Monitoring report form for CDM programme of activities (Version 03.0)

Complete this form in accordance with the instructions attached at the end of this form.

MONITORING REPORT		
Title of the PoA	Methane recovery and combustion with renewable energy generation from anaerobic animal manure management systems under the Land Bank of the Philippines' (LBP) Carbon Finance Support Facility	
UNFCCC reference number of the PoA	5979	
Version numbers of the PoA-DD applicable to this monitoring report	18	
Version number of this monitoring report	01	
Completion date of this monitoring report	28/02/2021	
Monitoring period number	first monitoring period	
Duration of this monitoring period	01/06/2019 – 31/12/2019	
Monitoring report number for this monitoring period	1	
Coordinating/managing entity	Land Bank of the Philippines (LBP)	
Host Parties	Host Party of the PoA	Is this the host Party of a CPA covered in this monitoring report? (yes/no)
	Philippines	Yes
Applied methodologies and standardized baselines	For PoA version 18: AMS-III.D version 21, Methane recovery in animal manure management systems AMS-I.F version 3, Renewable electricity generation for captive use and mini-grid	
Sectoral scopes	13: Waste handling and disposal 01: Energy industries (renewable / non-renewable sources)	
Amount of GHG emission reductions or net anthropogenic GHG removals achieved by all CPAs covered in this monitoring report in this monitoring period	Amount achieved before 1 January 2013	Amount achieved from 1 January 2013
	0 tCO2e	CPA 01: 1,827 tCO2e
Amount of GHG emission reductions or net anthropogenic GHG removals estimated ex ante for this monitoring period in the CPA-DDs for the CPAs covered in this monitoring report	21,169 tCO2e	

PART I Monitoring of programme of activities (PoA)

SECTION A. Description of PoA

A.1. General description of PoA

The PoA is a coordinated action by LBP to introduce wastewater methane recovery systems in livestock farms that are using open anaerobic systems to treat their wastewater. Through construction of the wastewater methane recovery systems, the PoA will reduce GHG emissions from methane compared to the emissions that would have occurred with the open anaerobic systems that would have been operating in the absence of the activities. With the installation of electricity generation units, GHG emissions will be further reduced by replacing grid electrical power with renewable energy from the recovered methane.

A.1.1. Corresponding generic component project activities (CPAs)

Title and reference number of the corresponding generic CPA	Version of the PoA-DD	Sectoral scopes	Applied methodologies and standardized baselines
CPA-xxxx: Methane recovery and combustion with renewable energy generation from anaerobic animal manure management systems under the Land Bank of the Philippines' (LBP) Carbon Finance Support Facility Ref No. 5979-P1-xxxx-CP2	18	13 01	AMS III.D version 21: Methane recovery in animal manure management systems AMS I.F. version 3: Renewable electricity generation for captive use and mini-grid

A.1.2. CPAs included in the PoA

Title and UNFCCC reference number of the CPA	Version of the PoA-DD	Title and reference number of the corresponding generic CPA	Crediting period type and duration	Covered in this monitoring report? (yes/no)
CPA-01: Methane recovery and combustion with renewable energy generation from anaerobic animal manure management systems under the Land Bank of the Philippines' (LBP) Carbon Finance Support Facility Ref No. 5979-P1-0001-CP2	18	From June 1-31 Dec 2019 CPA-xxxx : Methane recovery and combustion with renewable energy generation from anaerobic animal manure management systems under the Land Bank of the Philippines' (LBP) Carbon Finance Support Facility Ref No. 5979-P1-xxxx-CP2	Renewable, 01/06/2019-31/05/2026	Yes

A.2. Coordinating/managing entity

Land Bank of the Philippines (LBP)

SECTION B. Implementation of PoA

B.1. Description of implemented PoA

1. The management system of the PoA has been implemented by the CME as described in the PoA-DD. Land Bank of the Philippines (LBP):

- screened and validated the projects for inclusion in the PoA
- carried out the inclusion process - trained the CPA Implementers
- managed the records of each CPA including data required to calculate emission reductions
- ensured rigorous reporting from the CPAs
- verified information sent by the CPAs
- prepared the monitoring report at PoA level.

2. A sampling plan has been applied for the parameter Wsite (average animal weight for defined population). The sampling design which is in line with the requirements of the "Standard for sampling and surveys for CDM project activities and programme of activities": was implemented as follows:

- *Target population*: categories of pigs: breeding / market / sow / boar / finisher / nursery / suckling etc.
- *Sampling method*:
  - The following will be used for CPA-1 starting 01/06/2019 its renewal of crediting period: stratified random sampling approach with a level of confidence and precision of 90/10. This method is applicable because population is homogeneous within each category of pigs as per "Standard for sampling and surveys for CDM project activities and programme of activities" version 4.
- *Sample size*: it will depend on the total number of heads per category in each farm (parameter to be monitored as N_{LT})
  - *Parameter of interest:* average value of animal weight per type of animal (W_{site})
  - *Target value:* it will depend on the practice of the farm during the monitoring period
  - The following will be used:

    Sample calculator: stratified random sampling approach with a level of confidence and precision of 90/10. This method is applicable because population is homogeneous within each category of pigs

Data to be collected: total number of heads per type of animal, animal weight per type and number of samples.

- Collected data and analysis:

Target population: categories of pigs:

CPA-01 Marcela
Sow/Gilt
Boar
Finisher (Growing)
Nursery
Farrowing

Pig population monitoring and collection in each farm are carried out as follows:

CPA 01: population data monitored daily, recorded in a report called "Daily Stock Movement"

The animal weight per type is collected using a weighing scale and records during the year and are consolidated annually .

The number of samples for animal weight is calculated based on pig population using sampling methods described above.
Spreadsheet calculations including collected data and analysis are attached.
-Demonstration on whether the required confidence/ precision has been met:

The entire population of finishers, nurseries, farrows and weans is weighed before being transferred to another phase or being sold.

As for the sow and boars, more animals have been weighed than the minimum sample size required to reach a 90/10 confidence level.

B.2. Post-registration changes to PoA

B.2.1. Corrections

a) Corrections that have been approved by the Board as applicable from the periods prior to this monitoring period- not applicable

b) Corrections that have been approved by the Board as applicable from this monitoring period- not applicable

B.2.2. Inclusion of monitoring plan

>>not applicable

B.2.3. Permanent changes to the registered monitoring plan, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

>>

Changes that have been approved by the Board prior to the submission of this monitoring report - not applicable

B.2.4. Changes to programme design

>>

- Changes to the PoA have been approved prior to the submission of this monitoring report : not applicable

B.2.5. Changes specific to afforestation or reforestation activities

>> not applicable

PART II Monitoring of CPAs

>>

SECTION C. Implementation of CPAs

C.1. Description of implemented CPAs

>>

The specific-case CPA described in this Monitoring Report consist in the implementation of an anaerobic digestion system with methane recovery and combustion in a livestock farm. The purpose is to avoid GHG emission of methane from wastewater ponds and gainfully use the biogas to produce energy.

The CPA replaces an open anaerobic manure management system with an anaerobic digestion system with methane recovery and combustion. The projects typically consist of the following:

Anaerobic digestion system:
The waste produced from a livestock farm (piggery) is treated in an enclosed anaerobic system that prevents the release of methane. The system consists of a lagoon that is covered by HDPE or fixed domes with single or multiple reactors to collect the biogas and prevent atmospheric gases from leaking into the tank.

Biogas recovery and combustion system:
A system of collection and combustion of the biogas produced by the reactor is also installed. The system includes a blower system, piping system to collect the gas, a gas filtering system, gas engine(s) where the gas is combusted and/or a flare.

Sludge management system:
The treatment system produces sludge. The sludge is removed from the biodigester through a pipe via pull-plug mechanism or submersible pumps, dried and applied to soil as fertilizer in a manner that ensures aerobic conditions and avoids methane emissions.

Other components:
After the anaerobic digester, digested wastewater is discharged to aeration and settling ponds. All power to run the project activity is provided by the gas engine and as a result no fossil fuel based electricity or other fuel is used; or uses grid electricity.

Description of the installed technologies, technical processes and equipment of the CPAs are illustrated in the diagram in Figure C.1.1.

