Indicative simplified baseline and monitoring methodologies
for selected small-scale CDM project activity categories

TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall take into account the general guidance to the methodologies, information on additionality, abbreviations and general guidance on leakage provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html>.

III.D. Methane recovery in animal manure management systems

Technology/measure

1. This methodology covers project activities involving the replacement or modification of existing anaerobic manure management systems in livestock farms to achieve methane recovery and destruction by flaring/combustion or gainful use of the recovered methane. This methodology is only applicable under the following conditions:

   (a) The livestock population in the farm is managed under confined conditions;

   (b) Manure or the streams obtained after treatment are not discharged into natural water resources (e.g., river or estuaries), otherwise AMS-III.H shall be applied;

   (c) The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C;

   (d) In the baseline scenario the retention time of manure waste in the anaerobic treatment system is greater than 1 month, and in case of anaerobic lagoons in the baseline, their depths are at least 1 m;

   (e) No methane recovery and destruction by flaring, combustion or gainful use takes place in the baseline scenario.

2. The project activity shall satisfy the following conditions:

   (a) The final sludge must be handled aerobically. In case of soil application of the final sludge the proper conditions and procedures (not resulting in methane emissions) must be ensured;

   (b) Technical measures shall be used (including a flare for exigencies) to ensure that all biogas produced by the digester is used or flared;

   (c) The storage time of the manure after removal from the animal barns, including transportation, should not exceed 5 days before being fed into the anaerobic digester. If the project proponent can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.

3. Projects that recover methane from landfills shall use AMS-III.G and projects for wastewater treatment shall use AMS-III.H.

4. The recovered methane from the above measures may also be utilised for the following applications instead of flaring or combustion:

(a) Thermal or electrical energy generation directly; or

(b) Thermal or electrical energy generation after bottling of upgraded biogas; or

(c) Thermal or electrical energy generation after upgrading and distribution:

(i) Upgrading and injection of biogas into a natural gas distribution grid with no significant transmission constraints; or

(ii) Upgrading and transportation of biogas via a dedicated piped network to a group of end users.

5. If the recovered methane is used for project activities covered under paragraph 4 (a), that component of the project activity shall use a corresponding category under Type I.

6. If the recovered methane is used for project activities covered under paragraph 4 (b), or 4 (c) the relevant provisions in AMS-III.H related to upgrading, bottling of biogas, injection of biogas into a natural gas distribution grid and transportation of biogas via a dedicated piped network shall be used.

7. Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 kt CO_2 equivalent annually from all Type III components of the project activity. Emission reductions under this category are estimated *ex ante* ($ER_{ex\ ante}$) as the difference between baseline emissions (paragraph 9) and project emissions (paragraph 17).

Boundary

8. The project boundary is the physical, geographical site(s) of the livestock and manure generation and management systems, and the facilities which recover and flare/combust or use methane.

Baseline

9. The baseline scenario is the situation where, in the absence of the project activity, animal manure is left to decay anaerobically within the project boundary and methane is emitted to the atmosphere. Baseline emissions (BE_y) are calculated using the amount of the waste or raw material that would decay anaerobically in the absence of the project activity, with the most recent IPCC tier 2 approach (please refer to the chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories). For this calculation, information about the characteristics of the manure and of the management systems in the baseline is required. Manure characteristics include the amount of volatile solids (VS) produced by the livestock and the maximum amount of methane that can be potentially produced from that manure (B_o).

Baseline emissions are determined as follows:

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

Where:

BE_y	Baseline emissions in year y (tCO_2e)
GWP_{CH4}	Global Warming Potential (GWP) of CH_4 (21)
D_{CH4}	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure)
LT	Index for all types of livestock
j	Index for animal waste management system
MCF_j	Annual methane conversion factor (MCF) for the baseline animal waste management system j
$B_{0,LT}$	Maximum methane producing potential of the volatile solid generated for animal type "LT" (m^3 CH_4/kg dm)
$N_{LT,y}$	Annual average number of animals of type "LT" in year y (numbers)
$VS_{LT,y}$	Volatile solids for livestock "LT" entering the animal manure management system in year y (on a dry matter weight basis, kg dm/animal/year)
$MS\%_{Bl,j}$	Fraction of manure handled in baseline animal manure management system j
UF_b	Model correction factor to account for model uncertainties (0.94)[1]

10. The maximum methane-producing capacity of the manure (B_o) varies by species and diet. The preferred method to obtain Bo measurement values is to use data from country-specific published sources, measured with a standardised method (B_o shall be based on total as-excreted VS). These values shall be compared to IPCC default values and any significant differences shall be explained. If country specific Bo values are not available, default values provided in tables 10 A-4 to 10 A-9 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be used, provided that the project participants provide an assessment of suitability of those data to the specific situation of the treatment site.

