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 manure treatment system, 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);

- In case of anaerobic lagoons treatments systems, the depth of the lagoons used for manure management under the baseline scenario should be at least 1m[1].
- The annual average temperature in the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C.
- In the baseline case, the minimum retention time of manure waste in the anaerobic treatment system 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, 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:

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

<u>Step I: Define alternative scenarios to the proposed CDM project activity</u>

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 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Chapter 10, Table 10.17) 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 judgments from industry, educational institutions (e.g. universities, technical schools, training centers), 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 III (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 II. 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 "Identification of the baseline scenario" 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

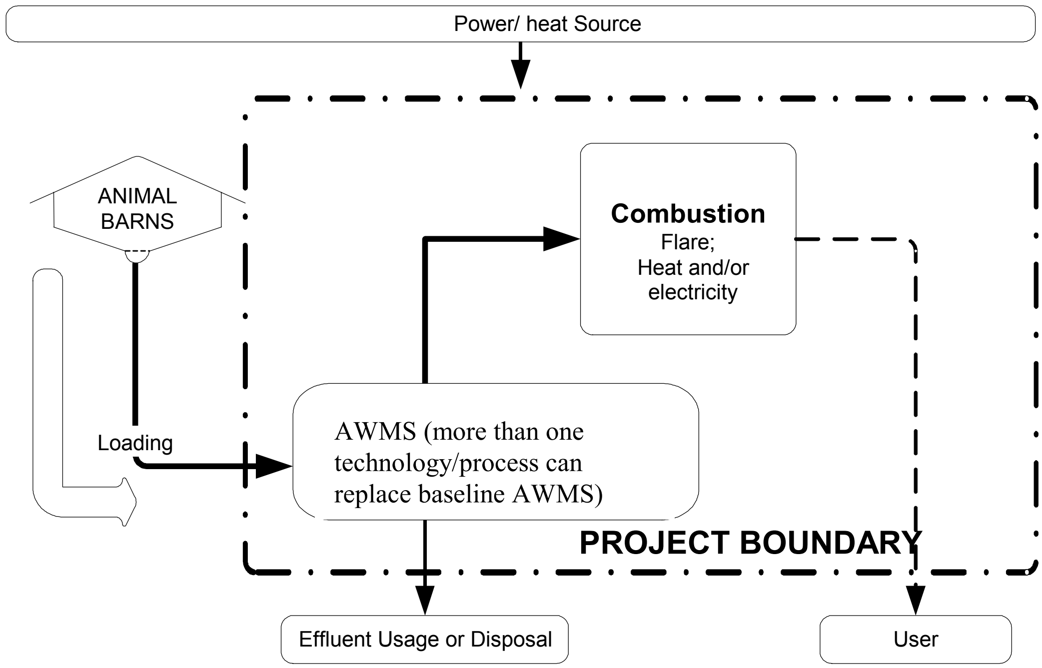

Figure 1: Project activity boundary

	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.

	Source	Gas		Justification / Explanation
Project Activity	Emissions from thermal energy generation	CO_2	Included	May be an important emission source
		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.
	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, physical leakage, and minor CH4 emissions from aerobic treatment.

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 AWMSs identified through the baseline selection procedure.

Baseline emissions are:

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

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 N_2O emissions in year y, in tCO_2e/year.
$BE_{elec/heat,y}$	Baseline CO_2 emissions from electricity and/or heat used in the baseline, in tCO_2e/year.

(i) Methane emissions

Manure management system in the baseline could be based on different treatment systems and on one or more stages. Therefore:

$$BE_{CH4,y} = GWP_{CH4} \cdot D_{CH4} * \sum_{j,LT} MCF_{annual,j} * B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{j} \qquad \textbf{(2)}$$

Where:

$BE_{CH4,y}$	Is the annual baseline methane emissions in t CO2e/y
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).
$MCF_{annual,j}$	Annual methane conversion factor (MCF) for the baseline $AWMS_j$ from IPCC 2006 table 10.17, chapter 10, volume 4.
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated, in m^3CH_4/kg_dm, by animal type LT.
N_{LT}	Number of animals of type LT for the year y, expressed in numbers.
$VS_{LT,y}$	Annual volatile solid for livestock LT entering all AWMS [on a dry matter weight basis (kg-dm/year), as estimated below.
$MS\%_j$	Fraction of manure handled in system j

Estimation of various variables and parameters for above equations:

(A) $VS_{LT,y}$ can be determined in one of the following ways, stated in the order of preference:

1. Using published country specific data. If the data is expressed in kg dm per day, multiply the value with nd_y (number of days in year y).

