures to be applied	The scale has been periodically calibrated according to the manufacturer's recommendation.												
Purpose of data	To ensure the project specific animal weights are similar to developed country IPCC default values.												

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)”¹⁰ to randomly select 300 adult breeding swine 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)¹¹ with the following inputs and outputs: <table border="1" data-bbox="634 491 1414 1047"> <thead> <tr> <th>Input</th><th>Value</th></tr> </thead> <tbody> <tr> <td>Expected mean</td><td>190</td></tr> <tr> <td>Expected standard deviation</td><td>190</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>10%</td></tr> <tr> <td>Population size, N</td><td>15,000</td></tr> <tr> <th>Output</th><th>Value</th></tr> <tr> <td>Predicted sample size, n</td><td>266</td></tr> </tbody> </table> The target population was the 15,000 adult 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 266. 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 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 precision of each month was below 1%, thus achieving the target precision level of 10%. CDM sample size calculator (Version 03.1) was also used for double-check.	Input	Value	Expected mean	190	Expected standard deviation	190	Confidence level	90%	z multiplier	1.645	Relative precision	10%	Population size, N	15,000	Output	Value	Predicted sample size, n	266
Input	Value																		
Expected mean	190																		
Expected standard deviation	190																		
Confidence level	90%																		
z multiplier	1.645																		
Relative precision	10%																		
Population size, N	15,000																		
Output	Value																		
Predicted sample size, n	266																		
Comments	It is ensured that the weights were similar to the default live weights for adult breeding swine in Western Europe as per 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, which is 190kg¹².																		

¹⁰ https://cdm.unfccc.int/sunsetcms/storage/contents/stored-file-20210531160756223/Meth_Stan05.pdf

¹¹ <https://cdm.unfccc.int/Reference/Guidclarif/index.html>

¹² Retrieved from 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 Chapter 10 Table 10A.5.

4.3 Monitoring Plan

The monitoring plan presented in this MR 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 has been implemented by the project owner during the project operation. The details of the monitoring plan are specified as follows:

(A) Monitoring structure

The project owner organizes a specific VCS team in the project development department to be responsible for data collection, supervision, and witness the whole process of data measuring and recording. A VCS manager is appointed to take full responsibility for the overall monitoring of the project. The monitoring and measurement are to be carried out by designated monitoring officers. In addition, the project developer appoints internal verifiers who are responsible for internal check of the measurement, collection of relevant receipts and invoices, and the calculation of the emission reductions. A monitoring and management manual of the project that identifies detailed duties and responsibilities of the relevant parties is developed and served as the basis of the project monitoring. Figure 4-1 shows the operation and management structure of the Project.

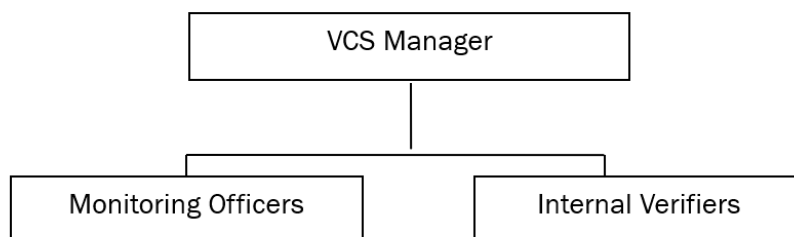


Figure 4-1 Operation and management structure of the project

(B) Data and parameters to be monitored

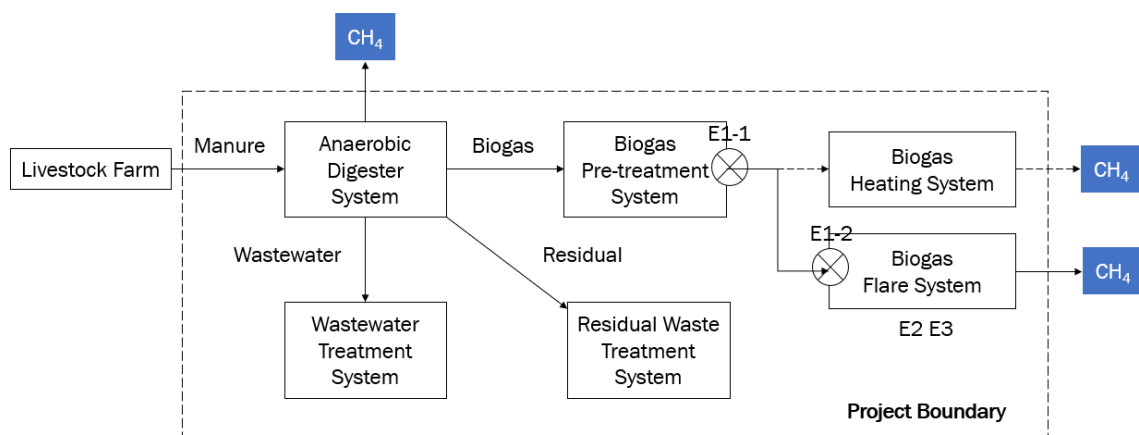
Table 4-1 lists the corresponding parameters monitored.