11. Volatile solids (VS) are the organic material in livestock manure and consist of both biodegradable and non-biodegradable fractions. For the calculations the total VS excreted by each animal species is required. The preferred method to obtain VS is to use data from nationally published sources. These values shall be compared with IPCC default values and any significant differences shall be explained. If data from nationally published sources are not available, country-specific VS excretion rates can be estimated from feed intake levels, via the enhanced characterisation method (tier 2) described in section 10.2 in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10. If country specific VS values are not available IPCC default values provided in 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10 A-4 to 10 A-9 can be used provided that the project participants

[1] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

provide an assessment of suitability of those data to the specific situation of the treatment site particularly with reference to feed intake levels.

12. In case default IPCC values for VS are adjusted for a site-specific average animal weight, it shall be well explained and documented. The following equation shall be used:

$$VS_{LT,y} = \left(\frac{W_{site}}{W_{default}} \right) * VS_{default} * nd_y \tag{2}$$

Where:

W_{site}	Average animal weight of a defined livestock population at the project site (kg)
$W_{default}$	Default average animal weight of a defined population, this data is sourced from IPCC 2006 (kg)
$VS_{default}$	Default value for the volatile solid excretion rate per day on a dry-matter basis for a defined livestock population (kg dm/animal/day)
nd_y	Number of days in year y where the treatment plant was operational.

13. Bo or VS values applicable to developed countries can be used provided the following four conditions are satisfied:

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

14. In case of sequential 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 - RVS), where RVS is the relative reduction of volatile solids from the previous stage. The relative reduction (RVS) 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 the table in annex 1.

15. Methane Conversion Factors (MCF) values are determined for a specific manure management system and represent the degree to which Bo is achieved. Where available country-specific MCF values that reflect the specific management systems used in particular countries or

regions shall be used. Alternatively, the IPCC default values provided in table 10.17 of 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 can be used.

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

$$N_{LT,y} = N_{da,y} * \left(\frac{N_{p,y}}{365} \right) \tag{3}$$

Where:

$N_{da,y}$	Number of days animal is alive in the farm in the year *y* (numbers)
$N_{p,y}$	Number of animals produced annually of type *LT* for the year *y* (numbers)

Project Activity Emissions

17. Project activity emissions consist of:

(a) Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use ($PE_{PL,y}$);

(b) Emissions from flaring or combustion of the gas stream ($PE_{flare,y}$);

(c) CO_2 emissions from use of fossil fuels or electricity for the operation of all the installed facilities ($PE_{power,y}$);

(d) Emissions from the storage of manure before being fed into the anaerobic digester ($PE_{storage,y}$).

$$PE_y = PE_{PL,y} + PE_{flare,y} + PE_{power,y} + PE_{storage,y} \tag{4}$$

Where:

PE_y	Project emissions in year *y* (tCO_2e)
$PE_{PL,y}$	Emissions due to physical leakage of biogas in year *y* (tCO_2e)
$PE_{flare,y}$	Emissions from flaring or combustion of the biogas stream in the year *y* (tCO_2e)
$PE_{power,y}$	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year *y* (tCO_2e)
$PE_{storage,y}$	Emissions from the storage of manure (tCO_2e)

18. Project emissions due to physical leakage of biogas from the animal manure management systems used to produce, collect and transport the biogas to the point of flaring or gainful use is

estimated as 10% of the maximum methane producing potential of the manure fed into the management systems implemented by the project activity[2], as follows:

$$PE_{PL,y} = 0.10 * GWP_{CH4} * D_{CH4} * \sum_{i,LT} B_{0,LT} * N_{LT,y} * VS_{LT,y} * MS\%_{i,y} \qquad \textbf{(5)}$$

Where:

$MS\%_{i,y}$	Fraction of manure handled in system *i* in year *y*

If the project activity involves sequential manure management systems, the procedure specified in paragraph 14 shall be used to estimate the project emissions due to physical leakage of biogas in each stage.