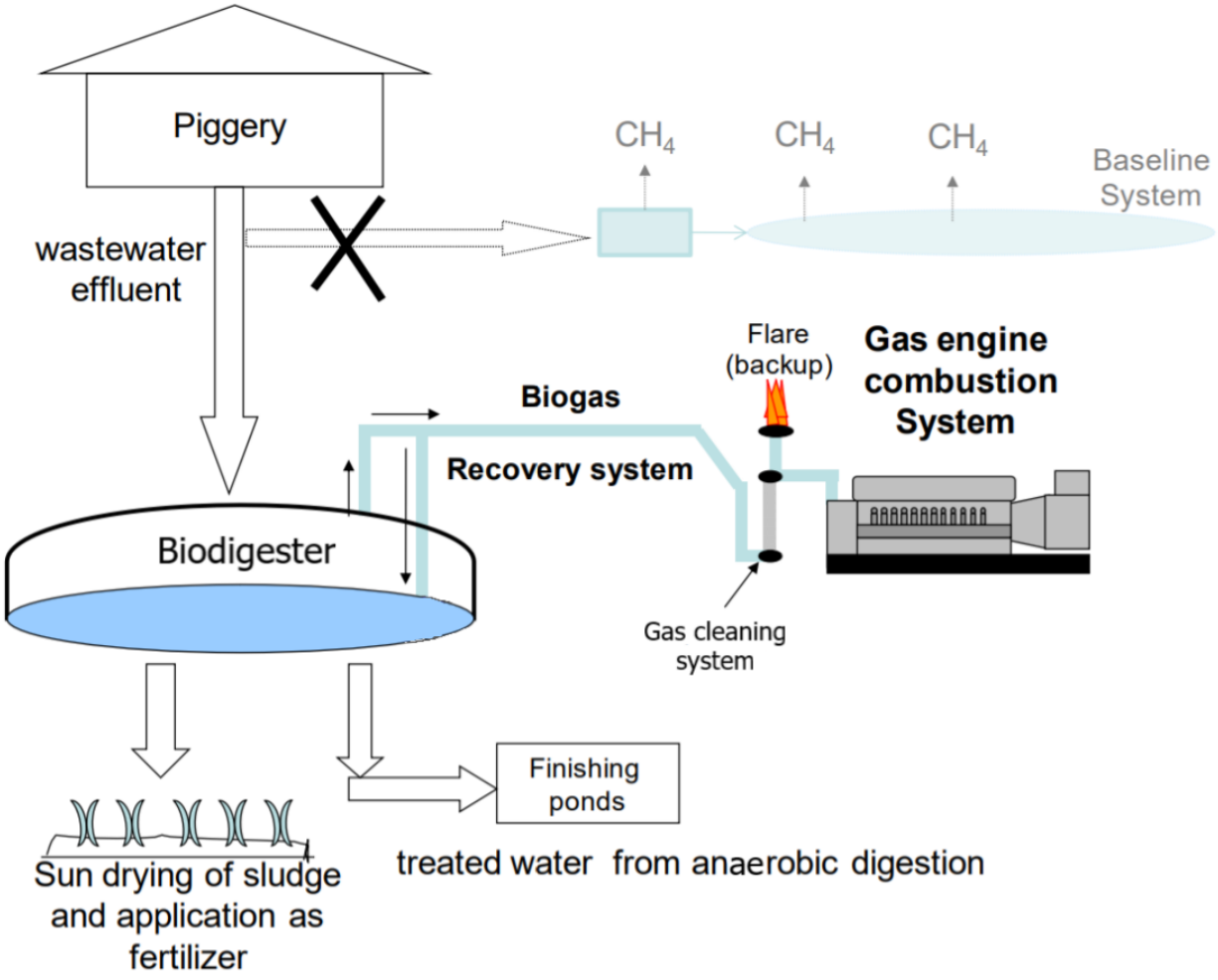

Figure C.1.1 Installed technologies, technical processes and equipment of the CPAs

The technical specifications of major equipment in the system for the CPA is presented in Table C.1.1

Table C.1.1 – Technical details of major components and equipment of farms

CPA	Farm	Digester (m^3)	Generator (kW)	Flare (type)
01	Marcela	1 x 25,553 1 x 31,647	2 x 300 2 x 280 (back up since 08/2018)	Low height Enclosed

The following are pictures of the installed technologies, and equipment for the CPA and information on the implementation and actual operation of the CPA, including relevant dates (e.g. construction, commissioning, start of operation).

CPA-01 Marcela Farms

Figure C.1.2. Biodigester, engines and enclosed flare of Marcela Farms

Status. Operational and monitoring. Claiming credits for second monitoring period

Relevant Dates
- Start date of CPA: 12/07/2007
- Commissioning of flaring system: 01/06/2011
- Commissioning of Engine 1: 01/12/2010
- Commissioning of Engine 2: 06/03/2013
- Commissioning of Engines 3a and 3b: 13/08/2018

Event	Cause	Corrective Action
none	-	-

C.2. Location of CPAs

The PoA covers all regions of the Philippines. The physical location of the participating farms of the small-scale CPAs are contained in Table C.2 and Figure C.2

Table C.2.– Locations of Participating Farms of CPAs

CPA	Farm	Nearest town	North coordinate	East Coordinate
01	Marcela	Cortes, Bohol	9.690278	123.870833

Figure C.2. Map and situation of Bohol in the archipelago of the Philippines

C.3. Post-registration changes to CPAs

C.3.1. Temporary deviations from the monitoring plans in the included CPA-DDs, applied methodologies, standardized baselines or other methodological regulatory documents

>> not applicable

C.3.2. Corrections

>>

(a) Corrections that have been notified to the secretariat as applicable from the period prior to this monitoring period- not applicable.

(b) Corrections that have been notified to the secretariat as applicable from this monitoring period- not applicable.

C.3.3. Changes to the start date of the crediting period

>> Not applicable

C.3.4. Inclusion of monitoring plan

>> Not applicable

C.3.5. Permanent changes to the included monitoring plans, or permanent deviation of monitoring from the applied methodologies, standardized baselines, or other methodological regulatory documents

(a) Changes that have been notified to the secretariat as applicable from the period prior to this monitoring period- not applicable

(b) Changes that have been notified to the secretariat as applicable from this monitoring period- not applicable.

C.3.6. Changes to project design

>> (a)Changes that have been notified to the secretariat as applicable from the period prior to this monitoring period -not applicable

(b) Changes that have been notified to the secretariat as applicable from this monitoring period- not applicable-not applicable.

C.3.7. Changes specific to afforestation or reforestation CPA

>> Not applicable

SECTION D. Description of monitoring system of CPAs

>> The raw data processing includes these records from data forms submitted by the farms:

- Manual farm records for the number of animals per type, recorded on a daily or weekly basis, and weight site per type collected using a weighting scale and recorded as described in section B.1.

- Automatic records every ten minutes in a data logger for the following parameters for CPA-01 :

1.Amount of biogas flared or combusted (BGBurnt,y). When the gas is flared, no CER is claimed when the flow is above 100 Nm3/h, which is the maximum capacity of the flare used.
2.Temperature of the flare (Tflare). Emission reductions are claimed only the temperature of the flare and the flow rate of the residual gas to the flare is within the manufacturer's specification.Tflare and the flow are thus used to monitor continuously the proper operation of the flare.

In case the data logger is not functioning, manual recordings are taken for amount of biogas flared or combusted (BGBurnt,y) and temperature of the flare (Tflare). No CER for flaring is claimed.

- Manual records on a daily basis for the following
  - Total electricity generated from the recovered biogas per year (EGy)
  - Quantity of electricity from the grid consumed (ECPJ,y).