Figure 4-2 indicates the positions of the monitoring instruments.

Table 4-1 Data and parameters to be monitored

Equipment No.	Parameter to be Monitored	Description
/	MS%	Fraction of manure handled in system i in year y
/	$N_{p,y}$	Number of animals produced annually of type LT for the year y

/	$N_{da,y}$	Number of days animal is alive in the farm in the year y
/	nd_y	The number of days the treatment plant was operational in year y
E1-2 E2 E3	$FE (\eta_{flare,m})$	The flare efficiency
E1-1	$BG_{burnt,y}$	Biogas volume in year y
E2	$T_{EG,m}$	Temperature in the exhaust gas of the enclosed flare in the minute m
E1-2	$F_{RG,m}$	Flow rate of the residual gas on a dry basis at reference conditions in the minute m
E3	$Flame_m$	Flame detection of flare in the minute m
/	Soil application	Soil application of residual waste
/	Genetic source of swine	Genetic source of the production operations swine
/	FFR	Formulated feed rations
/	Swine Weight	The project specific animal weights at project site



*According to AMS III-D, CH₄ generated from the Biogas Heating System would not be claimed for VCUs.

**Biogas heating system was inactive during the first monitoring period.

Figure 4-2 Project monitoring diagram

(C) Data collection

Monitoring officers are responsible for data collection. Designated teams reads and collects the

monitored data regularly. The computer system automatically monitors and records relevant meter data. The operation records serve as the main data source for emission reductions calculation. All data files are collected by a designated monitoring officer, who prepares backup in time and archive all documents properly.

(D) Quality assurance

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

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

The installation of flow meters fulfills the national standard (MT448-2008). All the meters are checked and maintained periodically.

(E) Data file management

All monitoring data are electronically filed by the end of each month. Other documents in paper (e.g. forms and environment assessment reports) are preserved as well. All data collected as part of monitoring are archived electronically and be kept at least for 2 years after the end of the crediting period. The Project owner should provide original records and documents if necessary.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

As per Section 4.1 of the registered VCS PD, baseline emission is calculated as below:

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

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

$$N_{LT,y} = N_{da,y} \times \left(\frac{N_{p,y}}{365}\right) \quad (2)$$

Volatile solids production/excretion per animal of livestock LT ($VS_{LT,y}$) is determined as follows:

$$VS_{LT,y} = VS_{default} \times nd_y$$

Table 5.1 lists the parameters used to calculate the ex-post BE_y and the results. During the first monitoring period of the project from 05-Aug-2020 to 31-May-2023, the total baseline emission of the project is 26,872tCO₂e.

Table 5.1 The ex-post calculation of $BE_{y,ex,post}$

Parameter	Unit	Year (y)			
		2020	2021	2022	2023
GWP_{CH_4}	tCO ₂ e/tCH ₄	28.0			
D_{CH_4}	kgCH ₄ /Nm ³ CH ₄	0.67			
UF_b	/	0.94			
MCF_j	/	73%			
$B_{0,LT}$	m ³ CH ₄ /kg-VS	0.45			
$VS_{default}$	kg-dm/hd/day	0.456			
$MS\%_{BI,j}$	/	100%			
nd_y	day	149	365	365	151
$N_{da,y}$	day	365	181	334	365
$N_{p,y}$	hd	13,243	8,280	12,595	16,522
$N_{LT,y}$	hd	13,243	4,106	11,525	16,522
$VS_{LT,y}$	kg-dm/hd/day	67.94	166.44	166.44	68.86
$BE_{y,ex,post}$	tCO ₂ e	5,212	3,958	11,112	6,590
Total $BE_{y,ex,post}$	tCO₂e	26,872			

5.2 Project Emissions

As per Section 4.2 of the registered VCS PD, project activity emissions consist of:

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y} \quad (3)$$

1. Emissions due to physical leakage of biogas in year y

As per Section 4.2 of the registered VCS PD, 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:

$$PE_{PL,y} = 0.10 \times GWP_{CH_4} \times D_{CH_4} \times \sum_{j,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y} \quad (4)$$

Table 5.2.1 lists the parameters used to calculate the ex-post $PE_{PL,y}$ and the results. During the first monitoring period of the project from 05-Aug-2020 to 31-May-2023, the project emission due to physical leakage of biogas is 3,918tCO₂e in total.

