Draft approved consolidated baseline methodology ACM00XX

"Consolidated baseline methodology for GHG emission reductions from manure management systems"

Source

This consolidated baseline methodology is based on elements from the following methodologies:

- AM0006: "GHG emission reductions from manure management systems", based on the CDM-PDD "Methane capture and combustion of swine manure treatment for Peralillo" whose baseline study, monitoring and verification plan and project design document were prepared by Agricola Super Limitada. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0022: "Methane capture and combustion of swine manure treatment for Peralillo" on http://cdm.unfccc.int/methodologies/approved.
- AM0016: "Greenhouse gas mitigation from improved Animal Waste Management Systems in confined animal feeding operations", whose baseline study, monitoring and verification plan and project design document were prepared by AgCert Canada Co. on behalf of Granja Becker, L.B.Pork, Inc. and AgCert Canada Co.For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0034-rev.2: "Granja Becker GHG Mitigation Project" on http://cdm.unfccc.int/methodologies/approved.

For more information regarding the proposals and their consideration by the Executive Board please refer to:

- case NM0022: "Methane capture and combustion of swine manure treatment for Peralillo"; and
- case NM0034-rev.2: "Granja Becker GHG Mitigation Project"

on http://cdm.unfccc.int/methodologies/approved.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment"

Applicability

This methodology is applicable generally to manure management on livestock farms where the existing anaerobic lagoon for manure management, within the project boundary, is replaced by one or a combination of more than one animal waste management systems (AWMSs) that result in less GHG emissions.

This methodology is applicable to manure management projects with the following conditions:

- Farms where livestock populations, comprising of Cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions;
- Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries);

- The depth of the anaerobic lagoons used for manure management under the baseline scenario should be at least 1m[1];
- The temperature of the anaerobic lagoons is higher than 10°C. If the monthly average temperature is less than 10 °C, this month is not included in the estimations, as it is assumed that no anaerobic activity occurs below such temperature..
- In the baseline case, the minimum retention time of manure waste in the anaerobic lagoon is greater than 1 month.
- The AWMS/process in the project case should ensure that no leakage of manure waste into ground water takes place, for e.g., the lagoon should have a non-permeable layer at the lagoon bottom.

This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM00XX (Consolidated baseline methodology for GHG emission reductions from manure management systems).

Identification of the baseline scenario

The methodology determines the baseline scenario through the following steps:

Step I: Define alternative scenarios to the proposed CDM project activity;
Step II: Barriers analysis;
Step III: Investment analysis;
Step IV: Baseline revision at renewal of crediting period.

Step I: Define alternative scenarios to the proposed CDM project activity

1. Identify realistic and credible alternative scenarios that are available either to the project participants or to other potential project developers[2] for managing the manure. These alternative scenarios should include:

- The proposed project activity not being registered as a CDM project activity;
- All other plausible and credible alternatives to the project activity scenario, including the common practices in the relevant sector. In doing so, the complete set of possible manure management systems listed in the 1996 Revised IPCC Guidelines (Chapter 4, Table 4.8) and in the IPCC Good Practice Guidance and Uncertainty Management (Chapter 4, Table 4.10 and 4.11) should be taken into account; In drawing up a list of possible scenarios, possible combinations of different Animal Waste Management Systems (AWMS) should be taken into account.

[1] In particular, loading in the waste water streams has to be high enough to assure that the lagoon develops an anaerobic bottom layer and that algal oxygen production can be ruled out.

[2] For example, a coal-fired power station or hydropower may not be an alternative for an independent power producer investing in wind energy or for a sugar factory owner investing in a co-generation, but may be an alternative for a public utility. As a result, the proposed project may be able to avoid emissions that would have occurred from the coal-fired power station that would have been built (or built earlier) by the utility in the absence of the CDM. Therefore, there may be cases where the baseline scenario includes an alternative that is not accessible to the project participant. However, there are also cases where all the alternatives are accessible to the project participant: for instance, this may be the case for projects flaring landfill gas, improving boilers, etc.

- If applicable, continuation of the current situation (no project activity or other alternatives undertaken).

Eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements. Apply Sub-step 1b of the latest version of the "Tool for demonstration assessment and of additionality".

For the purpose of identifying alternative scenarios that are common practice, provide an analysis of other manure management practices implemented previously or currently underway. Projects are considered similar if they are in the same country/region, are of a similar scale, and take place in a comparable environment with respect to regulatory framework, investment climate, access to technology, access to financing, etc. Other CDM project activities are not to be included in this analysis. Provide documented evidence. On the basis of that analysis, identify and include all alternative scenarios that are common practice.

Step II: Barrier analysis

Establish a complete list of barriers that would prevent alternative scenarios to occur in the absence of the CDM. Such barriers may include:

Investment barriers, *inter alia*:

- Debt funding is not available for this type of innovative activities.
- Neither access to international capital markets due to real or perceived risks associated with domestic or foreign direct investment in the country where the project activity is to be implemented.

Technological barriers, *inter alia:*

- Skilled and/or properly trained labour to operate and maintain the technology is not available and no education/training institution in the host country provides the needed skill, leading to equipment disrepair and malfunctioning;
- Lack of infrastructure for implementation of the technology.

Barriers due to prevailing practice, *inter alia*:

- The alternative is the "first of its kind": No alternative of this type is currently operational in the host country or region.

Since the proposed project activity not being registered as a CDM project activity shall be one of the considered alternatives, any barrier that may prevent the project activity to occur shall be included in that list.

Provide transparent and documented evidence, and offer conservative interpretations of this documented evidence, as to how it demonstrates the existence and significance of the identified barriers. Anecdotal evidence can be included, but alone is not sufficient proof of barriers. The type of evidence to be provided may include:

(a) Relevant legislation, regulatory information or industry norms;

(b) Relevant (sectoral) studies or surveys (e.g. market surveys, technology studies, etc) undertaken by universities, research institutions, industry associations, companies, bilateral/multilateral institutions, etc;

(c) Relevant statistical data from national or international statistics;

(d) Documentation of relevant market data (e.g. market prices, tariffs, rules);

(e) Written documentation from the company or institution developing or implementing the CDM project activity or the CDM project developer, such as minutes from Board meetings, correspondence, feasibility studies, financial or budgetary information, etc;

(f) Documents prepared by the project developer, contractors or project partners in the context of the proposed project activity or similar previous project implementations;

(g) Written documentation of independent expert judgements from industry, educational institutions (e.g. universities, technical schools, training centres), industry associations and others.

Assess for all barriers identified, which scenario alternatives would be prohibited from being implemented by the barrier and eliminate those alternatives from further consideration.

If there is only one scenario alternative that is not prevented by any barrier, and

i. ***if this alternative is not the proposed project activity not being registered as a CDM project activity, then this scenario alternative is the most plausible baseline scenario.***

ii. ***If this alternative is the proposed project activity not being registered as a CDM project activity, then the project activity is the most plausible baseline scenario.***

iii. ***If there are still several baseline scenario alternatives remaining, either go to step IV (investment analysis) or choose the alternative with the lowest emissions (i.e. the most conservative) as the most plausible baseline scenario.***

Step III: Investment analysis

Undertake investment analysis of all the alternatives that don't face any barriers, as identified in Step III. For each alternative, all costs and economic benefits attributable to the waste management scenario should be illustrated in a transparent and complete manner, as shown in table 1 below.