19. In case of flaring/combustion of biogas, project emissions are estimated using the procedures described in the "Tool to determine project emissions from flaring gases containing methane".

20. Project emissions from electricity consumption are determined as per the procedures described in AMS-I.D. For project emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used (tCO_2/tonne). Local values are to be used, if local values are difficult to obtain, IPCC default values may be used. If recovered methane is used to power auxiliary equipment of the project it should be taken into account accordingly, using zero as its emission factor.

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

(a) The storage time of the manure after removal from the animal barns, including transportation, exceeds 24 hours before being fed into the anaerobic digester; and

(b) The dry matter content of the manure when removed from the animal barns is less than 20%.

The following method shall be used to calculate project emissions from manure storage:

$$PE_{storage,y} = GWP_{CH_4} * D_{CH_4} * \sum_{LT,l} \left[\frac{365}{AI_l} \sum_{d=1}^{AI} (N_{LT,y} * VS_{LT,d} * MS\%_l * (1 - e^{-k\ (AI_l - d)}) * MCF_l * B_{0_{LT}}) \right] \qquad \textbf{(6)}$$

Where:

$PE_{storage,y}$	Project emissions on account of manure storage in year y (tCO_2e)
AI_l	Annual average interval between manure collection and delivery for treatment at a given storage device *l* (days)

[2] 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 guidelines specify a default value of 10% of the maximum methane producing potential (Bo) for the physical leakages from anaerobic digesters.

$VS_{LT,d}$	Amount of volatile solid production by type of animal LT in a day (kg VS/head/d)
$MS\%_l$	Fraction of volatile solids (%) handled by storage device *l*
k	Degradation rate constant (0.069)
d	Days for which cumulative methane emissions are calculated; d can vary from 1 to 45 and to be run from 1 up to AI_l
MCF_l	Annual methane conversion factor for the project manure storage device l from Table 10.17, Chapter 10, Volume 4

Leakage

22. No leakage calculation is required.

Monitoring

23. The emission reductions achieved by the project activity will be determined *ex post* through direct measurement of the amount of methane fuelled, flared or gainfully used. It is likely that the project activity involves manure treatment steps with higher methane conversion factors (MCF) than the MCF for the manure treatment systems used in the baseline situation, therefore the emission reductions achieved by the project activity is limited to the *ex post* calculated baseline emissions minus project emissions using the actual monitored data for the project activity ($N_{LT,y}$, $MS\%_{i,y}$ $MS\%_{l,}$ AI_l, and in case adjusted values for animal weight are used as defined in paragraph 12: $VS_{LT,y}$). The emission reductions achieved in any year are the lowest value of the following:

$$ER_{y,ex\,post} = \min[(BE_{y,ex\,post} - PE_{y,ex\,post}),(MD_y - PE_{power,y,ex\,post})] \quad \textbf{(7)}$$

Where:

$ER_{y,ex\,post}$	Emission reductions achieved by the project activity based on monitored values for year *y* (tCO_2e)
$BE_{y,ex\,post}$	Baseline emissions calculated using equation 1 using *ex post* monitored values of $N_{LT,y}$ and if applicable $VS_{LT,y}$
$PE_{y,ex\,post}$	Project emissions calculated using equation 4 using *ex post* monitored values of $N_{LT,y}$,$MS\%_{i,y,}$ $MS\%_{l,}$ AI_l, and if applicable $VS_{LT,y}$
MD_y	Methane captured and destroyed or used gainfully by the project activity in year *y* (tCO_2e)
$PE_{power,y,ex\,post}$	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities based on monitored values in the year *y* (tCO_2e)

In case of flaring/combustion MD_y will be measured using the conditions of the flaring process:

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4} \quad \textbf{(8)}$$

Where:

$BG_{burnt,y}$	Biogas[3] flared or combusted in year y (m^3)
$w_{CH4,y}$	Methane content[3] in biogas in the year y (volume fraction)
FE	Flare efficiency in the year y (fraction)

24. The method for integration of the terms in equation above to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period.