The amount/value of Tflare, BGBurnt,y, EGy, and ECPJ,y is based on the readings of the monitoring systems illustrated in the figures below:

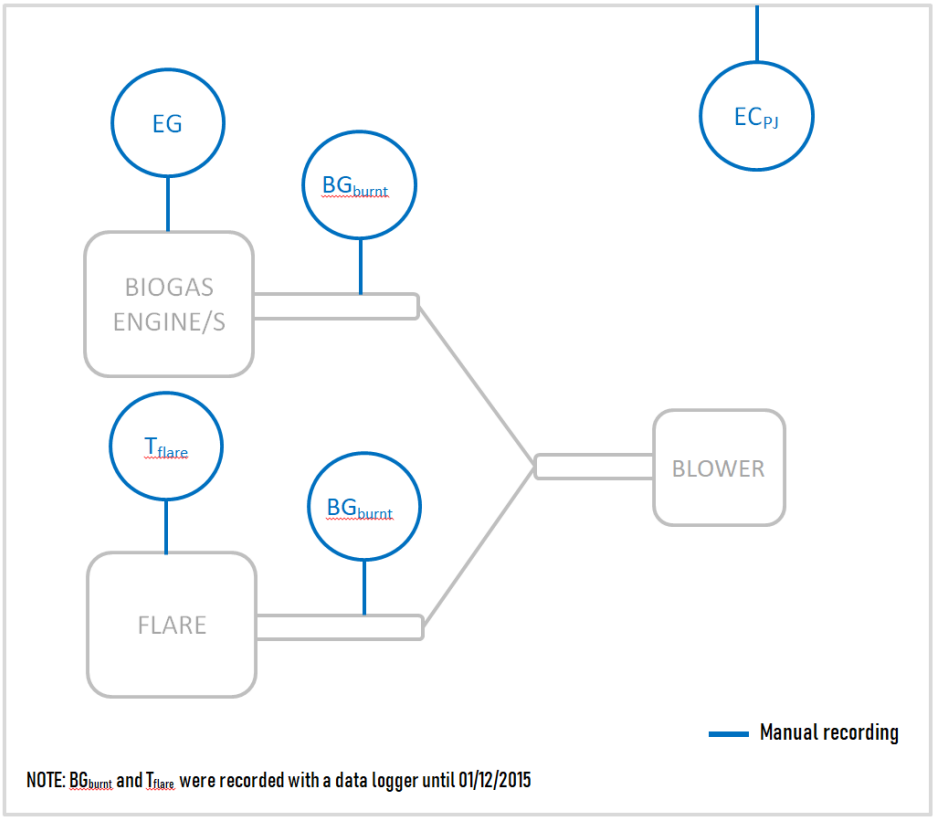

Figure D.1. Diagram of the monitoring system in CPA-01, alternative method for MDelec applied when flowmeter data are not available or unreliable.

SECTION E. Data and parameters

E.1. Data and parameters fixed ex ante

Data/Parameter	GWP_{CH4}
Unit	tCO_2e/tCH_4
Description	Global warming potential for CH_4
Source of data	IPCC
Value(s) applied	25
Choice of data or measurement methods and procedures	Default value
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	None

Data/Parameter	$W_{default}$
Unit	Kg
Description	Default animal weight for defined population (market and breeding).
Source of data	IPCC default Tables 10 A-7 & A-8 of IPCC 2006 Guidelines on Emissions from livestock and manure management.
Value(s) applied	CPA-01: 50 for market; 198 for breeding
Choice of data or measurement methods and procedures	CPA-01: Based on Western European (France) breeds as justified under the methodology and described in this section under the parameters $B_{o,LT}$ and $VS_{LT,y.}$
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

Data/Parameter	MCF_j
Unit	Fraction
Description	Annual methane conversion factor (MCF) for the baseline animal waste management system "j"
Source of data	Table 10.17 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10, "Uncovered Anaerobic Lagoon"
Value(s) applied	0.8
Choice of data or measurement methods and procedures	Corresponds to 'uncovered anaerobic lagoon' manure management systems with a mean annual temperature of greater than 26°C. According to the Philippine Atmospheric Geophysical & Astronomical Services Administration (PAGASA)[1], the mean annual temperature is > 26°C.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	None

Data/Parameter	$B_{o,LT}$
Unit	m^3 CH_4/kg dm
Description	Maximum methane producing potential of the volatile solid generated for animal type "LT".
Source of data	The genetic source of the production operations livestock originates from an Annex I country, and the CPA will use default values corresponding to Annex I species found in IPCC Guidelines, vol.4, Chap. 10.
Value(s) applied	See table below; CPA-01: $B_{o,breed}$ = 0.45; $B_{o,market}$ = 0.45

Region	Breeding swine	Market swine
North America	0.48	0.48
Western Europe	0.45	0.45
Eastern Europe	0.45	0.45
Oceania	0.45	0.45
Latin America	0.29	0.29
Africa	0.29	0.29
Middle East	0.29	0.29
Asia	0.29	0.29
Indian Subcontinent	0.29	0.29

[1] For details and record of annual mean temperature http://bagong.pagasa.dost.gov.ph/information/climate-philippines

Choice of data or measurement methods and procedures	The use of Annex I species defaults for VS is justified based on the requirements of AMS-III.D as follows: (i) The pig farm uses formulated feed rations (FFR) which are optimized for the various stages of animal growth, category, weight gain, productivity and genetics. (ii) The project's specified animal weight is more similar to developed country IPCC values than to Asian default values.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Default values applied ex-ante depending on the genetic source of the pigs of the CPA

Data/Parameter	$VS_{LT,default,y}$
Unit	kg dm/animal/year
Description	Volatile solids for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year).
Source of data	(i) Default values: The genetic source of the production operations livestock originates from an Annex I country, and the CPA will use default values corresponding to Annex I species found in IPCC Guidelines, vol.4, Chap. 10. (ii) Adjustment for animal weight: VS is adjusted for animal weight according to the calculations outlined in AMS-III.D and shown in section B.4.3 of CPA-DD.
Value(s) applied	See table below; CPA-01: $VS_{breed,y}$ = 0.46; $VS_{market,y}$ = 0.3
Choice of data or measurement methods and procedures	The use of Annex I species defaults for VS is justified based on the requirements of AMS III.D as follows: (i) The pig farm uses formulated feed rations (FFR) which are optimized for the various stages of animal growth, category, weight gain, productivity and genetics (ii) The project's specified animal weight is more similar to developed country IPCC values than to Asian default values
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Default values applied ex-ante depending on the genetic source of the pigs of the CPA

Region	Breeding swine	Market swine
North America	0.5	0.27
Western Europe	0.46	0.3
Eastern Europe	0.5	0.3
Oceania	0.5	0.28
Latin America	0.3	0.3
Africa	0.3	0.3
Middle East	0.3	0.3
Asia	0.3	0.3
Indian Subcontinent	0.3	0.3

Data/Parameter	$MS\%_{BI,j}$
Unit	Fraction
Description	Fraction of manure handled in the baseline animal manure management system "j"
Source of data	Based on baseline system operation
Value(s) applied	1.0
Choice of data or measurement methods and procedures	All manure was treated in the open lagoons.
Purpose of data/parameter	Calculation of baseline emissions

Data/Parameter	$W_{CH4,y}$
Unit	mass fraction
Description	Methane content in biogas in year "y"
Source of data	Based on options provided in AMS-III.D
Value(s) applied	60%
Choice of data or measurement methods and procedures	Default value used.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	None

Data / Parameter	FE
Unit	%
Description	Flare efficiency
Source of data	Based on defaults defined in tool for "Project emissions from flaring "
Value(s) applied	80
Choice of data or Measurement methods and procedures	As per the Tool for "Project emissions from flaring" the value will be set depending on the following conditions: For enclosed flares, Flare efficiency is 90% if (a)the temperature of the flare and the flow rate of the residual gas to the flare is within the manufacturer's specification for the flare in minute m; and (b) The flame is detected in minute m . Otherwise flare efficiency ,m is 0%. For enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points. For example, the default value applied shall be 80%, rather than 90%. In the case of open flares, the flare efficiency in the minute m is 50% when the flame is detected in the minute m ($Flame_m$), otherwise $FE_{,m}$ is 0%.
Purpose of data/parameter	Calculation of project emissions
Additional comment	For CPA-1, enclosed flare is a low height flare since its height is between 10 to 2 times of its diameter