Table 1: Calculation of NPV and IRR

COSTS AND BENEFITS	Year 1	Year 2	Year n	Year n+1
Equipment costs (specify the equipment needed)				
Installation costs				
Maintenance costs				
Other costs (e.g. operation, consultancy, engineering, etc.)				
Revenues from the sale of electricity or other project related products, when applicable				
SUBTOTAL				
TOTAL				
NPV (US$) (specify discount rate)				
IRR (%)				

For each alternative baseline scenario, the internal rate of return (IRR) and/or the net present value (NPV) should be calculated. The calculation of the IRR must include investment costs, operation and maintenance costs, as well as any other appropriate costs (engineering, consultancy, etc.), all revenues generated by each manure management scenario, including revenue from the sale of electricity and cost savings due to avoided electricity purchases, except revenues from the sale of CERs.

The IRR for all alternative scenarios should be calculated in a conservative manner. To ensure this, assumptions and parameters for the proposed project activity, if still under consideration, should be chosen in a conservative way such that they tend to lead to a higher IRR and NPV. For all other scenarios considered, assumptions and parameters should be chosen in a way such that they tend to lead to a lower IRR and NPV. This conservative choice of parameters and assumptions should be ensured by obtaining expert opinions and should be evaluated by the DOE as part of the validation of the project activity.

If the IRR cannot be calculated due to the existence of only negative flows in the financial analysis, the comparison should be based on the NPV, stating explicitly the discount rate used.

The baseline scenario is identified as the economically most attractive course of action i.e., alternative scenario with highest IRR or NPV, where the IRR cannot be calculated

Step IV: Baseline revision

Renewal of crediting period: The project participants, at the renewal of each credit period, will undertake the relevance of baseline scenario identified above taking into account change in the relevant national and/or sectoral regulations between two crediting periods as well as any increase in the animal stock above the pre-project animal stock. This assessment will be undertaken by the verifying DOE.

Additionality

If the baseline determination in this methodology (see section "Baseline" above) demonstrates that the baseline is different from the proposed project activity, not undertaken as a CDM project activity, it may be concluded that the project is additional.

Project boundary

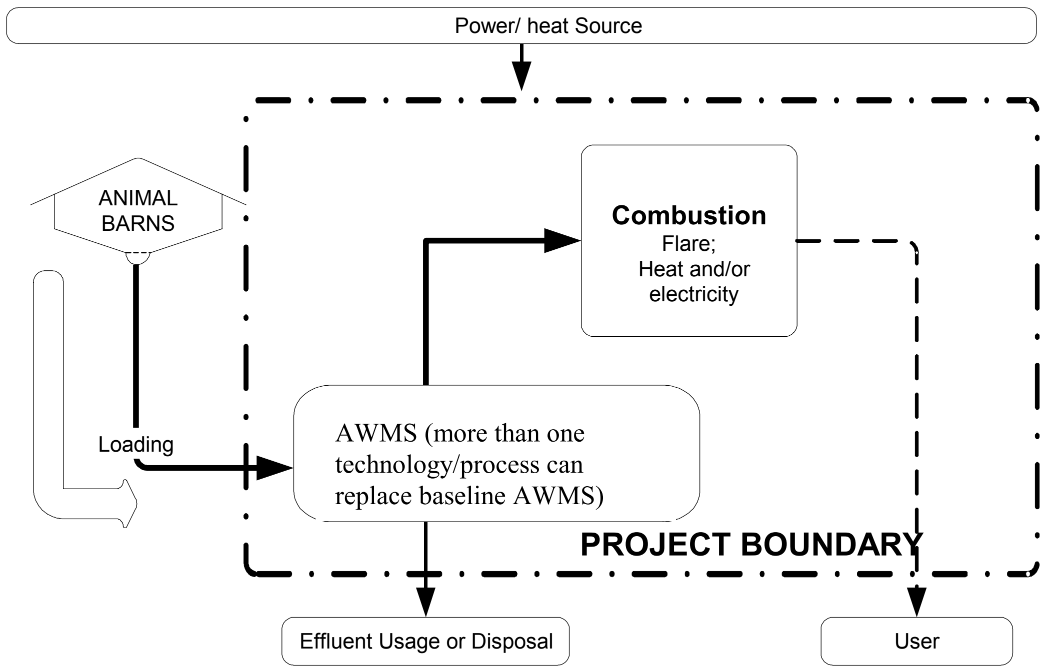

Figure 1: Project activity boundary

	Source	Gas		Justification / Explanation
Baseline	Direct emissions from the waste treatment processes.	CH_4	Included	The major source of emissions in the baseline
		N_2O	Included	
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
	Emissions from electricity consumption / generation	CO_2	Included	Electricity may be consumed from the grid or generated onsite in the baseline scenario.
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative.
	Emissions from thermal energy generation	CO_2	Included	If thermal energy generation is included in the project activity
		CH_4	Excluded	Excluded for simplification. This is conservative.
		N_2O	Excluded	Excluded for simplification. This is conservative. [This can be excluded as per methodology if emission reduction from biogas use are ignored. But including it can expand the methodology]
Project Activity	On-site fossil fuel consumpti	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.

	on due to the project activity	N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Included	May be an important emission source. If electricity is generated from collected biogas, these emissions are not accounted for.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Direct emissions from the waste treatment processes.	N_2O	Included	
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.
		CH_4	Included	The emission from uncombusted methane and also leakage from waste managed side.

The project proponents will provide a clear diagrammatic representation of the project scenario with all the treatments steps adopted in treating the manure waste as well as its final disposal in the CDM-PDD. The diagrammatic representation will also indicate the fraction of volatile solids degraded within the project boundary in pre-project situation before disposal. This shall include the final disposal of methane, if any captured, and also the auxiliary energy used to run project treatments steps.

The precise location of the farm(s) where the project activity takes place shall be identified in the CDM-PDD (e.g., co-ordinates of farm (s) using global positioning system).

Baseline Emissions:

The baseline is the AWMS(s) identified through the baseline selection procedure.

Baseline emissions are:

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

where,

$BE_{,y}$	Baseline emissions in year y, in tCO_2e/year.
$BE_{CH4,y}$	Baseline methane emissions in year y, in tCO_2e/year.
$BE_{N2O,y}$	Baseline methane emissions in year y, in tCO_2e/year.
$BE_{elec/heat,y}$	Baseline CO_2 emissions from electricity and/or heat used for the manure management system within the project boundary, in tCO_2e/year.

<u>(i) Methane emissions</u>

Manure management system in the baseline could be based on one or more stages. Therefore,

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * MCF_{bmm} * \sum_{LT} (B_{0,LT} * \sum_{m} N_{LT,m} * VS_{LT,m}) \quad (1a)$$

GWP_{CH4}	Global Warming Potential (GWP) of CH_4.
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).

MCF_{bmm}	methane conversion factor (MCF) for the baseline AWMS.
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated, in m^3CH_4/kg_dm, by animal type LT. This value varies by species and diet. Where default values are used, they should be taken from Appendix B of Chapter 4.2 in the Reference Manual of the 1996 Revised IPCC Guidelines specific to the country where the project is implemented.
$VS_{LT,m}$	Monthly volatile solid excretions [on a dry matter weight basis (kg-dm/month), is estimated as described in sub-section below.
$N_{LT,m}$	Number of animals of type LT for the month m, expressed in numbers.