Table 5.2.1 The ex-post calculation of $PE_{PL,y}$

Parameter	Unit	Year (y)			
		2020	2021	2022	2023
GWP_{CH_4}	tCO ₂ e/tCH ₄	28.0			
D_{CH_4}	kgCH ₄ /Nm ³ CH ₄	0.67			

B _{0,LT}	m ³ CH ₄ /kg-VS	0.45			
N _{LT,y}	hd	13,243	4,106	11,525	16,522
VS _{LT,y}	kg-dm/hd/day	67.94	166.44	166.44	68.86
MS% _{BI,j}	/	100%	100%	100%	100%
PE _{PL,y}	tCO ₂ e	760	577	1,620	961
Total PE_{PL,y}	tCO₂e	3,918			

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

As per Section 4.2 of the registered VCS PD, 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 03.0)."

As per “Project emissions from flaring” (version 03.0)", Emissions from flaring (PE_{flare,y}) should be calculated as follows:

$$PE_{flare,y} = GWP_{CH_4} \times \sum_{m=1}^{525600} F_{CH_4,RG,m} \times (1 - \eta_{flare,m}) \times 10^{-3} \quad (5)$$

For the Mass flow of methane in the residual gas (F_{CH₄,RG,m}), $\sum_{m=1}^{525600} F_{CH_4,RG,m}$ is equal to the quantity of methane produced in the anaerobic digester in year y,

$$\sum_{m=1}^{525600} F_{CH_4,RG,m} = Q_{CH_4,y} \quad (6)$$

And for Q_{CH₄,y} could be calculated based on the amount of biogas collected at the digester outlet in a year.

$$Q_{CH_4,y} = Q_{biogas,y} \times f_{CH_4,default} \times \rho_{CH_4} \quad (7)$$

Table 5.2.2 lists the parameters used to calculate the ex-post PE_{flare,y}. During the first monitoring period of the project from 05-Aug-2020 to 31-May-2023, the project emission from flaring or combustion of the biogas stream is 2,628tCO₂e in total.

Table 5.2.2 The ex-post calculation of PE_{flare,y}

Parameter	Unit	Year (y)			
		2020	2021	2022	2023
GWP _{CH₄}	tCO ₂ e/tCH ₄	28.0			
F _{CH₄,RG,m}	kgCH ₄	160,501	204,605	371,613	201,171
FE (η _{flare,m})	/	90%	90%	90%	90%
Q _{CH₄,y}	tCH ₄	160,501	204,605	371,613	201,171
Q _{biogas,y}	Nm ³ biogas	399,255	508,968	924,411	500,425
f _{CH₄,default}	m ³ CH ₄ /m ³ bio gas	0.6			
D _{CH₄}	tCH ₄ /Nm ³ CH ₄	0.67			
PE _{flare,y}	tCO ₂ e	450	573	1,041	564
Total PE_{flare,y}	tCO₂e	2,628			

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

During this monitoring period, the installed facilities of the project operated without consuming fossil fuels and therefore, emissions from the use of fossil fuel are not considered. In addition, the project has been using the HDPE membrane enclosed anaerobic digesters during this monitoring period. This is a commonly used kind of covered anaerobic lagoons with a default factor of 0 for the electricity consumption associated with the anaerobic digester per ton of methane generated, so emissions from the use of electricity were not considered. Therefore, $PE_{power} = 0$.

4. Emissions from incremental transportation in the year y

During this monitoring period, the project transmitted the manure to the HDPE membrane enclosed anaerobic digester installed within the geographic boundary of the breeding swine farm (project site) and did not involve any road and rail transportation. Therefore, $PE_{transp,y}$ is not included in the project emission.

5. Emissions from the storage of manure

During this monitoring period, the storage time of the manure before being fed into the anaerobic digester was approximately 12 hours less than 24 hours. Hence, project emissions on account of storage of manure before being fed into the anaerobic digester are not accounted for. Therefore, $PE_{storage,y}$ is 0 for this project.

In conclusion, the project emission of the project activity is calculated as follows:

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} = PE_{PL,y} + PE_{flare,y} + PE_{EC,y} \quad (10)$$

Table 5.2.3 list the parameters used to calculate the ex-post PE_y and the results. During the first monitoring period of the project from 05-Aug-2020 to 31-May-2023, the project emission of the project activity reaches to 6,546tCO₂e in total.

Table 5.2.3 The calculation of $PE_{y,ex,post}$

Parameter	Unit	Year (y)			
		2020	2021	2022	2023
$PE_{PL,y}$	tCO ₂ e	760	577	1,620	961
$PE_{flare,y}$	tCO ₂ e	450	573	1,041	564
$PE_{power,y}$	tCO ₂ e	-	-	-	-
$PE_{transp,y}$	tCO ₂ e	-	-	-	-
$PE_{storage,y}$	tCO ₂ e	-	-	-	-
$PE_{y,ex,post}$	tCO ₂ e	1,210	1,150	2,661	1,525
Total $PE_{y,ex,post}$	tCO₂e	6,546			

5.3 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.