25. In case of project activities covered under paragraph 4 (b) and 4 (c) the project participants shall maintain a biogas (or methane) balance based on:

(a) Continuous measurement of the amount of biogas captured at the methane recovery system of the animal manure waste management system;

(b) Continuous measurement of the amount of biogas used for various purposes in the project activity: e.g., heat, electricity, flare, injection into natural gas distribution grid, etc. The difference is considered as loss due to physical leakage and deducted from the emission reductions.

26. The amount of biogas recovered and fuelled[4], flared or used gainfully shall be monitored *ex post*, using flow meters. The system should be built and operated to ensure that there is no air ingress into the biogas pipeline. The fraction of methane in the biogas should be measured with a continuous analyser or, with periodical measurements at a 90/10 confidence/precision level or, alternatively a default value of 60% methane content can be used. Option chosen should be clearly specified in the PDD. Temperature and pressure of the biogas are required to determine the density of methane combusted. If the biogas flow meter employed measures flow, pressure and temperature and displays/outputs normalised flow of biogas, there is no need for separate monitoring of pressure and temperature of the biogas.

27. Regular maintenance should ensure optimal operation of flares. The flare efficiency, defined as the fraction of time in which the gas is combusted in the flare, multiplied by the efficiency of the flaring process, shall be monitored. One of the two following options shall be used to determine the efficiency of the flaring process in an enclosed flare:

(a) To adopt a 90% default value or

(b) To perform a continuous monitoring of the efficiency.[5]

[3] Biogas and methane content measurements shall be at the same location(s) in the system and on the same basis (wet or dry).

[4] If the biogas flared and fuelled (or utilized) are continuously monitored separately, the two fractions can be added to determine the biogas recovered. In that case, recovered biogas need not be monitored separately.

[5] The procedures described in the Methodological Tool to determine project emissions from flaring gases containing methane shall be used.

If option (a) is chosen, continuous check of compliance with the manufacturer's specification of the flare device (temperature, biogas flow rate) should be done. If in any specific hour any of the parameters is out of the range of specifications, 50% of default value should be used for this specific hour. For open flare 50% default value should be used, as it is not possible in this case to monitor the efficiency. If at any given time the temperature of the flare is below 500ºC, 0% default value should be used for this period.

Project activities where a portion of the biogas is destroyed through flaring and the other portion is used for energy may consider applying the flare efficiency to the portion of the biogas used for energy, if separate measurements are not performed. When the amount of methane that is combusted for energy and that is flared is separately monitored, a destruction efficiency of 100% can be used for the amount that is combusted for energy.

28. Flow meters, sampling devices and gas analysers shall be subject to regular maintenance, testing and calibration to ensure accuracy.

29. The annual fossil fuel or electricity used to operate the facility or power auxiliary equipment shall be monitored. Alternatively it shall be assumed that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum.

30. The number of days that the animal manure management system capturing methane and flaring/combusting or gainfully using methane was operational (nd_y) shall be monitored.

31. Where relevant in accordance with para 21, the fraction of manure handled in the storage devices ($MS\%_l$) and the interval between manure collection and commencement of treatment in anaerobic digester (AI_l) shall be monitored.

32. The PDD shall describe the system used for monitoring the fraction of the manure handled in the manure management system ($MS\%_{,i,y}$), the average weight of the livestock (W_{site}) and the livestock population ($N_{LT,y}$) taking into account the average number of days the animals are alive in the farm in a specific year. The consistency between these values and indirect information (records of sales, records of food purchases) shall be assessed. Significant changes in livestock population and average weight shall be explained.

33. In case developed country VS values are being used the following shall be monitored:

(a) Genetic source of the production operations livestock originate from an Annex I Party;

(b) The formulated feed rations (FFR). If equation 2 is used to estimate the value $VS_{default}$ (kg-dm/animal/day), the default average animal weight of a defined population (kg) shall be recorded and archived.

34. The proper soil application (not resulting in methane emissions) of the final sludge must be monitored.

35. The monitoring plan should include on site inspections for each individual farm included in the project boundary where the project activity is implemented for each verification period.