The relative reduction of volatile solids depend on the treatment technology and should estimated in a conservative manner. Default values for different treatment technologies can be found in Chapter 8.2 in US-EPA (2001).[3] These values are provided in Annex 2

Estimation of various variables and parameters for above equations:

(A) VS can be determined in one of the following ways, stated in the order of preference:

1. Estimation of VS based on dietary intake of livestock

$$VS_{LT} = GE * (1/ED) * (1-DE/100) * (1-Ash/100) * nd_m \quad (2)$$

where

VS_{LT}	*Monthly volatile solid excretions on a dry matter weight basis (kg-dm/month)*
GE_{LT}	*Daily average gross energy intake in MJ/day*
DE_{LT}	*Digestible energy of the feed in percent (IPCC defaults available)*
Ash_{LT}	*Ash content of the manure relative to the dry matter of the manure and not to the total matter (% - IPCC defaults),*
ED_{LT}	*Energy density of the feed in MJ/kg (IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg DM, which is relatively constant across a wide variety of grain-based feeds.) fed to livestock type LT. The project proponent will record the composition of the feed to enable the DOE to verify the energy density of the feed.*

2. Scaling default IPCC values $VS_{default}$ to adjust for a site-specific average animal weight as shown in equation below

$$VS_{site} = \left(\frac{w_{site}}{w_{default}} \right) \cdot VS_{default} * nd_m \quad (3)$$

where:

VS_{site}	Adjusted volatile solid excretion per day on a dry-matter basis for a defined livestock population at the project site in kg-dm/animal/month.
w_{site}	Average animal weight of a defined population at the project site in kg.
$w_{default}$	Default average animal weight of a defined population in kg from where the data on $VS_{default}$ is sourced (IPCCC or US-EPA, which ever is lower).
$VS_{default}$	Default value (IPCC or US-EPA, which ever is lower) for the volatile solid excretion per

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[3] http://www.epa.gov/ost/guide/cafo/pdf/DDChapters8.pdf .

day on a dry-matter basis for a defined livestock population in kg-dm/animal/day.

nd_m Number of days in month m.

3. Using published country specific data. If the data is expressed in kg_dm per day, multiply the value with nd_m (number of days in month m).

4. Utilizing published IPCC defaults, multiply the value with nd_m (number of days in month m).

The following sources should be used to calculate baseline emissions:

- 1996 Revised IPCC Guidelines, Chapter 4 of the Reference Manual
- IPCC Good Practice Guidance and Uncertainty management in National GHG Inventories, Chapter 4

US-EPA 2001: Development Document for the Proposed Revisions to the National Pollutant Discharge Elimination System Regulation and the Effluent Guidelines for Concentrated Animal Feeding Operations, Chapter 8.2 (http://epa.gov/ost/guide/cafo/devdoc.html)

(B)Methane conversion factors (MCFs):

MCF is estimated as a function of depth of the system where manure is treated and the temperature.

$$MCF = f_d * f_{t,annual} * 0.89 \quad (4)$$

f_d fraction of degradation as a function of depth of the anaerobic lagoon.

$f_{t,annual}$ fraction of degradation as a function of temperature.

0.89 An uncertainty conservativeness factor (equivalent to an uncertainty range of 30% to 50%) for the fact that the equation used to estimate $f_{t,annaul}$ assumes full anaerobic degradation at 30 ^oC.

Table 2: Default values for f_d.

	Deep > 5m	depth 1-5 m	depth <1m
f_d	0.7	0.5	0.0

The annual $f_{t,annual}$ is estimated as follows

$$f_{t,annual} = \frac{\sum_{m=1}^{12} CH_{4,m}}{B_0 * \sum_{m=1}^{12} VS_m} \quad (4a)$$

$$CH_{4,m} = B_0 * VS_m * f_{t,monthly} \quad (4a\text{-}1)$$

$$f_{t,monthly} = \exp[\frac{E * (T_2 - T_1)}{R * T_1 * T_2}] \quad (4a\text{-}1\text{-}1)$$

where

$CH_{4,m}$ estimated monthly methane production

B_0 is the maximum methane producing potential of organic waste

VS_m	monthly volatile solids available for degradation.
$f_{t,monthly}$	Monthly conversion efficiency of VS to CH_4 due to temperature. Months were the average temperature is less than 10 ^oC, $f_{t,monthly} = 0$. The value of $f_{t,monthly}$ cannot exceed unity.
E	Activation energy constant (15,175 cal/mol).
T_2	Ambient temperature (Kelvin) for the climate.
T_1	303.16 = (273.16° + 30°).
R	Ideal gas constant (1.987 cal/ K mol).

Procedure for applying the above steps for estimating $f_{t,\ monthly}$ is given in Annex 1. Project proponent has to monitor the time period when the lagoon is cleaned.

Carry on calculations are limited to a maximum of one year. In case the residence time is less than one year carry-on calculations are limited to this period where the sludge resides in the lagoon. Project participants should provide evidence of the residence time of the wastewater in the lagoon.

(ii) N_2O emissions from manure management

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000}\sum_{mmi} E_{N20,y} \qquad (1b)$$

where,

GWP_{N2O}	Global Warming Potential (GWP) for N_2O.
$CF_{N2O\text{-}N,N}$	conversion factor N_2O-N to N_2O (44/28).
$EF_{N2O,,y}$	N_2O emission from the i^{th} treatment process/technology of the manure management system expressed in kg N_2O-N.

The same method, as used here to estimate the emissions in the baseline, is used to estimate the project emissions of nitrous oxide.

$$E_{N2O,y} = EF_{N2O} * \sum_{LT}(NEX_{LT,m} \cdot \sum_{m} N_{LT,m}) \qquad (1b\text{-}1)$$

where:

$E_{N2O,y}$	Are the nitrous oxide emissions from the first stage of the manure management systems in tonnes of CO_2 equivalents per year.
EF_{N2O}	Is the N_2O emission factor for the treatment stage i of the manure management system in kg N_2O-N/kg N (EF_3 in 1996 Revised IPCC Guidelines and IPCC GPG).
NEX_{LT}	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.

Default values for different treatment technologies can be found in Annex 2.

Estimation of parameters and variables in equations:

i. $EF_{N2O,1}$ should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 4.12 and Table 4.13 of the IPCC GPG 2000 may be used.
ii. NEX should be estimated as described in Annex 3:

(iii) CO_2 emission from electricity and heat within the project boundary

$$BE_{elec/heat} = EG_y * CEF_{Bl,elec,,y} + EG_{d,y} * CEF_{grid} + HG_{BL,y} * CEF_{Bl,\ therm,y} \qquad (1C)$$

where,

EG_y	is the amount of electricity in the year y that would be consumed at the project site in the absence of the project activity (MWh) for operating AWMS.
$CEF_{Bl,\ elec,y}$	is the carbon emissions factor for electricity consumed at the project site in the absence of the project activity (tCO_2/MWh)
$EG_{d,y}$	is the amount of electricity generated utilizing the biogas collected during project activity and exported to the grid during the year y (MWh)
CEF_{grid}	is the carbon emissions factor for the grid in the project scenario (tCO_2/MWh)
$HG_{BL,\ y}$	is the quantity of thermal energy that would be consumed in year y at the project site in the absence of the project activity (MJ) using fossil fuel for operating AWMS.
$CEF_{Bl,\ therm}$	is the CO_2 emissions intensity for thermal energy generation (tCO_2 e/MJ)

Note: Project proponents need to estimate electricity component only if the captured methane is used for generation of electricity, which is at least as much as the project requirement, and the Project participants wish to claim emissions reduction due to the same. Similarly if the Heat in project case is completely met by biogas and project participants do not wish to claim the credits, the CO_2 emission from heat can be ignored.