During this monitoring period, the process of handling the residual waste did not involve storage or anaerobic compost. Therefore, leakage emissions of the project associated with the anaerobic digester is not accounted for.

5.4 Net GHG Emission Reductions and Removals

As per Section 4.2 of the registered VCS PD, the emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\ post} = \min[(BE_{y,ex\ post} - PE_{y,ex\ post}), (MD_y - PE_{power,y,ex\ post})] \quad (11)$$

Biogas flared or combusted (MD_y) shall be determined using the flare efficiency and methane content of biogas.

$$MD_y = BG_{burnt,y} \times w_{CH_4,y} \times D_{CH_4} \times FE \times GWP_{CH_4} \quad (12)$$

Where:

$BG_{burnt,y}$	=	Biogas flared or combusted in year y (m^3)
$w_{CH_4,y}$	=	Methane content in biogas in the year y (volume fraction)
FE	=	Flare efficiency in the year y (fraction)

Table 5.4.1 lists the parameters used to calculate the ex-post MD_y and the results. Details on parameter monitoring and values applied are documented in Section 4.2.

Table 5.4.1 The calculation of MD_y

Parameter	Unit	Year (y)			
		2020	2021	2022	2023
$BG_{burnt,y}$	m^3	399,255	508,968	924,411	500,425
$w_{CH_4,y}$	%	0.6			
D_{CH_4}	$kgCH_4/Nm^3CH_4$	0.67			
FE	%	90%	90%	90%	90%
GWP_{CH_4}	tCO_2e/tCH_4	28			
$MD_{y, total}$	tCO_2e	4,044	5,156	9,364	5,069

Table 5.4.2 shows the results. During the first monitoring period of the project from 05-Aug-2020 to 31-May-2023, the emission reduction reaches to 20,326tCO₂e in total.

Table 5.4.2 The calculation of $ER_{y,ex\ post}$

Period	BE _{y,ex post}	PE _{y,ex post}	BE _{y,ex post} – PE _{y,ex post}	MD _y	PE _{power, ex post}	MD _y – PE _{power, ex post}	ER _{y,ex post}
	A	B	C=A-B	D	E	F=D-E	G=min(C,F)
05-Aug-2020 to 31-Dec-2020	5,212	1,210	4,002	4,044	-	4,044	4,002
01-Jan-2021 to 31-Dec-2021	3,958	1,150	2,808	5,156	-	5,156	2,808
01-Jan-2022 to 31-Dec-2022	11,112	2,661	8,451	9,364	-	9,364	8,451
01-Jan-2023 to 31-May-2023	6,590	1,525	5,065	5,069	-	5,069	5,065
Total							20,326

Results from the above table are further clarified in the following table.

Year	Baseline emissions or removals (tCO _{2e})	Project emissions or removals (tCO _{2e})	Leakage emissions (tCO _{2e})	Net GHG emission reductions or removals (tCO _{2e})
05-Aug-2020 to 31-Dec-2020	5,212	1,210	0	4,002
01-Jan-2021 to 31-Dec-2021	3,958	1,150	0	2,808
01-Jan-2022 to 31-Dec-2022	11,112	2,661	0	8,451
01-Jan-2023 to 31-May-2023	6,590	1,525	0	5,065
Total	26,872	6,546	0	20,326

The first monitoring period of the Project spans from 05-Aug-2020 to 31-May-2023 (both days included), covering a total of 1,030 days. Based on the ex-ante annual estimated emission reductions, the amount of emission reductions for this monitoring period would be 33,284tCO_{2e}. The actual emission reduction calculated ex-post in this monitoring period is 20,326tCO_{2e}, which is 38.93% lower than the estimation. This was mainly due to a general reduction in the number of breeding swine on farms in 2021 and early 2022 as a result of swine fever.

Ex-ante emissions reductions /removals	Achieved emissions reductions /removals	Percent difference	Justification for the difference
33,284	20,326	-38.93%	This was mainly due to a general reduction in the number of breeding swine on farms in 2021 and early 2022 as a result of swine fever.

APPENDIX 1: SUPPORTING EVIDENCE

Evidence for SDG 8.5

Monthly employment statistics derived from the human resource database of this project have been submitted to VVB for verification.

Evidence for SDG 6.3 and SDG 13.0

From project operation date onwards, the amount of livestock manure recycled by the project and the emission reduction achieved in each monitoring period are listed as below.

Period			Manure Recycled	Emission Reduction
MP	From	To	tonnes	tCO ₂ e
1 st	05-Aug-2020	31-May-2023	4,639.0882	20,326
Cumulative impacts			4,639.0882	20,326