Data / Parameter	$SPEC_{flare}$
Unit	Temperature - °C Flow rate or heat flux - kg/h or m3/h Maintenance schedule - number of days
Description	Manufacturer's flare specifications for temperature, flow rate and maintenance schedule
Source of data	Flare manufacturer
Value(s) applied	For CPA-1: Temperature > 500 ºC and/or flow above 20 Nm3/hr Flow rate max to 100 Nm3/hr Maintenance schedule-burners/flare must be cleaned at least every three months

Choice of data or Measurement methods and procedures	The flare specifications set by the manufacturer for the correct operation of the flare for the following parameters: (a) Minimum and maximum inlet flow rate, if necessary converted to flow rate at reference conditions or heat flux; (b) Minimum and maximum operating temperature; and (c) Maximum duration in days between maintenance events [not applicable for Option A].
Purpose of data	Calculation of project emissions
Additional comment	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

Data/Parameter	$EF_{CO2,y}$ (same as EF_y)
Unit	tCO_2/MWh
Description	Factor of emissions of the Luzon-Visayas or Mindanao electricity grid
Source of data	Calculated according to CDM guidelines and data from the Philippines Department of Energy (DOE). Fixed ex-ante in the CPA-DDs.
Value(s) applied	CPA-01: 0.6265
Choice of data or measurement methods and procedures	Calculated using tool from Published 2015-2017 OM and BM by the Philippine Department of Energy for the Luzon-Visayas grid.
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	

E.2. Data and parameters monitored

Data/Parameter	$BG_{burnt,y}$
Unit	Nm^3
Description	Biogas flared or combusted in year “y”
Measured/calculated/ default	Measured
Source of data	Flow meters on site
Value(s) of monitored parameter	-

Monitoring equipment

CPA-01

Engine flow meter

Monitoring equipment type:	Thermal mass flow meter *Sage* SIP-05-06-DC24-DIG GAS
Accuracy class:	+/–1% of Reading +0.5% of Full Scale over 100: 1 turndown
Calibration frequency:	Yearly

Flare flow meter, Old (used until 01/12/2015)

Monitoring equipment type:	Thermal mass flow meter *Sage* SIP-05-06-DC24-DIG GAS
Accuracy class:	+/–1% of Reading +0.5% of Full Scale over 100: 1 turndown
Calibration frequency:	Yearly

Flare flow meter, New (used from 05/11/2019)

Monitoring equipment type:	Ultrasonic gas flow meter *Cubic-Ruiyi* BF-3000B
Accuracy class:	1.5
Calibration frequency:	Not required

Detailed information of flow meter at each farm:

CPA	Serial Number	Installation Date	Calibration frequency	Date of last Calibration	Validity
01	Engine flow meter: 66088-36405	22/07/2011	12 months	09/12/2015	09/12/2015 to 08/12/2016
	Flare flow meter, Old: 66087-36431	22/07/2011	12 months	09/12/2015	09/12/2015 to 08/12/2016
	Flare flow meter, New: DS2510000014	05/11/2019	Not required by manufacturer	Factory calibrated	On-going

Measuring/reading/recording frequency	Annually, based on continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)
Calculation method (if applicable)	Flow meters will measure continuously the volume of gas subject to combustion and/or use. If the biogas flared and fuelled (or utilized) is continuously monitored separately, the two fractions can be added to determine the biogas recovered. In that case, recovered biogas need not be monitored separately. The system should be built and operated to ensure that there is no air ingress into the biogas pipeline.
QA/QC procedures	Flow meters shall be subject to regular maintenance, testing and calibration. Calibration will be done as per the equipment's manufacturer specifications
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	Project activities where a portion of the biogas is destroyed through flaring and the other portion is used for energy may consider applying the flare efficiency to the portion of the biogas used for energy, if separate measurements of the respective flows are not performed. When the amount of methane that is combusted for energy and that is flared is separately monitored, a destruction efficiency of 100 % can be used for the amount that is combusted for energy. Alternatively, if the recovered methane is used for power generation, and if no flow meter is installed on site, this parameter will not be reported for monitoring. Data will be kept for two years after the end of the crediting period. For CPA-01, flow to engine was not measured from 01/06/2019-31/12/2019 and recovered methane was used for power generation; for flow to flare there was no discounts applied as there are no ERs claimed from flaring during the MP.

Data/Parameter	**$FV_{RG,m}$**
Unit	Nm^3
Description	Parameter related to project emissions from flaring of the residual gas stream in year y -Volumetric flow rate of the residual gas in dry basis at normal conditions in minute, m; also volumetric flow rate of gas going to the flare
Measured/calculated/ default	measured
Source of data	Flare flow meter, or if combined, total biogas flow meter on site
Value(s) of monitored parameter	-
Monitoring equipment	Flare flow meter, Old (used until 01/12/2015) Monitoring equipment type: Thermal mass flow meter *Sage* SIP-05-06-DC24-DIG GAS Accuracy class: +/–1% of Reading +0.5% of Full Scale over 100: 1 turndown Calibration frequency: Yearly Flare flow meter, New (used from 05/11/2019) Monitoring equipment type: Ultrasonic gas flow meter *Cubic-Ruiyi* BF-3000B Accuracy class: 1.5 Calibration frequency: Not required Detailed information of flow meter at each farm:
Measuring/reading/recording frequency	Annually, based on continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)

CPA	Serial Number	Installation Date	Calibration frequency	Date of last Calibration	Validity
01	Flare flow meter, Old: 66087-36431	22/07/2011	12 months	09/12/2015	09/12/2015 to 08/12/2016
	Flare flow meter, New: DS2510000014	05/11/2019	Not required by manufacturer	Factory calibrated	On-going

Calculation method (if applicable)	Used to calculate PEflare,y. As per the tool “Project emissions from flaring”
QA/QC procedures	Flow meters shall be subject to regular maintenance, testing and calibration.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Project activities where a portion of the biogas is destroyed through flaring and the other portion is used for energy may consider applying the flare efficiency to the portion of the biogas used for energy, if separate measurements of the respective flows are not performed. Data will be kept for two years after the end of the crediting period.

Data/Parameter	T
Unit	ºC
Description	Temperature of the biogas
Measured/calculated/ default	Measured
Source of data	Project Implementer
Value(s) of monitored parameter	-
Monitoring equipment	CPA-01: No thermocouple installed since the flowmeters automatically measure the temperature and pressure and reads biogas volumes in normalized cubic meters
Measuring/reading/recording frequency	Monitored continuously
Calculation method (if applicable)	Measured continuously. No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing biogas volumes in normalized cubic meters
QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer/supplier’s recommendations
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Alternatively, if the recovered methane is used for power generation, and if no flow meter is installed on site, this parameter will not be reported for monitoring. For CPA-01, flow to engine was not measured from 01/06/2019-31/12/2019. Data will be kept for two years after the end of the crediting period.

Data/Parameter	P
Unit	Pa
Description	Pressure of the biogas
Measured/calculated/ default	Measured
Source of data	Project implementer
Value(s) of monitored parameter	-
Monitoring equipment	Monitoring equipment: pressure meters CPA-01: No pressure meters installed since the flowmeters automatically measure the temperature and pressure and reads biogas volumes in normalized cubic meters.
Measuring/reading/recording frequency	Monitored continuously.
Calculation method (if applicable)	Measured continuously. No separate monitoring is necessary when using flow meters that automatically measure the temperature and pressure, expressing biogas volumes in normalized cubic meters

QA/QC procedures	Measuring instruments shall be subject to a regular maintenance and testing regime, based on the manufacturer/supplier's recommendations
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Alternatively, if the recovered methane is used for power generation, and if no flow meter is installed on site, this parameter will not be reported for monitoring. For CPA-01, flow to engine was not measured from 01/06/2019-31/12/2019. Data will be kept for two years after the end of the crediting period.