2. Estimation of VS based on dietary intake of livestock

$$VS_{LT,y} = \left[GE_{LT} * \left(1 - \frac{DE_{LT}}{100}\right) + \left(UE * GE_{LT}\right)\right] * \left[\left(\frac{1 - ASH}{ED_{LT}}\right)\right] * nd_y \qquad \textbf{(3)}$$

Where:

$VS_{LT,y}$	*Annual volatile solid excretions on a dry matter weight basis (kg-dm/year)*
GE_{LT}	*Daily average gross energy intake in MJ/day*
DE_{LT}	*Digestible energy of the feed in percent (IPCC 2006 defaults available)*
$UE*GE_{LT}$	*Urinary energy expressed as fraction of GE. Typically 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available*
ASH	*Ash content of manure calculated as a fraction of the dry matter feed intake. Use country-specific values where available.*

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.*
nd_y	*Number of days in year y where the treatment plant was operational.*

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

$$VS_{LT,y} = \left(\frac{w_{site}}{w_{default}} \right) \cdot VS_{default} \cdot nd_y \qquad \textbf{(4)}$$

Where:

$VS_{LT,y}$	Adjusted volatile solid excretion per year on a dry-matter basis for a defined livestock population at the project site in kg-dm/animal/yr.
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 (IPCC 2006 or US-EPA, which ever is lower).
$VS_{default}$	Default value (IPCC 2006 or US-EPA, which ever is lower) for the volatile solid excretion per day on a dry-matter basis for a defined livestock population in kg-dm/animal/day.
nd_y	Number of days in year y.

4. Utilizing published IPCC defaults, multiply the value with nd_y (number of days in year y).

Developed countries $VS_{LT,y}$ values can be used provided the following conditions can be satisfied:

- The genetic source of the production operations livestock originate from an Annex I Party
- The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics
- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.)
- The project specific animal weights are more similar to developed country IPCC default values

The following sources should be used to calculate baseline emissions:

- IPCC 2006 guidelines, volume 4, chapter 10;
- 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) Maximum Methane Production Potential ($B_{o,LT}$):

This value varies by species and diet. Where default values are used, they should be taken from tables 10A-4 through 10A-9 (IPCC 2006 Guidelines for National Greenhouse Gas Inventories volume 4, chapter 10) specific to the country where the project is implemented.

Developed countries $B_{o,LT}$ values can be used provided the following conditions are satisfied:

- The genetic source of the production operations livestock originate from an Annex I Party
- The farm use formulated feed rations (FFR) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics
- The use of FFR can be validated (through on-farm record keeping, feed supplier, etc.)
- The project specific animal weights are more similar to developed country IPCC default values

(C) Methane conversion factors (MCFs):

- The IPCC 2006 MCF values given in table 10.17 (chapter 10, volume 4) should be used. MCF values depend on the annual average temperature where the anaerobic manure treatment facility in the baseline existed. For average annual temperatures below 10 ^oC and above 5 ^oC, a linear interpolation should be used to estimate the MCF value at the specific temperature assuming an MCF value of 0 at an annual average of 5 ^oC. Future revisions to the IPCC Guidelines for National Greenhouse Gas Inventories should be taken into account.

- A conservativeness factor of 0.94 should be applied to MCF values to account for the 20% uncertainty in the MCF values as reported by IPCC 2006.

For subsequent treatment stages, the reduction of the volatile solids during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with volatile solids adjusted for the reduction from the previous treatment stages by multiplying by (1 - R_{VS}), where R_{VS} is the relative reduction of volatile solids from the previous stage. The relative reduction (R_{VS}) of volatile solids depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in Table 8.10 of chapter 8.2 in US-EPA (2001).[3] These values are provided in Annex 1.

(ii) N_2O emissions from manure management

$$BE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000}.(E_{N2O,D,y} + E_{N2O,ID,y}) \quad \textbf{(5)}$$

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

Where:

$BE_{N2O,y}$	Annual baseline N_2O emissions in t CO2e / yr
GWP_{N2O}	Global Warming Potential (GWP) for N_2O.
$CF_{N2O\text{-}N,N}$	Conversion factor N_2O-N to N_2O (44/28).
$E_{N2O,D,y}$	Direct N_2O emission in kg N_2O-N/year.
$E_{N2O,ID,y}$	Indirect N_2O emission in kg N_2O-N/year.

$$E_{N2O,D,y} = \sum_{j,LT}(EF_{N2O,D,j} \cdot NEX_{LT,y} \cdot N_{LT} \cdot MS_j) \qquad \textbf{(6)}$$

Where:

$E_{N2O,D,y}$	Are the direct nitrous oxide emissions in kg of N_2O per year.
$EF_{N2O,D,j}$	Is the direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available, otherwise use default EF_3 from table 10.21, chapter 10, volume 4, in the IPCC 2006 Guidelines for National Greenhouse Gas Inventories).
$NEX_{LT,y}$	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 2.
MS_j	Fraction of manure handled in system j, in %
N_{LT}	Number of animals of type LT for the year y, expressed in numbers.

$$E_{N2O,ID,y} = \sum_{j,LT}(EF_{N2O,ID,j} \cdot F_{GASM} \cdot NEX_{LT,a} \cdot N_{LT} \cdot MS_j) \qquad \textbf{(7)}$$

Where:

$E_{N2O,ID,y}$	Are the indirect nitrous oxide emissions in kg of N_2O per year.
$EF_{N2O,ID,j}$	Is the indirect N_2O emission factor for N_2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N_2O-N/kg NH3-N and NOx-N emitted, estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 Guidelines for National Greenhouse Gas Inventories can be used.
$NEX_{LT,y}$	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 2.
MS%j	Fraction of manure handled in system j
F_{GASM}	Percent of managed manure nitrogen for livestock category that volatilises as NH_3 and NOx in the manure management system.
N_{LT}	Number of animals of type LT for the year y, expressed in numbers.