Determination of $CEF_{Bl,elec}$:

- In cases where electricity would in the absence of the project activity be generated in an on-site fossil fuel fired power plant, project participants should use for $CEF_{Bl,elec}$, the default emission factor for a diesel generator with a capacity of more than 200 kW for small-scale project activities (0.8 tCO_2/MWh, see AMS 1.D.1 in the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories).
- In cases where electricity would, in the absence of the project activity, be purchased from the grid, the emission factor $CEF_{Bl,elec}$ should be calculated according to approved methodology ACM0002 ("Consolidated baseline methodology for grid-connected electricity generation from renewable sources"). If electricity consumption is less than small scale threshold (15 GWh/yr), the default emission factor for a diesel generator with a capacity of more than 200 kW for small-scale project activities (0.8 tCO_2/MWh, see AMS 1.D.1 in the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories).

Determination of CEF_{grid}: CEF_{grid} should be calculated according to methodology ACM0002 ("Consolidated baseline methodology for grid-connected electricity generation from renewable sources"). If the generation capacity is less than the small-scale project activity (15 MW), AMS 1.D simplified baseline methodology for small-scale CDM project activity could be used.

Determination of $CEF_{Bl,therm}$: The emission factor is estimated as product of (i) carbon emission factor for fuel used (tCO_2/MJ), and (ii) oxidation factor for the thermal device.

Baseline electricity and thermal energy consumptions should be estimated as the average of the historical 3 years consumption.

Project Emissions

The project activity might include one or more AWMS to treat the manure. For example, the manure might be first treated in an anaerobic digester and the treated waste might be further processed using an aerobic pond. Each AWMS is referred to as a treatment stage.

Project emissions are estimated as follows:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y} + PE_{CH4\_IC,y} + PE_{elec/heat} \quad (7)$$

$PE_{AD,y}$	Leakage from AWMS systems that capture's methane
$PE_{Aer,y}$	methane emissions from AWMS that aerobically treats the manure
$PE_{N2O,y}$	Nitrous oxide emission from project manure waste management system
$PE_{PL,y}$	Leakage of emissions from biogas network to flare the captured methane or supply to the facility where it is used for heat and/or electricity generation
$PE_{CH4\_IC,y}$	In complete combustion of methane in flaring, heat, electricity etc.

(i) Methane emissions from AWMS where gas is captured ($PE_{AD,y}$):

IPCC guidelines specify physical leakage from anaerobic digesters as being 15% of total biogas production. Where project participants use lower values for percentage of physical leakage, they should provide measurements proving that this lower value is appropriate for the project.

Ex-ante leakage to be reported in the CDM-PDD will be estimated using equation 7a-1 or 7a-2 below, with an leakage factor of 0.15 or a lower value, if properly justified through documented evidence.

If project case AWMS is anaerobic digester only, then use equation (7a-1) , else use equation (7a-2).

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} (B_{0,LT} * \sum_{m} N_{LT,m} \cdot VS_{LT,m}) \quad (7a\text{-}1)$$

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \left[\prod_{n=2}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{LT} (B_{0,LT} * \sum_{m} N_{LT,m} \cdot VS_{LT,m}) \quad (7a\text{-}2)$$

LF_{AD}	methane leakage from Anaerobic digesters, default of 0.15
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).
F_{AD}	Fraction of volatile solid treated in Anaerobic digester. The project proponents shall provide the values based on proven test results. In absence of such values the conservative value of volatile solids treated in Annex 2 shall be used.
$R_{VS,n}$	Fraction of volatile solid treated in AWMS stage n. The project proponents shall provide the values based on proven test results. In absence of such values the conservative value of volatile solids treated in Annex 2 shall be used.
LT	index for livestock type
$B_{0,LT}$	CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the Baseline methodology section.
$VS_{LT,m}$	volatile solid excretion for month m of livestock type LT on a dry-matter basis in kg/animal/month.
$N_{LT,m}$	population of livestock type LT.

As noted in equation (7a), not all volatile solids are degraded in the Anaerobic digester. If the undegraded volatile solid in the effluent from anaerobic digester is discharged outside the project boundary without further treatment, these emissions should be treated as leakage and appropriately reported and accounted.

(ii) Methane emissions from aerobic AWMS treatment ($PE_{Aer,y}$):

IPCC guidelines specify emissions from aerobic lagoons as 0.1% of total methane generating potential of the waste processed.

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{LT} (B_{0,LT} * \sum_{m} N_{LT,m} \cdot VS_{LT,m}) + PE_{Sl,y} \quad (7b)$$

$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method n of the N treatment steps prior to waste being treated in Aerobic lagoon.
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).
F_{AD}	Fraction of volatile solid treated in Anaerobic digester. The project proponents shall provide the values based on proven test results. In absence of such values the conservative value of volatile solids treated in Annex 2 shall be used.
LT	index for livestock type
$B_{0,LT}$	CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the Baseline methodology section.
$VS_{LT,m}$	volatile solid excretion for month m of livestock type LT on a dry-matter basis in kg/animal/month.
$N_{LT,m}$	population of livestock type LT.

Aerobic treatment results in large accumulations of sludge. Sludge requires removal and has large VS values. It is important to identify the next management process for the sludge and estimate the emissions from that management process. If the sludge ponds are not within the project boundary, the emissions should be included in leakages. The emissions from sludge ponds shall be estimated as follows:

$$PE_{Sl,y} = GWP_{CH4} * MCF_{Sl} * B_o * \sum_{t=1}^{T} (COD_{Sl,y,t} * F_{Sl,y,t}) \quad (7b\text{-}1)$$

$PE_{Sl,y}$	CH_4 emissions from sludge disposed of in storage pit prior to disposal during the year y, expressed in tons of CO_2 equivalents.
$COD_{Sl,y}$	Chemical oxygen demand of the Sludge during year y in tCOD/tSludge measured T times a year.
$F_{Sl,y}$	Is the manure flow to the treatment stage i during the year y in tonnes, accumulated over period 1/T year.
MCF_{Sl}	methane conversion factor (MCF) for the sludge stored in sludge pits. Project proponents can use a default value of 0.9 or use the procedure defined in Baseline emission section.
B_0	Methane producing capacity, tCH_4/tCOD, IPCC default value of 0.21should be used.
GWP_{CH4}	Is the approved Global Warming Potential (GWP) of CH_4.

(iii) N_2O emissions from manure management

$$PE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} \sum_{mmi} E_{N20,mmi,y} \quad (7C)$$

where,

GWP_{N2O}	Global Warming Potential (GWP) for N_2O.
$CF_{N2O-N,N}$	conversion factor N_2O-N to N_2O (44/28).

$E_{N2O,mmi,y}$	N_2O emission from the i[th] treatment process/technology of the manure management system expressed in kg N_2O-N.

The same method, as used here to estimate the emissions in the baseline, is used to estimate the project emissions of nitrous oxide.

$$E_{N2O,mmi,y} = EF_{N2O,mmi} * \left[\prod_{n=1}^{mmi-1}(1 - R_{N,mmi})\right] * \sum_{LT}(NEX_{LT,m} \cdot \sum_{m} N_{LT,m}) \qquad (7c\text{-}1)$$

where:

$E_{N2O,mmi,y}$	Are the nitrous oxide emissions from the i[th] stage of the manure management systems in tonnes of CO_2 equivalents per year.
$EF_{N2O,mmi}$	Is the N_2O emission factor for the treatment stage i of the manure management system in kg N_2O-N/kg N (EF_3 in 1996 Revised IPCC Guidelines and IPCC GPG).
NEX_{LT}	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.
$R_{N,mmi}$	Is the relative reduction of nitrogen in the treatment stage n in per cent. The project proponents shall provide the values based on proven test results. In absence of such values the conservative value of volatile solids treated in Annex 2 shall be used.