Project activity under a programme of activities

The following conditions apply for use of this methodology in a project activity under a programme of activities:

36. In case the project activity involves the replacement of equipment, and the leakage effect of the use of the replaced equipment in another activity is neglected, because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented. The monitoring should include a check if the number of project activity equipment distributed by the project and the number of scrapped equipment correspond with each other. For this purpose scrapped equipment should be stored until such correspondence has been checked. The scrapping of replaced equipment should be documented and independently verified.

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

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History of the document *

Version	Date	Nature of revision
16	EB 53, Annex 16 26 March 2010	To include additional guidance for long term storage of manure after removal from the animal barns.
15	EB 48, Annex 18 17 July 2009	To provide additional guidance on consideration of the storage time of animal manure taking into account the fact that the manure could be transported from locations other than the location of the anaerobic digester.
14	EB 38, Annex 11 14 March 2008	To: • Clarify the use of the tier 2 approach of 2006 IPCC guidelines for emission reduction calculations for manure management systems, and • Expand the applicability of the methodology to include the possibility of pipeline transport of the recovered and upgraded biogas to the end-users, similar to the revision recommended to AMS-III.H.
13	EB 33, Annex 32 27 July 2007	Revision of the approved small-scale methodology AMS-III.D to allow for its application under a programme of activities (PoA).
12	EB 31, Annex 22 04 May 2007	To clarify that in the monitoring plan on-site inspections are to be conducted for each individual farm and includes additional guidance on how to determine the efficiency of the flaring process in an enclosed flare and in an open flare; To assign scope 15 to this methodology and exclude this methodology from sectoral scopes 10 and 13, and to clarify that that DOE functions (validation, verification etc.) of project activities applying earlier versions can only be performed by DOEs accredited to all of the sectoral scopes to which the earlier versions of these methodologies respectively belong to.
11	EB 28, Meeting report, Para. 64 23 December 2006	Removed the interim applicability condition i.e., 25 ktCO2e/y limit from all Type III categories.
10	EB 25, Annex 25 28 July 2006	To expand its applicability to cover project activities that change manure management practices e.g. from ‘lagoon’, ‘liquid/slurry’, ‘solid storage’ or ‘drylot’ to ‘anaerobic digestion’ for the treatment of swine or cattle manure.
9	EB 24, Meeting report, Para. 64 12 May 2006	Introduced the interim applicability condition i.e., 25ktCO2e/y limit for all Type III categories.
8	EB 23, Annex 25 03 March 2006	To clarify its applicability and align it with AMS-III.F, AMS-III.G, AMS III.H and AMS-III.I.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		

[*] This document, together with the ‘General Guidance’ and all other approved SSC methodologies, was part of a single document entitled: Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM project activities until version 07.

History of the document: Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM project activities

Appendix B of the Simplified Modalities and Procedures for Small-Scale CDM project activities contained both the General Guidance and Approved Methodologies until version 07. After version 07 the document was divided into separate documents: 'General Guidance' and separate approved small-scale methodologies (AMS).		
Version	**Date**	**Nature of revision**
07	EB 22, Para. 59 25 November 2005	References to "non-renewable biomass" in Appendix B deleted.
06	EB 21, Annex 22 20 September 2005	Guidance on consideration of non-renewable biomass in Type I methodologies, thermal equivalence of Type II GWhe limits included.
05	EB 18, Annex 6 25 February 2005	Guidance on 'capacity addition' and 'cofiring' in Type I methodologies and monitoring of methane in AMS-III.D included.
04	EB 16, Annex 2 22 October 2004	AMS-II.F was adopted, leakage due to equipment transfer was included in all Type I and Type II methodologies.
03	EB 14, Annex 2 30 June 2004	New methodology AMS-III.E was adopted.
02	EB 12, Annex 2 28 November 2003	Definition of build margin included in AMS-I.D, minor revisions to AMS-I.A, AMS-III.D, AMS-II.E.
01	EB 7, Annex 6 21 January 2003	Initial adoption. The Board at its seventh meeting noted the adoption by the Conference of the Parties (COP), by its decision 21/CP.8, of simplified modalities and procedures for small-scale CDM project activities (SSC M&P).
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		