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by (1 - R_N), where R_N is the relative reduction of nitrogen from the previous stage. The relative reduction (R_N) of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in Chapter 8.2 in US-EPA (2001).[4] These values are provided in Annex 1.

(iii) CO2 emission from electricity and heat within the project boundary

$$BE_{elec/heat,y} = EG_y \cdot CEF_{Bl,elec,y} + EG_{d,y} \cdot CEF_{gird} + HG_{BL,y} \cdot CEF_{Bl,therm,y} \quad \textbf{(8)}$$

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)

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 Table I.D.1 in the simplified baseline and monitoring methodology AMS.I.D 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), use 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 Table I.D.1 in the simplified baseline and monitoring methodology AMS.I.D 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), the method for the calculation of the grid emission factor in the simplified baseline methodology for small-scale CDM project activity AMS.I.D could be used.

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

Determination of $CEF_{Bl,therm}$:

$CEF_{Bl,therm}$ is the CO_2 emissions intensity for thermal energy generation (tCO2e/MJ).

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:

$$PE_y = PE_{AD,y} + PE_{Aer,y} + PE_{N2O,y} + PE_{PL,y} + PE_{CH4\_IC,y} + PE_{elec/heat} \quad \textbf{(9)}$$

$PE_{AD,y}$	Leakage from AWMS systems that capture's methane in t CO2e/yr
$PE_{Aer,y}$	Methane emissions from AWMS that aerobically treats the manure in t CO2e/yr
$PE_{N2O,y}$	Nitrous oxide emission from project manure waste management system in t CO2e/yr
$PE_{PL,y}$	Physical 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 in t CO2e/yr
$PE_{CH4\_IC,y}$	Incomplete combustion of methane in flaring in t CO2e/yr
$PE_{elec/heat}$	Project emissions from use of heat and/or electricity in the project case in t CO2e/yr

(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 10.a or 10.b below, with a leakage factor of 0.15 or a lower value, if properly justified through documented evidence (which should be verified by the DOE).

If project case AWMS is anaerobic digester only, then use equation (10.a), else use equation (10.b).

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \sum_{LT} (B_{0,LT} * N_{LT} * VS_{LT,y}) \quad \textbf{(10.a)}$$

$$PE_{AD,y} = GWP_{CH4} \cdot D_{CH4} * LF_{AD} * F_{AD} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j) \quad \textbf{(10.b)}$$

D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).
LF_{AD}	Methane leakage from Anaerobic digesters, default of 0.15 multiplied by methane content of biogas.
F_{AD}	Fraction of volatile solid directed to anaerobic digester.
$R_{VS,n}$	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 1 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.
$N_{LT,,}$	Population of livestock type LT for the year y, expressed in numbers.
$VS_{LT,y}$	Annual volatile solid excretion of livestock type LT on a dry-matter basis in kg/animal/year
$MS\%_j$	Fraction of manure handled in system j

As noted in equations (10.a) and (10.b), 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.

$$PE_{Aer,y} = GWP_{CH4} \cdot D_{CH4} * 0.001 * F_{Aer} * \left[\prod_{n=1}^{N}\left(1 - R_{VS,n}\right)\right] * \sum_{j,LT}(B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j) + PE_{Sl,y} \quad \textbf{(11)}$$

$R_{VS,n}$	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_{Aer}	Fraction of volatile solid directed to Aerobic system.
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.
$VS_{LT,y}$	Annual volatile solid excretion livestock type LT on a dry-matter basis in kg/animal/year.
N_{LT}	Population of livestock type LT for the year y, expressed in numbers..
$PE_{Sl,y}$	CH4 emissions from sludge disposed of in storage pit prior to disposal during the year y, expressed in tons of CO2e /yr.
$MS\%_j$	Fraction of manure handled in system j

Aerobic treatment results in large accumulations of sludge. Sludge requires removal and has large VS values. It is important to identify the following 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:

$$PE_{Sl,y} = GWP_{CH4} \cdot D_{CH4} * MCF_{sl} * F_{Aer} * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n}\right) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_{j}) \tag{12}$$

$R_{VS,n}$	Fraction of volatile solid degraded in AWMS treatment method *n* of the N treatment steps prior to sludge being treated. Values for Rvs should be taken from Annex 1.
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure).
F_{Aer}	Fraction of volatile solid directed to Aerobic system.
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.
$VS_{LT,y}$	Annual volatile solid excretion of livestock type LT on a dry-matter basis in kg/animal/year.
$N_{LT,}$	Population of livestock type LT for the year y, expressed in numbers.
$MS\%_j$	Fraction of manure handled in system j
MCF_{sl}	Methane conversion factor (MCF) for the sludge stored in sludge pits estimated as in the baseline emissions section.