<u>Estimation of parameters and variables in equations 7c-1:</u>

i. $EF_{N2O,1}$ should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 4.12 and Table 4.13 of the IPCC GPG 2000 may be used.
ii. NEX should be estimated as described in Annex 3.

<u>(iv) Leakage from distribution network of the captured methane in (PE_{PL})</u>

This refers to leaks in the biogas system from the biogas pipeline delivery system. Although no proposal is set out here as to how to estimate the leaks, this is a purely project specific factor, the project developer must provide, justify and take into account specific data required to calculate related emissions when applying this methodology. Where these pipelines are short (ie, less than 2km, and for on site delivery only) there may be limited leakage where high quality materials are utilised in construction. To test this assertion, tests should be carried out annually to determine how much biogas (and finally methane) leaks.

<u>(iv) Inefficient combustion of captured methane flared or used for heat and/or electricity generation ($PE_{CH4\ IC,\ y}$):</u>

The combustion of biogas methane may give rise to significant methane emissions as a result of incomplete, or inefficient combustion. The three predominant potential routes for the destruction of methane are:

- Biogas flaring;
- Biogas use in heating systems;
- Biogas use for on site electricity generation.

Methane emissions should be quantified as follows.

$$PE_{CH4\_IC} = GWP_{CH4} * C_{CH4\_r} * D_{CH4} * \sum_{r} (V_r * (1 - f_r)) \quad (7d)$$

where:

r	index for flaring, heat generation and power generation
V_r	biogas supplied to combustion process r, expressed in volume (Nm^3)
C_{CH4}	methane concentration in biogas, expressed as fraction
f_r	Efficiency of combustion in process r

The flare efficiency (f_r) shall be calculated as:
- the fraction of time in which the flare is operational, i.e., the gas is being flared
- multiplied by the fraction of methane completely oxidised in the flare (can be measured as (1- fraction of methane in exhaust gas of the flare) when the flare is operational.

For this purpose, the methane content of the flare emissions should be measured at least quarterly. This procedure requires the use of enclosed flares. Project participants may assume a default efficiency of 99% for closed flares and 50% for open flare.
Default efficiency for efficiency of heat and electricity generation can be assumed as 99.5%, as per IPCC.

(iv) Project emissions from heat use and electricity use due to the project activity ($PE_{elec/heat}$):

$$PE_{elec/heat} = EL_y * CEF_d + HG_{Pr,y} * CEF_{Pr,therm,y} \quad (7e)$$

where,

$EL_{P,y}$	is the amount of electricity in the year y that is consumed at the project site for the project activity (MWh).
CEF_d	is the carbon emissions factor for electricity consumed at the project site during the project activity (tCO_2/MWh), estimated as described below. Factor is zero if biogas is used to produce electricity.
$HG_{PR,y}$	is the quantity of thermal energy consumed in year y at the project site due to the project activity (MJ).
$CEF_{Pr,therm,y}$	is the CO_2 emissions intensity for thermal energy generation (tCO_2e/MJ), estimated as per method described for baseline thermal energy use. Factor is zero if biogas is used for generating thermal energy.

Determination of CEF_d: Where the project activity involves electricity generation from biogas, CEF_d should be chosen as follows:

- In case the generated electricity from the biogas displaces electricity that would have been generated in an on-site fossil fuel fired power plant in the baseline, the default emission factor for a diesel generator with a capacity of more than 200 kW for small-scale project activities (0.8 tCO2/MWh, see AMS 1.D.1 in the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories).
- In case the generated electricity from the biogas displaces electricity that would have been generated in other power plants in the grid in the baseline, CEF_d should be calculated according to methodology ACM0002 ("Consolidated baseline methodology for grid-connected electricity generation from renewable sources"). If electricity generation is less than small scale threshold (15 GWh/year), AMS. 1.D.1 may be used.

Leakage

Leakage covers the emissions from land application of treated waste, outside the project boundary. These emissions are estimated as net of those released under project activity and those released in the baseline scenario. The leakage are taken into account only if the leakage is positive, else leakage is ignored.

$$LE_y = (LE_{P,N2O} - LE_{B,N2O}) + (LE_{P,CH4} - LE_{B,CH4}) \quad (9)$$

Where,

$LE_{P,N2O}$	Are the N_2O emissions released during project activity from land application of the treated waste water, in tCO_2e/year.
$LE_{B,N2O}$	Are the N_2O emissions released during baseline scenario from land application of the treated waste water, in tCO_2e/year.
$LE_{P,CH4}$	Are the CH_4 emissions released during project activity from land application of the treated waste water, in tCO_2e/year.
$LE_{B,CH4}$	Are the CH_4 emissions released during baseline scenario from land application of the treated waste water, in tCO_2e/year.

(i) Estimation of N_2O emissions:

$$LE_{B,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * (LE_{N2O,land} + LE_{N2O,runoff}) \quad (9a)$$

$$LE_{N2O,land} = EF_1 * (1 - F_{GASM}) * (1 - R_N) * \sum_{LT} NEX_{LT} \cdot N_{LT} \quad (9a\text{-}1)$$

$$LE_{N2O,runoff} = EF_5 * (1 - F_{GASM}) * F_{Leach} * (1 - R_N) * \sum_{LT} NEX_{LT} \cdot N_{LT} \quad (9a\text{-}2)$$

where,

$LE_{N2O,land}$	Direct nitrous oxide emission from application of manure waste, in Kg N_2O-N/year.
$LE_{N2O,runoff}$	Nitrous oxide emission due to leaching and run-off, in Kg N_2O-N/year.
F_{gasm}	Fraction of animal manure N that volatizes as NH_3 and NO_X in kg NH_3-N and NO_X-N per kg of N, use IPCC default as per Table 4.19 of IPCC 1996 Revised Inventory reference book.
N_{LT}	Number of animals of type LT
NEX_{LT}	Average annual N excretion per head per animal category LT in kg - N/animal-year.
EF_1	Emission factor for direct emission of N_2O from soils in Kg N_2O-N/kg N, use IPCC defaults.
EF_5	Emission factor for indirect emission of N_2O from runoff in Kg N_2O-N/kg N, use IPCC defaults as per Table 4.24 of IPCC 1996 Revised Inventory reference book.
F_{leach}	Fraction of N that is leached or is in runoff.
$CF_{N20-N,N}$	Conversion factor (= 44/28).

$R_{N,n}$	Fraction of NEX in manure waste that is reduced in the Baseline AWMS. The relative reduction of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in Annex 2.

Estimation of parameters and variables in equations 9a-1 and 9a-2:

i. EF_1 and EF_5 should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from Table 4.17 and Table 4.18, respectively, of the IPCC GPG 2000 may be used.

ii. NEX should be estimated as per details provided in Annex 3.