Data/Parameter	FE
Unit	%
Description	Flare efficiency in the year "y"
Measured/calculated/ default	Calculated
Source of data	Default will be used as per the Tool "Project emissions from flaring"
Value(s) of monitored parameter	-
Monitoring equipment	Refer to $T_{EG,m}$
Measuring/reading/recording frequency	Continuous
Calculation method (if applicable)	As per the Tool for "Project emissions from flaring" the value will be set depending on the following conditions: For enclosed flares 0.9 If (a)the temperature of the flare and the flow rate of the residual gas to the flare is within the manufacturer's specification for the flare in minute m; and (b) The flame is detected in minute m . 0 otherwise. Otherwise flare efficiency ,m is 0%. For enclosed flares that are defined as low height flares, the flare efficiency shall be adjusted, as a conservative approach, by subtracting 10 percentile points. For example, the default value applied shall be 80%, rather than 90%. For open flares, 0.5 flare efficiency in the minute m is 50% when the flame is detected in the minute m 0 otherwise
QA/QC procedures	Regular maintenance shall be carried out to ensure optimal operation of flares as per manufacturer/supplier recommendations.
Purpose of data/parameter	Calculation of project emissions
Additional comments	Data will be kept for two years after the end of the crediting period. No claims for flaring for CPA-01.

Data/Parameter	$T_{EG,m}$
Unit	^{o}C
Description	Temperature in the exhaust gas of the flare.
Measured/calculated/ default	Measured
Source of data	Measurements by farm owners.
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	Once per minute

Calculation method (if applicable)	Measure the temperature of the exhaust gas in the flare by an appropriate temperature measurement equipment. Measurements outside the operational temperature specified by the manufacturer may indicate that the flare is not functioning correctly and may require maintenance. Flare manufacturers must provide suitable monitoring ports for the monitoring of the temperature of the flare. These would normally be expected to be in the middle third of the flare. Where more than one temperature port is fitted to the flare, the flare manufacturer must provide written instructions detailing the conditions under which each location shall be used and the port most suitable for monitoring the operation of the flare according to manufacturer's specifications for temperature
QA/QC procedures	Temperature measurement equipment should be replaced or calibrated in accordance with their maintenance schedule
Purpose of data/parameter	Calculation of baseline emissions
Additional 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 the issue. Monitoring of this parameter is applicable in case of enclosed flares. Measurements are required to determine if manufacturer's flare specifications for operating temperature are met No ERs from flaring claimed for CPA-1 since data logger was not working.

Data/Parameter	$Flame_m$
Unit	Flame on or Flame off
Description	Flame detection of flare in the minute m
Measured/calculated/ default	Measured
Source of data	Project participants
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	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
Calculation method (if applicable)	Measure using a fixed installation optical flame detector: Ultra Violet detector or Infra-Red or both
QA/QC procedures	Equipment shall be maintained and calibrated in accordance with manufacturer's recommendations
Purpose of data/parameter	Calculation of project emissions
Additional comments	Applicable to all flares. Not applicable-no ERs from flaring claimed for CPA-1 since data logger was not working.

Data/Parameter	nd_y
Unit	Days per year
Description	The number of days that the animal manure management system capturing methane and flaring/combusting methane was operational.
Measured/calculated/ default	Default/Measured
Source of data	Recorded on farm based on actual operation.
Value(s) of monitored parameter	see ER spreadsheets for exhaustive values
Monitoring equipment	-

Measuring/reading/recording frequency	Continuously, aggregated as required for the period used for the verification of the PoA
Calculation method (if applicable)	Recorded data
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be kept for two years after the end of the crediting period

Data/Parameter	$MS\%_{i,y}$
Unit	Fraction
Description	Fraction of manure handled in system i in project activity in year y
Measured/calculated/ default	Measured
Source of data	Recorded on farm based on actual operation
Value(s) of monitored parameter	1
Monitoring equipment	-
Measuring/reading/recording frequency	Annually, based on daily measurement and monthly aggregation
Calculation method (if applicable)	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
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions ex-post
Additional comments	Data will be kept for two years after the end of the crediting period

Data/Parameter	$N_{p,y}$
Unit	Number
Description	Number of animals produced annually of type “LT” for the year “y”
Measured/calculated/ default	Measured
Source of data	Farm records
Value(s) of monitored parameter	Refer to excel spreadsheet calculations for exhaustive monitored values and tables section E.3
Monitoring equipment	-
Measuring/reading/recording frequency	Annually, based on monthly records.
Calculation method (if applicable)	Based on pig census.
QA/QC procedures	Cross checked against indirect information (records of sales and food purchases for example).
Purpose of data/parameter	Calculation of baseline emissions

Additional comments	The calculation of the average number of animals ($N_{LT,y}$) is done monthly based on each farms internal records filled in by farm manager or assigned personnel. It presents the records of animal entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals per animal category (ex: nursery, farrow/wean, finisher and, boar, sow/gilt).Using this approach for calculating $N_{LT,y}$, it is not necessary to calculate separately an $N_{da,y}$ and $N_{p,y}$, since the number of days the animal are alive (Nda,y) and the number of animals produced per category LT ($N_{p,y}$) are already implicitly considered in the monthly records and taken into account when calculating $N_{LT,y}$. The farms internal records with weekly logs are then the input for the emission reduction calculation spreadsheet and aggregates the monthly average number of animals per animal category per farm for CPA-01. Data will be kept for two years after the end of the crediting period.

Data/Parameter	$N_{da,y}$
Unit	Days
Description	Number of days animal is alive in the farm in the year “y”
Measured/calculated/ default	Measured
Source of data	Farm recorded data keeping system
Value(s) of monitored parameter	Please refer to calculation spreadsheet
Monitoring equipment	
Measuring/reading/recording frequency	CPA 01: daily
Calculation method (if applicable)	As per farm records
QA/QC procedures	Cross checked records for sale of animals
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	The calculation of the average number of animals ($N_{LT,y}$) is done monthly based on each farms internal records filled in by farm manager or assigned personnel. It presents the records of animal entries (purchase; births, internal transfer) and exit (ex: sale, death, internal transfer) and the final monthly record of animals per animal category (ex: nursery, farrow/wean, finisher and, boar, sow/gilt).Using this approach for calculating $N_{LT,y}$, it is not necessary to calculate separately an $N_{da,y}$ and $N_{p,y}$, since the number of days the animal are alive (Nda,y) and the number of animals produced per category LT ($N_{p,y}$) are already implicitly considered in the monthly records and taken into account when calculating $N_{LT,y}$. The farms internal records with weekly logs are then the input for the emission reduction calculation spreadsheet and aggregates the monthly average number of animals per animal category per farm. Data will be kept for two years after the end of the crediting period

Data/Parameter	W_{site}
Unit	kg
Description	Average animal weight of the farm’s livestock population
`Measured/calculated/ default	Measured
Source of data	Farm recorded data keeping system
Value(s) of monitored parameter	Refer to excel spreadsheet calculations for exhaustive monitored values

<table>
<tr><td>Monitoring equipment</td><td>Weighing scale
<table>
<tr><th>CPA/ Farm</th><th>Equipment type</th><th>Accuracy class</th><th>Serial Number</th><th>Calibration Frequency</th><th>Date of last Calibration</th><th>Validity</th></tr>
<tr><td>CPA-1 Marcela</td><td>ICONIX FX-21</td><td>+/-0.5%</td><td>245</td><td>Annual</td><td>13/08/2014</td><td>13/08/2014 to 12/08/2015</td></tr>
</table></td></tr>
<tr><td>Measuring/reading/recording frequency</td><td>Annual</td></tr>
<tr><td>Calculation method (if applicable)</td><td>Weighed on site. The weight will be monthly monitored with the scale installed at the farm by project owner
The entire population will be weighed or alternately sampling procedures may be used to estimate this variable as per the latest “Standard for sampling and surveys for CDM project activities and Programmes of Activities”, using a 90/10 confidence/precision as the criteria for reliability of sampling efforts for small-scale project activities. Stratified random sampling approach will be preferred. The sample size will be determined depending on the animal population at each CPA.</td></tr>
<tr><td>QA/QC procedures</td><td>Every technician to monitor the sampled animal type will fill in the date and signature; the monitor forms will be collected, summarized and kept by the project participant. In addition, the scale will be calibrated annually.</td></tr>
<tr><td>Purpose of data/parameter</td><td>Calculation of baseline emissions</td></tr>
<tr><td>Additional comments</td><td>If current practice of farm is not to weigh sow/boar to avoid stressing them, an alternative method used by the farm to determine weights with same sample size required will be used. Data will be kept for two years after the end of the crediting period.
Discounts are applied for CPA-01, from 01/06/2019 to 31/12/2019 due to delay in calibration of the weigh scale.</td></tr>
</table>

Data/Parameter	Genetic source of the production operations livestock originating from an Annex I Party
Unit	-
Description	Genetic source of the production operations livestock originating from an Annex I Party.
Measured/calculated/ default	Default
Source of data	Based on documentation of purchases of livestock
Value(s) of monitored parameter	CPA-01: Values for Western Europe - France
Monitoring equipment	-
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	As per certificate
QA/QC procedures	-
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be kept for two years after the end of the crediting period.