(iii) N_2O emissions from manure management

$$PE_{N2O,y} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} . (E_{N2O,D,y} + E_{N2O,ID,y}) \tag{13}$$

Where:

$PE_{N2O,y}$	Annual project N_2O emissions in t CO2e / yr
GWP_{N2O}	Global Warming Potential (GWP) for N_2O.
$CF_{N2O-N,N}$	Conversion factor N_2O-N to N_2O (44/28).
$E_{N2O,D,y}$	Direct N_2O emission in kg N_2O-N/year.
$E_{N2O,ID,y}$	Indirect N_2O emission in kg N_2O-N/year.

$$E_{N2O,D,y} = \sum_{j,LT} (EF_{N2O,D,j} \cdot NEX_{LT,a} \cdot N_{LT} \cdot MS_{j}) \tag{14}$$

Where:

$E_{N2O,D,y}$	Are the direct nitrous oxide emissions in kg of N_2O per year.
$EF_{N2O,D,j}$	Is the direct N_2O emission factor for the treatment system j of the manure management system in kg N_2O-N/kg N (estimated with site-specific, regional or national data if such data is available. otherwise use default EF_3 in volume 4, chapter 10, table 10.21 in IPCC 2006 Guidelines).
$NEX_{LT,a}$	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 2.
MS_j	Fraction of manure handled in system j, in %.
N_{LT}	Population of livestock type LT for the year y, expressed in numbers.

$$E_{N2O,ID,y} = \sum_{j,LT} (EF_{N2O,ID,j} * F_{GASM} * NEX_{LT,a} * N_{LT} * MS\%_j) \quad \textbf{(15)}$$

Where:

$E_{N2O,y}$	Are the indirect nitrous oxide emissions in kg of N_2O per year.
$EF_{N2O,ID,j}$	Is the indirect N_2O emission factor for N2O emissions from atmospheric deposition of nitrogen on soils and water surfaces, kg N2O-N/kg NH3-N and NOx-N emitted ,estimated with site-specific, regional or national data if such data is available. Otherwise, default values for EF_4 from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
$NEX_{LT,a}$	Is the annual average nitrogen excretion per head of a defined livestock population in kg N/animal/year estimated as described in Annex 2.
$MS\%_j$	Fraction of manure handled in system j
F_{GASM}	Percent of managed manure nitrogen for livestock category that volatilises as NH3 and NOx in the manure management system
N_{LT}	Population of livestock type LT for the year y, expressed in numbers.

For subsequent treatment stages, the reduction of the nitrogen during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with nitrogen adjusted for the reduction from the previous treatment stages by multiplying by ($1-R_N$), where R_N is the relative reduction of nitrogen from the previous stage. The relative reduction (R_N) of nitrogen depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in Chapter 8.2 in US-EPA (2001).[5] These values are provided in Annex 1.

(iv) Physical Leakage from distribution network of the captured methane in (PE_{PL})

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 (i.e., less than 2 km, and for on site delivery only) there may be limited leakage where high quality materials are utilized in construction. To test this assertion, tests should be carried out annually to determine how much biogas (and finally methane) leaks.

(v) Inefficient combustion of captured methane flared ($PE_{CH4\_IC,y}$):

The combustion of biogas methane may give rise to significant methane emissions as a result of incomplete or inefficient combustion.

Methane emissions should be quantified as follows.

$$PE_{CH4\_IC} = GWP_{CH4} * C_{CH4} * D_{CH4} * V_f * (1-f) \quad \textbf{(16)}$$

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

Where:

V_f	biogas flared, expressed in volume (m^3)
C_{CH4}	methane concentration in biogas flared, expressed as fraction
f	Efficiency of flaring process

The flare efficiency (*f*) 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.

If an enclosed flare is used, the project participants shall measure and quantify the efficiency of the flare (% of methane completely oxidized by combustion in the flare) on a yearly basis, with the first measurement to be made at the time of installation. The measured value of the efficiency of the flare shall be applicable for the period up to the next measurement. In case the yearly measurement of efficiency of the flare is not performed, the efficiency of the flare shall be a default value of 90%. If the last measured value of efficiency of the flare is lower than 90%, then the last lower measured value shall be used. Project participants may assume a default efficiency of 90% for closed flares for the ex-ante calculations.
In case open flares are used, since flare efficiency cannot be measured in a reliable manner (i.e. external air will be mixed and lower the concentration of methane) a default value of 50% may be used.

(vi) Project emissions from heat use and electricity use ($PE_{elec/heat}$):

$$PE_{elec/heat,y} = EL_{Pr,y} * CEF_d + HG_{Pr,y} * CEF_{Pr,therm,y} \quad \textbf{(17)}$$

where,

$EL_{Pr,y}$	is the amount of electricity in the year y that is consumed at the project site in the project case (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 in the project case (MJ).
$CEF_{Pr,therm,y}$	is the CO2 emissions intensity for thermal energy generation (tCO_2e/MJ),. Factor is zero if biogas is used for generating thermal energy.