The project case N_2O emissions are estimated using following equations:

$$LE_{P,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * (LE_{N2O,land} + LE_{N2O,runoff}) \qquad (9b)$$

$$LE_{N2O,land} = EF_1 * (1 - F_{GASM}) * \sum N_{DM} * Q_{DM} \qquad (9b\text{-}1)$$

$$LE_{N2O,runoff} = EF_5 * (1 - F_{GASM}) * F_{Leach} * \sum N_{DM} * Q_{DM} \qquad (9b\text{-}2)$$

where

N_{DM}	is the measured N concentration in manure disposed outside project boundary, measured for each batch disposed, in tN_20-N/t effluent.
Q_{DM}	is the quantity of each batch of manure disposed outside the project boundary.

(ii) Methane emissions from disposal of treated manure

The calculation of methane emissions is based on the chemical oxygen demand (COD) of the treated manure, which is disposed of:

$$LE_{B,CH4} = GWP_{CH4} * \left[\prod_{n=1}^{N} (1 - R_{VS,n})\right] * \sum_{LT} (B_{0,LT} * \sum_{m} N_{LT,m} * VS_{LT,m}) \qquad (6b)$$

$$LE_{P,CH4} = GWP_{CH4} * B_o * \sum_{t=1}^{T} (COD_{DM,} * Q_{DM}) \qquad (9c)$$

$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment in the various AWMS used. In case of baseline the value is o and N=1.
LT	index for livestock type
$B_{0,LT}$	CH_4 production capacity from manure for livestock type LT, in m^3 CH_4/kg-VS, to be chosen based on procedure provided for in the Baseline methodology section.
$VS_{LT,m}$	volatile solid excretion for month m of livestock type LT on a dry-matter basis in kg/animal/month.

COD_{DM}	Chemical oxygen demand of the each batch of disposed manure, in tCOD/t disposed manure, measured at time of disposal.
B_0	Methane producing capacity, tCH_4/tCOD, IPCC default value of 0.21should be used.
GWP_{CH4}	Is the approved Global Warming Potential (GWP) of CH_4.

As a further conservative assumption, it is assumed in equation 9c that all degradable carbon in the treated manure would be oxidized to methane (no methane conversion factor is considered).

Emission Reduction

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

$$ER_y = BE_y - PE_y - LE_y \qquad (10)$$

Note, LE is only deducted if the components of leakage due to N_2O and CH_4 are negative. If any of this component is positive that component of leakage is ignored.
Further, in estimating emissions reduction for claiming certified emissions reductions, if the actual methane captured from an anaerobic digester is lower than ($BE_{CH4,y}$ - $PE_{AD,y}$), where $BE_{CH4,y}$ is estimated using equation (1a) and $PE_{AD,y}$ is estimated using equation 7a, then ($BE_{CH4,y}$ - $PE_{AD,y}$) in equation 10 is replaced by actual methane captured. The value of the actual methane captured and flared should be multiplied by the flare efficiency. Flare efficiency is estimated as per procedure explained above and monitored as per the monitoring methodology.

Draft approved consolidated monitoring methodology ACM00XX

"Consolidated baseline methodology for GHG emission reductions from manure management systems"

Source

This consolidated monitoring methodology is based on elements from the following methodologies:

- AM0006: "GHG emission reductions from manure management systems", based on the CDM-PDD "Methane capture and combustion of swine manure treatment for Peralillo" whose baseline study, monitoring and verification plan and project design document were prepared by Agricola Super Limitada. For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0022: "Methane capture and combustion of swine manure treatment for Peralillo" on http://cdm.unfccc.int/methodologies/approved.
- AM0016: "Greenhouse gas mitigation from improved Animal Waste Management Systems in confined animal feeding operations", whose baseline study, monitoring and verification plan and project design document were prepared by AgCert Canada Co. on behalf of Granja Becker, L.B.Pork, Inc. and AgCert Canada Co.For more information regarding the proposal and its consideration by the Executive Board please refer to case NM0034-rev.2: "Granja Becker GHG Mitigation Project" on http://cdm.unfccc.int/methodologies/approved.

For more information regarding the proposals and their consideration by the Executive Board please refer to:

- case NM0022: "Methane capture and combustion of swine manure treatment for Peralillo"; and
- case NM0034-rev.2: "Granja Becker GHG Mitigation Project"

on http://cdm.unfccc.int/methodologies/approved.

Applicability

This methodology is applicable generally to manure management on livestock farms where the existing manure management system, within the project boundary, is replaced by one or more than one animal waste management system (AWMS)/process that result in less GHG emissions.

This methodology is applicable to manure management projects with the following conditions:

- Farms where livestock populations, comprising of Cattle, buffalo, swine, sheep, goats, and/or poultry, is managed under confined conditions;
- Farms where manure is not discharged into natural water resources (e.g. rivers or estuaries);
- The depth of the anaerobic lagoons used for manure management under the baseline scenario should be at least 1m[4];
- The temperature of the anaerobic lagoons is higher than 10°C. If the monthly average temperature is less than 10 °C, this month is not included in the estimations, as it is assumed that no anaerobic activity occurs below such temperature..

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[4] In particular, loading in the waste water streams has to be high enough to assure that the lagoon develops an anaerobic bottom layer and that algal oxygen production can be ruled out.

- In the baseline case, the minimum retention time of manure waste in the anaerobic lagoon is greater than 1 month.

*The AWMS/process in the project case should ensure that no leakage of manure waste into ground water takes place, for e.g., the lagoon should have a non-permeable layer at the lagoon bottom.*This baseline methodology shall be used in conjunction with the approved baseline methodology ACM00XX (Consolidated baseline methodology for GHG emission reductions from manure management systems).

Monitoring Methodology

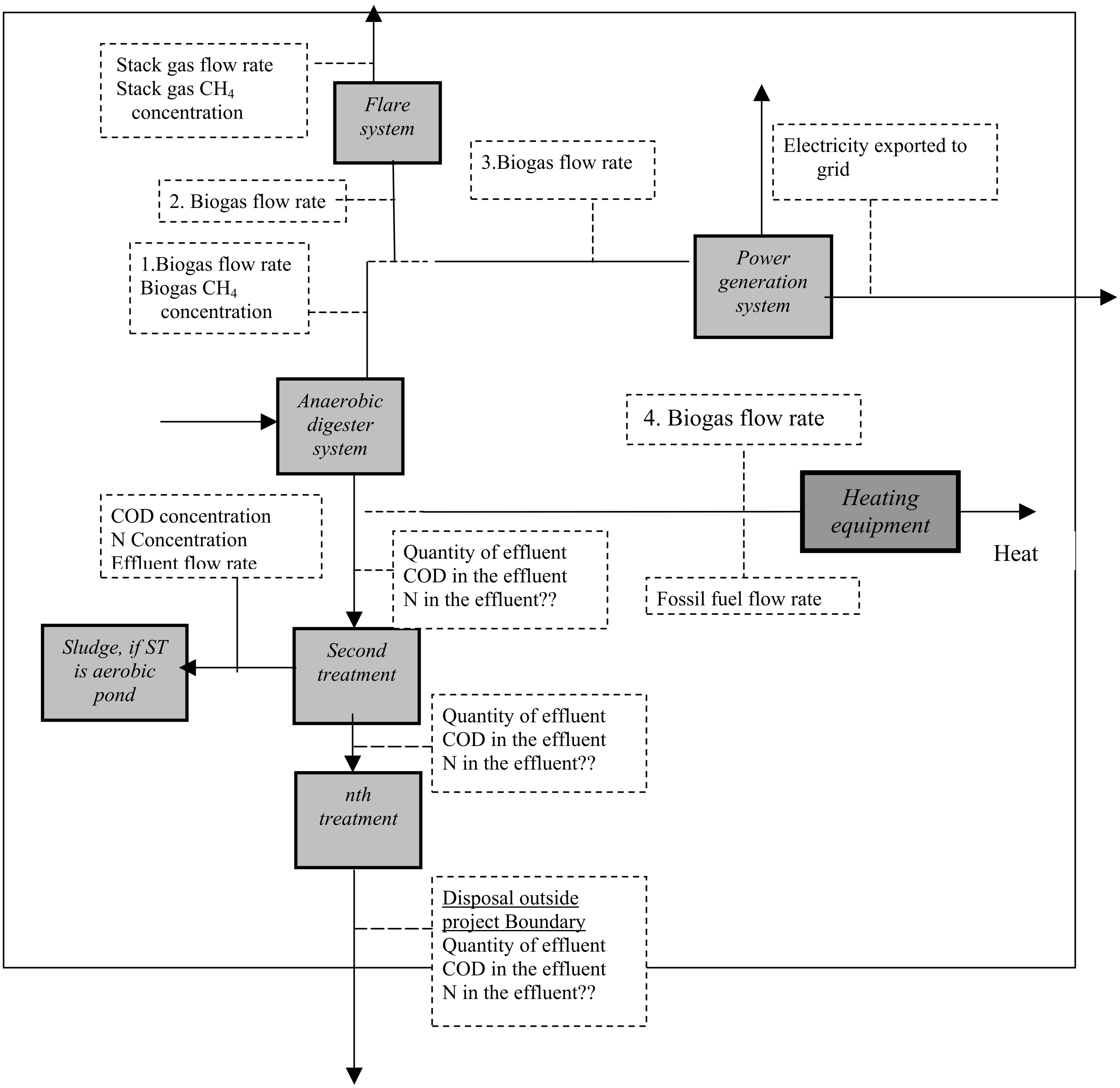
In this methodology, monitoring comprises several activities.