Data/Parameter	FFR
Unit	-
Description	Use of formulated feed rations
Measured/calculated/ default	Measured

Source of data	Based on on-farm record keeping, feed supplier and other documentation
Value(s) of monitored parameter	-
Monitoring equipment	-
Measuring/reading/recording frequency	Annual
Calculation method (if applicable)	Information collected will validate that the farm is using formulated feed rations which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics
QA/QC procedures	As per farm veterinarians report
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be kept for two years after the end of the crediting period

Data/Parameter	EG_y
Unit	MWh
Description	Total electricity generated from the recovered biogas in the year y
Measured/calculated/ default	Measured
Source of data	Power Plant (electric meters)
Value(s) of monitored parameter	CPA: 01 — 2019 (MWh): 383
Monitoring equipment	Electric meter
Measuring/reading/recording frequency	Continuously, aggregated as required for the period used for the verification of the PoA
Calculation method (if applicable)	Only required for project activities that utilize the recovered methane for power generation
QA/QC procedures	Equipment shall be maintained as per manufacturer/supplier specifications
Purpose of data/parameter	Calculation of baseline emissions
Additional comments	Data will be kept for two years after the end of the crediting period. CPA-01 Engine 1 is not in use for the MP.

Electric meter

CPA	Manufacturer Type Accuracy	Serial number	Installation date	Calibration frequency	Date of last Calibration	Validity of the calibration
01	Engine 2 New: *Schneider* EasyLogic PM2120 Class 1.0	540210035308	17/08/2018	Not required *	20/03/2018 (factory calibration)	Ongoing validity
	Engines 3a&3b New: *Schneider* EasyLogic PM2120 Class 1.0	540210035226	17/09/2018	Not required *	03/03/2018 (factory calibration)	Ongoing validity
	Engines 3a&3b New: *Schneider* EasyLogic PM2120 Class 1.0	540210035226	17/09/2018	Not required *	03/03/2018 (factory calibration)	Ongoing validity

Data/Parameter	EC_{AE}
Unit	MWh
Description	Electricity consumed by the auxiliary equipment within the project activity during the year y
Measured/calculated/ default	Measured or calculated
Source of data	Electricity sub-meter/calculation
Value(s) of monitored parameter	-
Monitoring equipment	Calculated
Measuring/reading/recording frequency	Continuously, aggregated as required for the period used for the verification of the PoA
Calculation method (if applicable)	To be measured from electrical sub-meters installed at the site. Data will be archived electronically.
QA/QC procedures	Internal audits, capacity assessments, equipment monitoring & performance standards, equipment calibration, process control. Calibration will be done as per the equipment's manufacturer specifications
Purpose of data/parameter	Calculation of project emissions
Additional comments	Only to be monitored if the recovered biogas is used to power auxiliary equipment of the project activity. Data will be kept for two years after the end of the crediting period. Not applicable for CPA-01

Data/Parameter	$EC_{PJ,j,y}$
Unit	MWh
Description	Quantity of electricity from the grid consumed by the project activity during the year
Measured/calculated/ default	Measured/calculated
Source of data	Project participants, electricity meter or calculated (see ER spreadsheets)
Value(s) of monitored parameter	CPA: 01 — 2019 (MWh): 31
Monitoring equipment	Electric meter

CPA	Manufacturer Type Accuracy	Serial number	Calibration frequency	Date of last Calibration	Validity of the calibration
01	*EDMI* Mk6N Genius Class 0.5S (+/- 0.5%)	209535798	Not required*	04/09/2015 (during installation)	Ongoing validity

*Not required based on manufacturer's specification

Measuring/reading/recording frequency	Continuously, aggregated as required for the period used for the verification of the PoA
Calculation method (if applicable)	Electricity meter reading/calculation (please see additional comments)
QA/QC procedures	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. Calibration will be done as per the equipment's manufacturer specifications
Purpose of data/parameter	Calculation of project emissions

Additional comments	As per the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"; scenario A. Data will be kept for at least two years after the end of the crediting period. Alternatively, in case no separate electricity meter is installed to monitor the electricity consumption of the project, it will be estimated based on the relevant equipment operating at full rated capacity plus 10% to account for distribution losses, for 8760 hours per annum", in accordance with para. 26 of the methodology.

E.3. Implementation of sampling plan

Desired Precision and Sampling Size

Parameter W_{site} was monitored following a sampling approach (stratified random sampling) as per the monitoring plan (defined in Section E.2). For each farm, a representative sample of animals was weighed for each of the swine categories, as applicable, i.e. Farrowing, Nursery, Finisher, Breed Male, Breed Female. An annual sampling size was appropriately determined at a 90/10 precision and the results (y=2019 CP2) are presented in the tables below as examples.

CPA-01

Marcela - 2019		Sow/Gilt	Boar	Finisher	Nursery	Farrow/Wean
Population	N	3,976	107	22,447	13,388	7,366
Target range	Min	108.50	182.30	83.89	21.91	2.84
Target range	Max	225.75	375.80	115.50	37.61	4.38
Standard deviation	SD =(max-min)/4	29.31	48.38	7.90	3.92	0.39
Target mean value	Mean	167.13	279.05	99.70	29.76	3.61
V	$V = (SD/mean)^2$	0.030763	0.030052	0.006283	0.017385	0.011374
Precision level	E	0.1	0.1	0.1	0.1	0.1
Confidence level	%	90	90	90	90	90
Z		1.645	1.645	1.645	1.645	1.645
Sample size	**n**	1	1	3	2	1

As per the evidences provided to the DOE, the sample size per animal category has been met for year 2019 CP2.

Sampling Procedure and Quality Control

The scale at each participating farm was tuned onsite using a weight set calibrated according to the national standards, and recalibrated at appropriate intervals according to manufacturer specifications.

The weight of an individual or a certain group / batch was recorded on paper (farm forms), logbook, or encoded/registered in an electronic file (using a software). A staff is in charge of collating weight reports. In some farms, random checks were conducted. Records have been kept in both hard copy and electronic format or in a farm's database. Calculation of emission reductions or net anthropogenic removals

SECTION F. Calculation of emission reductions or net anthropogenic removals

F.1. Calculation of baseline emissions or baseline net removals

For AMS-III.D

Ex-post baseline emissions from methane recovery are calculated applying the following formula, using ex post monitored values of $N_{LT,y}$ and $VS_{LT,y}$:. The following formula was used:

$$MBE_{y,ex\text{-}post} = GWP_{CH4} * D_{CH4} * UF_b * \sum_{j,LT} MCF_j * B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{Bl,j} \quad (1)$$

Where:

$MBE_{y,ex\text{-}post}$	baseline emissions in year "y" (tCO_2e/yr), ex-post
GWP_{CH4}	Global Warming Potential of CH_4
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20ºC) and 1 atm pressure).
LT	Index for all types of livestock
J	Index for animal waste management system
MCFj	Annual methane conversion factor (MCF) for the baseline animal waste management system "j" in percentages (digester in project scenario).
$B_{o,LT}$	Maximum methane producing potential of the volatile solid generated for animal type "LT" (m3 CH4/kg dm)
$N_{LT,y}$	Annual average number of animals of type "LT" in year "y" (numbers) calculated using the formula below.
$VS_{LT,y}$	Volatile solids for livestock "LT" entering the animal manure management system 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)

Sample calculation for CPA-01 (y=2019 CP2)

Annual average animal population is determined from actual pig census at the farm, $N_{LT,y}$:

For CPA-01 Marcela (2019 CP2)

Breeding Swine				Market Swine					
Sow		Boar		Finisher		Nursery		Farrowing	
Average population	Average weight (kg)	Average population	Average weight (kg)	Average population	Average weight (kg)	Average population	Average weight (kg)	Average population	Average weight (kg)
3,976	175.31	107	252.42	22,447	101.21	13,388	28.27	7,365	3.88

Calculation of $VS_{site,LT,y}$*:* VS are calculated by adjusting default VS using site specific animal weights as follows:

$$VS_{site,LT,y} = (W_{site} / W_{default}) \times VS_{default} * nd_y \quad (2)$$

Where:

$VS_{site,LT,y}$	Adjusted volatile solid excretion for livestock "LT" entering the animal manure management system in year "y" (on a dry matter weight basis, kg dm/animal/year)
W_{site}	Average site animal weight for defined population, in kg
$W_{default}$	Default average animal weight for defined population, in kg.