Determination of CEF_d:

- In case the electricity is 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 should be used (0.8 tCO_2/MWh, see Table I.D.1 in the simplified baseline and monitoring methodology AMS.I.D for selected small-scale CDM project activity categories).

- In case the electricity is imported from the grid, 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), the method for the calculation of the grid emission factor in the small scale methodology AMS.I.D could be used.

Leakage

Leakage covers the emissions from land application of treated manure, outside the project boundary. These emissions are estimated as net of those released under project activity and those released in the baseline scenario. Net leakage of N_2O and CH_4 are only considered if they are positive.

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$$LE_y = (LE_{P,N2O} - LE_{B,N2O}) + (LE_{P,CH4} - LE_{B,CH4}) \quad \textbf{(18)}$$

Where:

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

(i) Estimation of N_2O emissions:

The baseline case N2O emissions are estimated using the following equations:

$$LE_{B,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * (LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}) \quad \textbf{(19)}$$

$$LE_{N2O,land} = EF_1 * \prod_{n=1}^{N} (1 - R_{N,n}) * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(20)}$$

$$LE_{N2O,runoff} = EF_5 * F_{Leach} * \prod_{n=1}^{N} (1 - R_{N,n}) * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(21)}$$

$$LE_{N2O,vol} = EF_4 * \prod_{n=1}^{N} (1 - R_{N,n}) * F_{GASM} * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(22)}$$

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, estimated with site-specific, regional or national data if such data is

available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.

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 (estimated as in annex 2)
EF_1	Emission factor for direct emission of N_2O from soils in Kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.1, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
EF_5	Emission factor for indirect emission of N_2O from runoff in Kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
EF_4	Emission factor for N2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N2O / (kg NH3-N + NOx-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
F_{leach}	Fraction of *all* N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
$CF_{N20-N,N}$	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 1.

The project case N2O emissions are estimated using the following equations:

$$LE_{P,N2O} = GWP_{N2O} \cdot CF_{N2O-N,N} \cdot \frac{1}{1000} * (LE_{N2O,land} + LE_{N2O,runoff} + LE_{N2O,vol}) \quad \textbf{(23)}$$

$$LE_{N2O,land} = EF_1 * \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(24)}$$

$$LE_{N2O,runoff} = EF_5 * F_{Leach} * \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(25)}$$

$$LE_{N2O,vol} = EF_4 * \prod_{n=1}^{N} \left(1 - R_{N,n}\right) * F_{GASM} * \sum_{LT} NEX_{LT,a} \cdot N_{LT} \quad \textbf{(26)}$$

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, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
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 (estimated as in annex 2)
EF_1	Emission factor for direct emission of N_2O from soils in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.1, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
EF_5	Emission factor for indirect emission of N_2O from runoff in kg N_2O-N/kg N, estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
EF_4	Emission factor for N2O emissions from atmospheric deposition of N on soils and water surfaces, [kg N- N2O / (kg NH3-N + NOx-N volatilized)], estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
F_{leach}	Fraction of *all* N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff should be estimated with site-specific, regional or national data if such data is available. Otherwise, default values from table 11.3, chapter 11, volume 4 of IPCC 2006 guidelines can be used.
$CF_{N20-N,N}$	Conversion factor (= 44/28).
$R_{N,n}$	Fraction of NEX in manure waste that is reduced in the project 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 1.

It is possible to measure the quantity of manure applied to land in kg manure/yr (Q_{DM}) and the nitrogen concentration in kg N / kg manure (N_{DM}) in the manure to estimate the total quantity of nitrogen applied to land. In this case, $\prod_{n=1}^{N}(1-R_{N,n})*\sum_{LT} NEX_{LT,a}\cdot N_{LT}$ in equations (24), (25) and (26) above should be substituted by $Q_{DM}*N_{DM}$.

(ii) Methane emissions from disposal of treated manure

The calculation of methane emissions from land application of manure in the baseline and project cases are estimated from equations (27) and (28), below:

$$LE_{B,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n} \right) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,a} * MS\%_j) \quad \textbf{(27)}$$

$$LE_{P,CH4} = GWP_{CH4} * D_{CH4} * MCF_d * \left[\prod_{n=1}^{N} \left(1 - R_{VS,n} \right) \right] * \sum_{j,LT} (B_{0,LT} * N_{LT} * VS_{LT,y} * MS\%_j) \quad \textbf{(28)}$$

$LE_{B,CH4}$	Methane leakage emissions in the baseline (t CO_2e / yr)
$LE_{P,CH4}$	Methane leakage emissions in the project case (t CO_2e / yr)
$R_{VS,n}$	Fraction of volatile solid degraded in $AWMS_j$ prior to sludge being treated. Values for R_{vs} should be taken from annex 1.
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).
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated, in m^3CH_4/kg_dm, by animal type LT.
N_{LT}	Number of animals of type LT for the year y, expressed in numbers.
$VS_{LT,y}$	Annual volatile solids from livestock LT, on a dry matter weight basis (kg-dm/year).
MS%j	Fraction of manure handled in system j
MCF_d	Methane conversion factor (MCF) assumed to be equal to 1.