Baseline emissions:
- Diagrammatic representation of animal waste management system existing on the project site prior to project implementation.
- Parameters MCF, B_o, and R_{VS} for estimating methane emissions from AWMS in the baseline.
- EF_{N2O} and R_N for estimating nitrogen emission from AWMS in the baseline;
- Ambient temperature at the AWMS site;
- Depth of the baseline AWMS, if relevant;
- Amount of electricity used for the operation of the AWMS in the baseline;
- Amount of fossil fuel used for the operation of the AWMS in the baseline;
- Biogas based electricity exported to the grid, needs to be monitored only if emissions reduction for electricity generation from biogas are claimed;
- Data and parameters for estimating heat and electricity emission factors.

Project emissions:
- The livestock populations by different livestock types. This includes the heads of each population and the average animal weight in each population;
- Parameters MCF, B_o, and R_{VS} for estimating methane emissions from AWMSs in the project case.
- EF_{N2O} and R_N for estimating nitrogen emission from AWMS in the baseline.
- The default volatile solid excretion values or other parameters required for estimating the volatile solids. If dietary intake method is used, the feed intake of animals and its energy will be monitored.
- Leakage from anaerobic digester, if used. The default value is 15%, but in case project participants use a lower value, the appropriate measurement to support the lower value shall be monitored and reported.
- MCF value for Sludge storage system, if the project uses aerobic lagoon to process animal waste. A default value of 0.9 may be used. If sludge from system is disposed outside the project boundary, then this shall be covered as leakage.
- The default nitrogen excretion per animal or parameters required to estimate nitrogen excretion. If N intake method is used the amount of dry matter intake by livestock shall be monitored;
- Amount of electricity used for the operation of the AWMS in the project case;
- Amount of heat used for the operation of the AWMS in the project case;
- Flow of biogas to the flare, heat generation, and electricity generation.
- Flare operation, i.e., time of the year when the flare is operational when the biogas is flowing through the flare;
- Concentration of methane in biogas at outlet of anaerobic digester;
- Concentration of methane in flue gases of the flare;
- Biogas leakage in project: through leaks in the pipeline during transportation of biogas.

<u>Leakage:</u>

- Nitrogen concentration and COD in waste water/sludge disposed outside the project boundary;



Baseline Emissions:

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
1	Classi-fication	Type of barn and AWMS	Type	m				Duration of project + 5 yrs	Barn and AWMS layout and configuration.
2. MCF	Factor	Methane correction factor	Fraction	c	Annual	100%		Duration of project + 5 yrs	The factor MCF is estimated using formulae provided in Equation 4a in the Baseline methodology. The
3. $B_{o,LT}$	Factor	Max methane production	Fraction	e	Annual	100%		Duration of project + 5 yrs	The value is taken from published sources. The parameter value should be updates on latest available public data source.
4. R_{VS}	Factor	VS degradation factor	Fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 2.
5. EF_{N2O}	Emission factor	N_2O emission from manure manage-ment system	kg N_20-N/ kg N	e	Annually	100%	Electronic	Duration of project + 5 yrs	

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
7. T_2	Tempe-rature	Ambient temperature at Project site	^oKelvin	m	Monthly	100%	Electronic	Duration of project + 5 yrs	Used in equation ##.
8.	Depth	Depth of AWMS	m	m	at start of project	100%	Electronic	Duration of project + 5 yrs	This is relevant if a lagoon is AWMS. In case existing AWMS at project site is different from identified baseline AWMS, the depth should be based on general depth of similar system in the area.
9 EG_y	Electricity	Electricity consumptio n by Baseline AWMS	MWh	m	at start of project	100%	Electronic	Duration of project + 5 yrs	Estimation is based on three years data prior to start of the project.
10. $CEF_{baseline, elec}$	Emission factor	Emission factor of baseline electricity use	tCO_2/MWh	c	at start of project	100%	Electronic	Duration of project + 5 yrs	Calculated as per procedure described in the baseline methodology.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
10.$EG_{d,y}$	Electri-city	Electri-city exported to grid	MWh	m	Annual	100%	Electronic	Duration of project + 5 yrs	
11. CEF_d	Emission factor	Emission factor of exported electri-city	tCO_2/MWh	c	Annual	100%	Electronic	Duration of project + 5 yrs	Calculated as per procedure described in the baseline methodology.
12. HG	Heat	Heat used by baseline AWMS	MJ	m	At start of project	100%	Electronic	Duration of project + 5 yrs	Estimation is based on three years data prior to start of the project.
10. $CEF_{baseline,therm}$	Emission factor	Emission factor of baseline heat use	tCO_2/MJ	c	At start of project	100%	Electronic	Duration of project + 5 yrs	Calculated as per procedure described in the baseline methodology.