$VS_{default}$	Default value (IPCC) for the volatile solid excretion per day on a dry-matter basis for defined livestock population, in kg-dm/animal/day
nd_y	Number of days in year "y" where the treatment plant was operational

Sample calculation for CPA-01 Marcela (y=2019 CP2)

Parameter	W_{site}	$W_{default}$	$VS_{default}$	nd_y	Calculated value ($VS_{LT,y}$)
$VS_{breed,y}$					
Sow	175.31	198	0.46	214	87
Boar	252.42	198	0.46	214	125
$VS_{market,y}$	62.20	50	0.30	214	80

$VS_{breed,y\ (sow)}$=175.41 kg/ 198 kg x 0.46 kg dm/animal/day x 214 day
= 87 kg dm/animal

VS_{market}
= (Wsite/Wdefault) x 0.30 x nd_y
= 62.20 / 50 kg x 0.30 kg dm/animal/day x 214 days
= 80 kg dm/animal

Summary of Calculation of 2019 CP2 Baseline Emissions: Summarized below are the constants and outcome of the calculation from equation (1) for $MBE_{y,ex\text{-}post}$. $MBE_{y,ex\text{-}post}$ is discounted by -0.5% (maximum accuracy) due to delay in calibration of the weigh scale.

Parameter	CPA-01
GWP_{CH4}	25
DCH_4	0.00067
Ufb	0.94
MCF_j	0.8
$Bo_{breed,y}$	0.45
$Bo_{market,y}$	0.45
$VS_{breed,y}$	
- Sow	87
- Boar	125
$VS_{market,y}$	80
$N_{breed,y}$	
2019 CP2 Average	
Sow	3,976
Boar	107
$N_{market,y}$ *2019 Average*	43,200
$MS\%_{BI,j}$	1
$MBE_{y,ex\text{-}post}$ (discounted)	21,590 tCO2e

Full detailed calculations of baseline emissions are provided in electronic spreadsheets attached to the monitoring report.

For AMS-I.F
The baseline emissions and emission reductions achieved from renewable electricity generation ex-post are calculated as follows:

GBEy,ex-post = (EGy, ex-post - EGbaseline) * EFy,ex-ante (3)

Where
GBEy, ex-post Baseline emissions based on monitored values for year "y" (tCO2) from renewable electricity generation

EGy,ex-post Electricity generated based on monitored values for year "y" (MWh/yr)
EGbaseline Baseline electricity supplied to the grid in case of modified or retrofit units based on monitored values
EFy,ex-ante Grid emissions factor (tCO2e/MWh) *ex-ante* values applied throughout the crediting period

The baseline emissions and emission reductions from renewable electricity generation calculated for CPA-01 Marcela (y= 2019 CP2):

GBEy = (EGy,ex-post - EGbaseline) * EFy,ex-ante
= (383 MWh - 0 MWh) * 0.6265 tCO_2e/MWh
= 239. tCO_2e

Full detailed calculations of baseline emissions are provided in electronic spreadsheets attached to the monitoring report.

MDy is calculated based on the following parameters:

$MDy = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * \eta_{flare,h} * GWP_{CH4}$ (4)

Where:
$BG_{burnt,y}$ Biogas flared or combusted in year y (m3).
$w_{CH4,y}$ Methane content in biogas in the year y (mass fraction fixed at 60%)
$\eta_{flare,h}$ Flare efficiency (fraction) when biogas is flared
D_{CH4} Density of methane (0.00067 tCH4/m3CH4)

When the biogas is sent to the engines, the combustion efficiency is 100%.

The equation applied is: $MD_{elec} = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * 100\% * GWP_{CH4}$ (5)

When the biogas is flared, the flow considered in the equation is the minimum of the flare capacity and the actual recorded flow:

The equation applied is: $MD_{flare} = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * \eta_{flare,h} * GWP_{CH4}$ (6)

Flare efficiency ($\eta_{flare,h}$) will be determined using default values.

Sample calculation for CPA-01 (y=2019 CP2) using equation (5)

The flowrate (Nm3/hr) for CPA-01 is recorded in a data logger every 10 minutes and MDelec is calculated and sum is taken for the year. However, the datalogger for y=2019 CP2 is not available and methane is used for power generation, the alternative method (equation 7) is used. Please refer to exhaustive values in electronic spreadsheets for 2019 CP2 attached to the monitoring report.

Since the datalogger is not available, T_{flare} and BG_{flare} data were not taken, thus there are no ER claims due to flaring.

MDflare = 0

Alternatively, if the recovered methane is used for power generation, MDy may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration

$MDy = EG_y \times 3600 / (NCV_{CH4} \times EE_y) \times D_{CH4} \times GWP_{CH4}$ (7)

Where:

EGy	Total electricity generated from the recovered biogas in year *y* (MWh)
3600	Conversion factor (1 MWh = 3600 MJ)
NCV_{CH4}	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% (more likely option to be used by the CPAs)

Sample calculation for CPA-01 (y= 2019 CP2) when flow meter readings are not available:

$MDy = EG_y \times 3600 / (NCV_{CH4} \times EE_y) \times D_{CH4} \times GWP_{CH4}$
$= 383 \text{ MWh} \times 3600 \text{ MJ} / (35.9 \text{ MJ/Nm}^3 \times 0.4) \times 0.00067 \text{ t/m}^3 \times 25$
$= 1{,}607 tCO2e$

Full detailed calculations of MDy are provided in electronic spreadsheets attached to the monitoring report.

F.2. Calculation of project emissions or actual net removals

>>

Project Emissions from methane recovery and destruction (MPE_y)

Ex-post project emissions from methane recovery are calculated as follows

$MPE_{y,ex\ post} = PE_{PL,,y} + PE_{flare,y} + PE_{power,y}$ (8)

Where:

$MPE_{y,ex\ post}$	Project emissions in year "y" (tCO_2e)
$PE_{PL,y}$	Emissions due to physical leakage of biogas in year "y" (tCO_2e)
$PE_{flare,y}$	Emissions from flaring of the biogas stream in the year "y" (tCO_2e)
$PE_{power,y}$	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year "y" (tCO_2e)

Emissions due to physical leakage ($PE_{PL,y}$) are estimated as per AMS-III.D as 10% of the maximum methane producing potential of the manure fed into the management systems implemented by the project activity. As the pig farm system is not a sequential treatment system no adjustment (RVS) is necessary to account for sequential stages.

$PE_{PL,y} = 0.10 * GWP_{CH4} * D_{CH4} * \sum_{j,LT} B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{i,y}$, (9)

Refer to MBE_y formula for the value of the parameters applied in $PE_{PL,y}$ equation, and refer to electronic spreadsheets for detailed calculations.

Sample calculation for CPA-01(y=2019 CP2) using equation (9)

$PE_{PL,y} = 0.10 * GWP_{CH4} * D_{CH4} * \sum_{j,LT} B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{i,y,}$

= 0.10 * 25 * 0.00067 * {(0.45 m^3 CH_4/kg dm * 3,969 * 87 kg dm/animal/year * 1.0) + (0.45 m^3 CH_4/kg dm * 107 * 125 kg dm/animal/year * 1.0) + [0.45 m^3 CH_4/kg dm * (43,200* 80 kg dm/animal/year * 1.0]}
= 2,871 tCO_2e

$PE_{PL,y}$ is already discounted by -0.5% (maximum accuracy) due to delay in calibration of the weigh scale.