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:

$$ER_y = BE_y - PE_y - LE_y \quad \textbf{(29)}$$

Further, in estimating emissions reduction for claiming certified emissions reductions, if the actual methane captured from an anaerobic digester is lower than ($BE_{CH4,y}$ - $PE_{AD,y}$), then ($BE_{CH4,y}$ - $PE_{AD,y}$) (which is a component of BE_y -PE_y)in equation (29) is replaced by actual methane captured and destroyed. In the calculation of the value of the actual methane captured and destroyed in the flare, the flare efficiency should be considered, multiplying the measured value at the flare inlet 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 anaerobic manure treatment system, 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);
- In case of anaerobic lagoons treatments systems, the depth of the lagoons used for manure management under the baseline scenario should be at least 1m[6].
- The annual average temperature in the site where the anaerobic manure treatment facility in the baseline existed is higher than 5°C.

[6] 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 treatment system 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

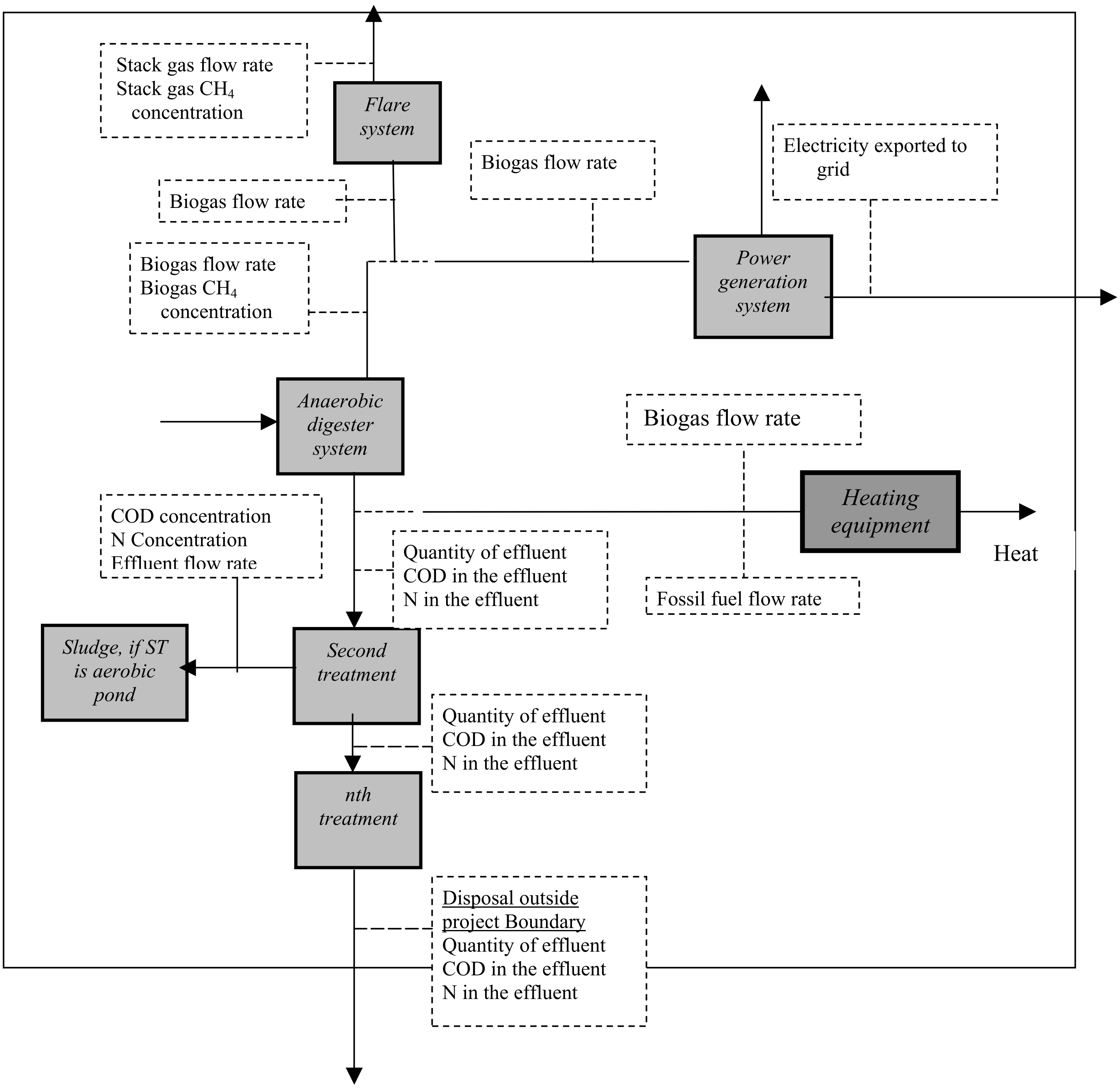
In this methodology, monitoring comprises several activities.