Project Emissions:

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived ?	For how long is archived data to be kept?	Comment
1. N	Numbers	Livestock population	number	m	Monthly	100%	Electronic	Duration of project + 5 yrs	The PDD should describe the system on monitoring the numbes.
2. W	Weight	Weight of livestock	kg	m	Monthly	100%	Electronic	Duration of project + 5 yrs	The PDD should describe the system on monitoring the numbes.
3. $B_{o,LT}$	Factor	Max methane production	fraction	e	Annual	100%		Duration of project + 5 yrs	The value is taken from published sources. The parameter value should be updates on latest available public data source.
4. R_{VS}	Factor	VS degradation factor	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 2.
5. EF_{N2O}	Emission factor	N_2O emission from manure manage-ment system	kg N_20-N/ kg N	e	Annually	100%	Electronic	Duration of project + 5 yrs	
6. R_N	Factor	Nitrogen degradation factor	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 2.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
7. LF	Factor	leakage from anaerobic digester	fraction	m	????	100%	Electronic	Duration of project + 5 yrs	A default value of 0.15 can be used. In case Project participants use project specific value, they shall describe the method as well frequency of measuring the leakage factor in CDM-PDD.
8. MCF_{SL}	Factor	Methane conversion factor for sludge pits	fraction	m	annually	100%	Electronic	Duration of project + 5 yrs	If the sludge pit are not included in the project boundary, they shall be reported in the leakage.
9.EL_y	Electri-city	Electricity used in Project AWMSs	MWh	m	annual	100%	Electronic	Duration of project + 5 yrs	
10. CEF_y	Emis-sion factor	Emission factor of exported electricity	tCO_2/MWh	c	annual	100%	Electronic	Duration of project + 5 yrs	Calculated as per procedure described in the baseline methodology. If electricity used is produced using biogas, the factor is zero.
11. HG_y	Heat	Heat used by baseline AWMS	MJ	m	at start of project	100%	Electronic	Duration of project + 5 yrs	
12. $CEF_{project, therm}$	Emis-sion factor	Emission factor of baseline heat use	tCO_2/MJ	c	at start of project	100%	Electronic	Duration of project + 5 yrs	Calculated as per procedure described in the baseline methodology. If heat used is produced using biogas, the factor is zero.

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
13. V_r		Biogas flow	Nm^3	m	Continuously by flow meter and reported cumulatively on Weekly basis	100%	Electronic	Duration of project + 5 yrs	The biogas flow will be measured at 4 points, as shown in the figure. But if the project participants can demonstrate that leakage in distribution pipeline is zero, it need be measured at any three points.
14.	Concen-tration	methane fraction of biogas	Fraction	m	to be decided by PPs.	100%	Electronic	Duration of project + 5 yrs	The project proponents shall define the variability of the concentration. They shall also define the error in estimate for different level of measurement frequency. The level of accuracy will be deducted from average concentration of measurement.
15. f_{fl}	Fraction	Flare efficiency%		m / c	(1) Continuously (2) quarterly, monthly if unstable	n/a	Electronic	During the crediting period and two years after	(1) Periodic measurement of methane content of flare exhaust gas. (2) Continuous measurement of operation time of flare (e.g. with temperature)

Leakage:

ID number	Data type	Data variable	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived?	For how long is archived data to be kept?	Comment
1. EF_1, EF_5	Emission factor	N_2O emission from soil and runoff water	kg $N_2$0-N/ kg N	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC default values from Table 4.17, for EF_1, and Table 4.18, for EF_5, of the IPCC GPG 2000 may be used, if country specific or region specific data are not available.
2. F_{gasm}		N lost due to volatilization	fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC default value, as per Table 4.19 of IPCC Revised Inventory reference book, can be used.
3. F_{Leach}		Fraction of N leached	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	IPCC default value, as per Table 4-24 of IPCC Revised Inventory reference book, can be used.
4.N_{DM}		N concentration in disposed manure	tN20-N/t effluent	m	Every batch disposed	100%	Electronic	Duration of project + 5 yrs	
5.Q_{DM}	Mass	Mass of manure disposed outside project boundary	tons	m	Every batch disposed	100%	Electronic	Duration of project + 5 yrs	
6. $COD_{DM,}$	Activity level	COD of disposed manure	tCOD/t effluent	m	Every batch disposed	100%	Electronic	Duration of project + 5 yrs	

ANNEX 1: Steps to Estimate $f_{t,monthly}$

The $f_{t,monthly}$ is calculated as follows:

(1) The monthly average temperature for the area is obtained from published national weather service information[5].
(2) Monthly temperatures are used to calculate a monthly 'f_t' factor above. A minimum temperature of 10° C is used.
(3) Estimate monthly production of volatile solids (VS_m) added to the system.
(4) The amount of volatile solids available for conversion to methane is assumed to be equal to the amount of volatile solids produced during the month (from step 3). The amount of volatile solids available also includes volatile solids that may remain in the system from previous months.
(5) The amount of volatile solids consumed during the month is equal to the amount available for consumption multiplied by the 'f_t' factor.
(6) For anaerobic lagoons, the amount of volatile solids carried over from one month to the next equals to the amount available for conversion minus the amount consumed and minus the amount removed from the lagoon. In the case of the emptying of the lagoon, the accumulation of volatile solids restarts with the next inflow. For partial removal (e.g., dewatering for irrigation) the volatile solid carryover should be reduced by an amount that is proportional to the partial fraction (of the lagoon's storage capacity or 'HRT') that is removed.
(7) The estimated amount of methane generated ($CH_{4,m}$) during the month is equal to the monthly volatile solids consumed multiplied by the maximum methane potential (B_0).

[5] www.weatheronline.co.uk, for instance, provides access to published data for a wide range of global locations

ANNEX 2: % of VS degraded by different AWMS.

Table 8-10. Anaerobic Unit Process Performance

Anaerobic Treatment	HRT	COD	TS	VS	TN	P	K
	days	Percent Reduction					
Pull plug pits	4-30	—	0-30	0-30	0-20	0-20	0-15
Underfloor pit storage	30-180	—	30-40	20-30	5-20	5-15	5-15
Open top tank	30-180	—	—	—	25-30	10-20	10-20
Open pond	30-180	—	—	—	70-80	50-65	40-50
Heated digester effluent prior to storage	12-20	35-70	25-50	40-70	0	0	0
Covered first cell of two cell lagoon	30-90	70-90	75-95	80-90	25-35	50-80	30-50
One-cell lagoon	>365	70-90	75-95	75-85	60-80	50-70	30-50
Two-cell lagoon	210+	90-95	80-95	90-98	50-80	85-90	30-50

HRT=hydraulic retention time; COD=chemical oxygen demand; TS=total solids; VS=volatile solids; TN=total nitrogen; P=phosphorus; K= potassium; — =data not available.

Source: Moser and Martin, 1999

ANNEX 3: Procedure for estimating NEX

$$NEX = N_{intake} * (1 - N_{retention}) \quad (1)$$

where,

N_{intake}	The annual N intake per animal – kg N/animal-year.
$N_{retention}$	The portion of that N intake that is retained in the animal. (default values are reported in Table 4.15 in IPCC GPG 2003)

N_{intake} may be calculated using: $N_{intake} = DM * \frac{P}{6.25}$ (1a)

where,

P	Percent of protein (decimal).
DM	Intake volume of dry matter in kg/day

In absence of availability of project specific information on Protein intake, which should be justified in the CDM-PDD, site-specific national or regional data should be used for the nitrogen excretion NEX, if available. In the absence of such data, default values from Table 4.20 in the IPCC Guidelines (adjusted with the factors in Table 4.14 of the IPCC GPG for young animals) may be used and should be corrected for the animal weight at the project site in the following way:

$$NEX_{site} = \frac{w_{site}}{w_{default}} \cdot NEX_{IPCCdefault} \quad (2)$$

where:

NEX_{site}	Is the adjusted annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year.
w_{site}	Is the average animal weight of a defined population at the project site in kg.
$w_{default}$	Is the default average animal weight of a defined population in kg.
$NEX_{IPCCdefault}$	Is the default value (IPCC or US-EPA) for the nitrogen excretion per head of a defined livestock population in kg N/animal/year.