For $PE_{power,y}$ as per the methodology if methane used to power auxiliary equipment of the project (EC_{AE}) will be taken into account accordingly, using zero as its emission factor.

Otherwise, Project emission due to electricity consumption ($PE_{power,y,}$ also considered as $PE_{power,y,ex-post}$ as refered to in equation:

$PE_{power,y} = ECPJ_{,j,y} * EFCO2_{,y}$ (10)

Where
$EC_{PJ,j,y}$ net quantity of electricity consumed from the grid (MWh)
$EF_{CO2,y}$ Emission Factor of the grid used for CPA's electric consumption (tCO_2/MWh)

Sample calculation for CPA-01(y=2019 CP2) using equation (10)

$PE_{power,y} = ECPJ_{,j,y} * EFCO2_{,y}$
= 31 MWh *0.6265 tCO_2e/MWh
= 19.67 tCO_2e

Emissions due to flaring or combustion ($PE_{flare,y}$)

Ex-post, these will be calculated using the Tool for "Project emissions from flaring"' through the following formula:

$PE_{flare} = \Sigma F_{CH4\ RG,m} * (1 - FE_{,m)} * GWP_{CH4} / 1000$ (11)

Where:
$F_{CH4\ RG,m}$ is the mass flow rate of methane in residual gas in minute m.
$FE_{,m}$ is the flare efficiency in minute,m
GWP_{CH4} is the GWP of methane according to IPCC.

Sample calculation for CPA-01(y=2019 CP2) using equation (11).

There is no flaring data records for CPA-01 (y=2019 CP2), PE_{flare} = 0.

.***Average annual project emissions from methane recovery and destruction (MPE_y)***

$MPE_{,y} = PE_{PL,y} + PE_{flare,y} + PE_{power,y}$

Sample calculation for CPA-01(y=2019) using equation (8)

$MPE_{,y} = PE_{PL,y} + PE_{flare,y} + PE_{power,y}$
= 2,871 tCO_2e + 0 tCO_2e + 19.67 tCO_2e
= 2,891 tCO_2e

F.3. Calculation of leakage emissions

>>No leakage is considered for the PoA.

F.4. Calculation of emission reductions or net anthropogenic removals

Calculation of emissions reductions: Based on the monitoring data the emission reductions will be calculated ex-post using the following approach:

$PER_y = MER_{y,\text{ ex-post}} + GER_{y,\text{ ex-post}}$ (12)

Where:
$MER_{y,\text{ ex-post}}$ Emission reduction in year "y" (tCO_2e) from methane recovery (as per AMS-III.D)
$GER_{y,\text{ ex-post}}$ Emission reduction in year "y" (tCO_2e) from renewable electricity generation (as per AMS-I.F)

Ex post emissions from methane recovery are calculated using the following formula:

$MER_y = MBE_y - (MPE_y + MLeakage_y)$ (13)

Where:
MER_y Emission reduction in year "y" (tCO_2e)
MBE_y Baseline emissions in year "y" (tCO_2e)
MPE_y Project emissions in year "y" (tCO_2e)
$MLeakage_y$ Project leakage in year "y" (tCO_2e)

Sample calculation for CPA-01(y=2019 CP2) using equation (13).

MER_y = 21,590 tCO2e – (2,891 tCO_2e + 0)
= 18,700 tCO2e

Ex post emissions from electricity generation are calculated using the following formula

$GER_y = GBE_y - (GPE_y + GLeakage_y)$ (14)
Where:
GER_y Emission reduction in year "y" (tCO_2e) from electricity generation
GBE_y Baseline emissions in year "y" (tCO_2e) from renewable electricity generation
GPE_y Project emissions in year "y" (tCO_2e) from renewable electricity generation

Sample calculation for CPA-01(y=2019 CP2) using equation (14).

GER_y = 240 tCO_2e- (0 + 0)
= 240 tCO_2e

The emission reductions achieved in any year from methane recovery are the lowest value of the following:

$MER_{y,ex\text{-}post} = \min [(MBE_{y,ex\text{-}post} - MPE_{y,ex\text{-}post}) , (MD_{y-} PE_{power,ex\text{-}post})]$ (15)

Where:

ERy,ex-post Emission reductions achieved by the project activity based on monitored values for year "y" (tCO2e)
MBEy,ex-post Baseline emissions calculated using the formula found in Section F.1 using ex-post monitored values of NLT,y and if applicable VSLT,y
MPEy,ex-post Project emissions calculated using the formula found in Section F.2 using ex post monitored values of NLT,y ,MS%i,y and if applicable VSLT,y

MDy Methane captured and destroyed or used gainfully by the project activity in year "y" (tCO2e)

Sample calculation for CPA-01(y=2019 CP2) using equation (15).

$MER_{y,ex\text{-}post} = \min [(MBE_{y,ex\text{-}post} - MPE_{y,ex\text{-}post}) , (MD_y - PE_{power,ex\text{-}post})]$

$=\min[(21,590-2,891), (1,607 – 19.67)]$

$= 1,587$ tCO2e

The baseline and project emissions presented in the table hereafter refer to the minimum of (MBEy,ex-post - MPEy,ex-post) and (MDy - PEpower,ex-post) as in equation (15) and GBE,y,ex-post.

Sample calculation for CPA-01(y=2019 CP2) using equation (12).

$PER_y = MER_{y, ex\text{-}post} + GER_{y, ex\text{-}post}$

$=$ 1,587 tCO2e + 240 tCO2e

$=$ 1,827 t CO2e

Please refer to electronic spreadsheets attached to the monitoring report for detailed calculations of CPAs during the moitoring period.

CPA UNFCCC reference number	Baseline GHG emissions or baseline net GHG removals (t CO_2e)	Project GHG emissions or actual net GHG removals (t CO_2e)	Leakage GHG emissions (t CO_2e)	GHG emission reductions or net anthropogenic GHG removals (t CO_2e)		
				Before 01/01/2013	From 01/01/2013	Total amount
5979-P1-0001-CP2	1,847	20	0	0	1,827	1,827

F.5. Comparison of emission reductions or net anthropogenic removals achieved with estimates in the included CPA-DDs

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO_2e)	Amount estimated ex ante for this monitoring period in the CPA-DD (t CO_2e)
5979-P1-0001-CP2	1,827	21,169
Total	1,827	21,169

F.5.1. Remarks on Explanation of calculation of "amount estimated ex ante for this monitoring period in the CPA-DD"

The amount estimated ex-ante for this monitoring period are calculated from date of start of crediting period of the CPA-01 for CP2 until end of this MP (31/12/2019).

CPA UNFCCC reference number	Amount achieved during this monitoring period (t CO_2e)	Days considered in CPA-DD	Amount estimated ex ante for this monitoring period in the CPA-DD (t CO_2e)	Days actual monitoring of CPA	Amount estimated ex ante for this monitoring period in the CPA-DD,adjusted (t CO_2e)
5979-P1-0001-CP2	1,827	214	21,169	214	21,169
Total	1,827	214	21,169	214	21,169

F.6. increase in achieved emission reductions

>> Not applicable

F.7. Remarks on scale of small-scale CPAs

>> The amounts achieved per year for all the CPAs were under the limit of that type every year during the crediting period,i.e. Type III- less than 60,000 tCO2e/yr, and Type I- less than 15 MWe.

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Document information

Version	*Date*	*Description*
03.0	31 May 2019	Revision to: - Ensure consistency with version 02.0 of the “CDM project standard for programmes of activities” (CDM-EB93-A07-STAN); - Add a section on remarks on the observance of the scale limit of small-scale CPAs during the crediting periods; - Add "changes specific to afforestation or reforestation activities/CPA" as a possible post-registration changes; - Clarify the reporting of net anthropogenic GHG removals for A/R PoAs between two commitment periods; - Make structural and editorial improvements.
02.0	7 June 2017	Revision to: - Ensure consistency with version 01.0 of the “CDM project standard for programmes of activities (CDM-EB93-A07-STAN); - Make editorial improvements.
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