<u>Baseline emissions:</u>
- 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;
- 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.

<u>Project emissions:</u>
- The livestock populations by different livestock types. This includes the number of 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.
- 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 in the project case;
- Amount of heat used 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

	Classification	Type of barn and AWMS	Type	m				Duration of project + 5 yrs	Barn and AWMS layout and configuration.
1. MCF	Factor	Methane correction factor	Fraction	c	Annual	100%	Electronic	Duration of project + 5 yrs	The factor MCF is taken from IPCC 2006 guidelines. If annual average temperature is lower than 10 ^oC and higher than 5 ^oC, Annual MCF should be estimated using linear interpolation assuming MCF=0 at annual average temperature of 5 ^oC.
2. $B_{o,LT}$	Factor	Max methane production	Fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	The value is taken from published sources. The parameter value should be updates on latest available public data source.
3. R_{VS}	Factor	VS degradation factor	Fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 1. The most conservative value for the given technology must be used.
4. VS	Activity data	Volatile Solids	KG dm/yr	e	Annually	100%	Electronic	Duration of project + 5 yrs	See baseline methodology for order of preference
5. $MS\%_j$	Fraction	Fraction of manure handled in system j	Fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	
6. nd_y	Number	Number of days treatement plant was operational	Number	e	Annually	100%	Electronic	Duration of project + 5 yrs	

7. N_{LT}	Numbers	Average number of each type of animal in the barn	number	m	Monthly	100%	Electronic	Duration of project + 5 yrs	The PDD should describe the system on monitoring the number of livestock population. The consistency between the value and indirect information (records of sales, records of food purchases) should be assessed.
8. CP	Activity data	Crude protien percent	percent	e	Annually	100%	Electronic	Duration of project + 5 yrs	
9. GE	Activity Data	Gross energy intake of the animal	MJ/d	e	Annually	100%	Electronic	Duration of project + 5 yrs	
10. F_{GASM}	Fraction	N lost due to volatilization	fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values can be used.
11. EF3, EF4	Emission factor	Direct and indirect N2O emissions	kg N2O-N/ kg N and kg N2O-N/ kg NH3-N and NOX-N	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values may be used, if country specific or region specific data are not available.

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
12. T	Tempe-rature	Annual Average ambient temperature at Project site	^{o}C	m	Monthly	100%	Electronic	Duration of project + 5 yrs	Used to select the annual MCF from IPCC 2006 guidelines
13 EG_y	Electricity	Electricity consump-tion 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.
14. $CEF_{baseline, elec}$	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
15.$EG_{d,y}$	Electri-city	Electri-city exported to grid	MWh	m	Annual	100%	Electronic	Duration of project + 5 yrs	
16. CEF_{grid}	Emission 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.
17. $HG_{BL,y}$	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.
18. $CEF_{Bl,therm,y}$	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.
19. Regulations		Existence and enforcement of relevant regulation			At start of crediting period				

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_{LT}	Numbers	Average livestock population	number	m	Monthly	100%	Electronic	Duration of project + 5 yrs	The PDD should describe the system on monitoring the number of livestock population. .
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 weight of livestock. .
3. VS_{LT}	concentration	Volatile solid excretion per animal per day)	kg dry matter / animal / day	e	monthly	100%	paper	At least two years from completion of authorisation period or last CERs issued	If it is required to use developed country VS values, the following should be monitored: - Genetic source of the production operations livestock originate from an Annex I Party - The formulated feed rations (FFR)

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
4. $B_{o,LT}$	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.
5. R_{VS}	Factor	VS degradation factor	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 1. The most conservative value for the given technology must be used.
6. F_{AD}	Factor	Fraction of volatile solids directed to anaerobic digesters	Fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	
7. LF_{AD}	Fraction	Methane leakage from anaerobic digester	Fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC default of 0.15 or less if documented evidence can be provided (to be checked by DOE)
8. $MS\%_j$	Fraction	Fraction of manure handled in system j	Fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	
9. F_{Aer}	Factor	Fraction of volatile solids directed to aerobic treatment	Fraction	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
10. MCF_{sl}	Factor	Methane correction factor	Fraction	c	Annual	100%	electronic	Duration of project + 5 yrs	The factor MCF is taken from IPCC 2006 guidelines. If annual average temperature is lower than 10 °C and higher than 5 °C, Annual MCF should be estimated using linear interpolation assuming MCF=0 at annual average temperature of 5 °C.
11. EF3, EF4	Emission factor	Direct and indirect N2O emissions	kg N2O-N/ kg N and kg N2O-N/ kg NH3-N and NOX-N	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values may be used, if country specific or region specific data are not available.
12. F_{GASM}	Fraction	N lost due to volatilization	fraction	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values can be used.
13. R_N	Factor	Nitrogen degradation factor	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	Estimated from Table provided in Annex 1. The most conservative value for the given technology must be used.

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
14 EL_y	Electricity	Electricity used in Project AWMSs	MWh	m	annual	100%	Electronic	Duration of project + 5 yrs	
15. CEF_d	Emission factor	Emission factor for project activity consumption	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.
16. $HG_{pr,y}$	Heat	Heat used by baseline AWMS	MJ	m	at start of project	100%	Electronic	Duration of project + 5 yrs	
17. $CEF_{pr,therm,y}$	Emission factor	Emission factor for thermal energy	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

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
18. V	Activity Data	Biogas flow	m^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. The biogas flow to electricity or heat equipment in a moment can be considered destroyed, by monitoring that the equipment was working at this time.
19. C_{CH4}	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.
20. f	Fraction	Flare efficiency%		m / c	(1) Continuously (2) Yearly	n/a	Electronic	During the crediting period and two years after	(1) Continuous measurement of operation time of flare (e.g. with temperature) (2) Measurement of methane content of flare exhaust gas.

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

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_4, EF_5	Emission factor	N_2O emission from soil and runoff water	kg N_2O-N/ kg N	e	Annually	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values 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 2006 default values can be used.
3. F_{Leach}		Fraction of N leached	fraction	e	Annual	100%	Electronic	Duration of project + 5 yrs	IPCC 2006 default values can be used.
4.N_{DM}		N concentration in disposed manure	Kg N20-N/KG effluent	m	Every batch disposed	100%	Electronic	Duration of project + 5 yrs	
5.Q_{DM}	Mass	Mass of manure disposed outside project boundary	KG	m	Every batch disposed	100%	Electronic	Duration of project + 5 yrs	
6. $B_{o,LT}$	Factor	Max methane production	Fraction	e	Annual	100%	electronic	Duration of project + 5 yrs	The value is taken from published sources. The parameter value should be updates on latest available public data source.
7. R_{VS}	Factor	VS degradatio	Fraction	e	Annual	100%	Electronic	Duration of project	Estimated from Table provided in Annex 1. The most conservative value

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
		n factor						+ 5 yrs	for the given technology must be used.
8. VS	Activity data	Volatile Solids	KG dm/yr	e	Annually	100%	Electronic	Duration of project + 5 yrs	See baseline methodology for order of preference
9. $MS\%_{j}$	Fraction	Fraction of manure handled in system j	Fractio n	e	Annually	100%	Electronic	Duration of project + 5 yrs	
10. N_{LT}	Numbers	Average number of each type of animal in the barn	number	m	Monthly	100%	Electronic	Duration of project + 5 yrs	The PDD should describe the system on monitoring the number of livestock population.. The consistency between the value and indirect information (records of sales, records of food purchases) should be assessed.

Quality Control (QC) and Quality Assurance (QA) Procedures

Data	Uncertainty Level of Data (High/Medium/Low)	Are QA/QC procedures planned for these data?	Outline explanation why QA/QC procedures are planned
18 (PE)	Low	Yes	Flow meters will undergo maintenance/calibration subject to appropriate industry standards. The frequency of calibration and control procedures would be different for each application. This maintenance/calibration practice should be clearly stated in the CDM-PDD.
19 (PE)	Medium	Yes	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.
13 (BE), 15 (BE), 14 (PE)	Low	Yes	Electricity meters will undergo maintenance/calibration subject to appropriate industry standards. The accuracy of the meter readings will be verified by receipts issued by the purchasing power company. Uncertainty of the meters to be obtained from the manufacturers. This uncertainty to be included in a conservative manner while calculating CERs and procedure for doing so should be described in the CDM-PDD.
17 (BE), 16 (PE)	Low	Yes	Fuel purchase records to be cross checked with estimates.
19	Low	Yes	Quality control for the existence and enforcement of relevant regulations and incentives is beyond the bounds of the project activity. Instead, the DOE will verify the evidence collected.

Annex 1: Anaerobic Unit Process Performance

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 2: Procedure for estimating NEX

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

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 10.20 in IPCC 2006 guidelines, volume 4, chapter 10)

N_{intake} may be calculated using: $N_{intake} = \left(\frac{GE}{18.45}\right) * \left(\frac{CP/100}{6.25}\right)$ (1a)

where,

CP	Crude percent of protein (percent).
GE	gross energy intake of the animal, in enteric model, based on digestible energy, milk production, pregnancy, current weight, mature weight, rate of weight gain, and IPCC constants, MJ day^{-1}
18.45	conversion factor for dietary GE per kg of dry matter (MJ/kg). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock.
6.25	conversion from kg of dietary protein to kg of dietary N, kg feed protein $(kg\ N)^{-1}$

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 10.19 of the IPCC 2006, volume 4, chapter 10.) may be used and should be corrected for the animal weight at the project site in the following way:

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

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 2006 or US-EPA) for the nitrogen excretion per head of a defined livestock population in kg N/animal/year.