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.I. Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems

Technology/measure

1. This methodology comprises technologies and measures that avoid the production of methane from biogenic organic matter in wastewaters being treated in anaerobic systems. Due to the project activity, the anaerobic systems[1] (without methane recovery) are substituted by aerobic biological systems[2]. The project activity does not recover or combust methane in wastewater treatment facilities (unlike AMS-III.H).

2. Measures are limited to those that result in emission reductions of less than or equal to 60 kt CO_2 equivalent annually.

Boundary

3. The project boundary is the physical, geographical sites where:

(a) The wastewater treatment would have taken place and the methane emission occurred in absence of the project activity;

(b) The wastewater treatment takes place in the project activity;

(c) The sludge is treated and disposed off in the baseline and project situation.

Baseline

4. The baseline scenario is the situation where, in the absence of the project activity, degradable organic matter in wastewater is treated in anaerobic systems and methane is emitted to the atmosphere. Baseline emissions are:

(a) Methane produced in the anaerobic baseline wastewater treatment system(s) that is/are being replaced with the biological aerobic system(s) ($BE_{ww,treatment,y}$);

(b) Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea etc. ($BE_{ww,discharge,y}$);

[1] As defined in 2006 IPCC Guidelines for National Greenhouse Gas inventories, Volume 5, Chapter 6, Wastewater treatment and discharge, table 6.3 and 6.8. Under this methodology anaerobic lagoons are ponds deeper than 2 meters, without aeration, ambient temperature above 15^0C, at least during part of the year, on a monthly average basis, and with a volumetric loading rate of Chemical Oxygen Demand above 0.1 kg $COD.m^{-3}.day^{-1}$.

[2] Systems using oxygen and microbial action to treat wastewaters.

(c) Methane produced in the baseline sludge treatment system(s) ($BE_{s,treatment,y}$);

(d) Methane emissions from anaerobic decay of the final sludge produced in the baseline situation. If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in the baseline scenario, this term shall be neglected ($BE_{s,final,y}$).

$$BE_y = BE_{ww,treatment,y} + BE_{ww,discharge,y} + BE_{s,treatment,y} + BE_{s,final,y} \quad (1)$$

Where:

BE_y	Baseline emissions in the year *y* (tCO_2e)
$BE_{ww,treatment,y}$	Methane produced in the anaerobic baseline wastewater treatment system(s) that is/are being replaced with the biological aerobic system(s) (tCO_2e)
$BE_{ww,discharge,y}$	Methane emissions on account of inefficiencies in the baseline wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea etc. (tCO_2e)
$BE_{s,treatment,y}$	Methane produced in the baseline sludge treatment system(s) (tCO_2e)
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced (tCO_2e)

5. In the determination of baseline emissions using equation 1), historical records of at least one year prior to the project implementation shall be used. This shall include COD removal efficiency of the wastewater treatment systems, amount of dry matter in sludge, power and electricity consumption per m^3 of wastewater treated, amount of final sludge generated per tonne of COD treated and all other parameters required for determination of baseline emissions.

6. In case one year of historical data are not available, the parameters shall be determined by a measurement campaign in the baseline wastewater systems of at least 10 days. The measurements should be undertaken during a period that is representative for the typical operation conditions of the systems and ambient conditions of the site (temperature, etc). Average values from the measurement campaign shall be used and the result shall be multiplied by 0.89 to account for the uncertainty range (30% to 50%) associated with this approach as compared to one-year historical data.

7. The baseline emissions from the anaerobic wastewater treatment system(s) are estimated as follows:

$$BE_{ww,treatment,y} = \sum_{i,m} \left(Q_{ww,m,y} * COD_{removed,i,m,y} * MCF_{anaerobic,i} \right) * B_o * UF_{BL} * GWP_{CH4} \quad (2)$$

Where:

$Q_{ww,m,y}$	Volume of the wastewater treated during the months m, during year *y*, for the months with ambient average temperature above 15°C (m^3)
i	Index for baseline wastewater treatment system
$MCF_{anaerobic,i}$	Methane correction factor for the anaerobic baseline wastewater treatment system *i* replaced by the project activity, value as per table III.I.1
$COD_{removed,i,m,y}$	Chemical oxygen demand removed[3] by the anaerobic wastewater treatment system *i* in the baseline situation in the year *y* for the months *m* with ambient average temperature above 15° C (tonnes/m^3)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[4]
B_o	Methane producing capacity for the wastewater (IPCC default value ~~for domestic wastewater~~ of 0.21 kg CH_4/kg COD)[5]
GWP_{CH4}	Global Warming Potential for CH_4 (value of 21)

To determine $COD_{removed,i,m,y}$: as the baseline treatment system(s) is different from the treatment system(s) in the project scenario, the monitored values of the COD inflow during crediting period will be used to calculate the baseline emissions *ex post*. The COD removed by the baseline system(s) shall be based on the removal efficiency of the baseline systems estimated as per paragraphs 5 or 6.

8. The Methane Correction Factor (MCF) shall be determined based on the following table:

Table III.I.1. IPCC default values[6] for Methane Correction Factor (MCF)

Type of wastewater treatment and discharge pathway or system	MCF value
Discharge of wastewater to sea, river or lake	0.1
Aerobic treatment, well managed	0
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8

[3] Difference of inflow COD and the outflow COD.

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

[5] The IPCC default value of 0.25 kg CH_4/kg COD was corrected to take into account the uncertainties. ~~For domestic waste water, a COD based value of $B_{o,ww}$ can be converted to BOD_5 based value by dividing it by 2.4 i.e. a default value of 0.504 kg CH_4/kg BOD can be used.~~ Project activities may use the default value of 0.6 kg CH4/kg BOD, in case the parameter $BOD_{5,20}$ is used to determine the organic content of the wastewater. In this case the monitoring shall be based in direct measurements of $BOD_{5,20}$, i.e., the estimation of BOD values based on COD measurements is not allowed.

[6] Default values from chapter 6 of volume 5. Waste in *2006 IPCC Guidelines for National Greenhouse Gas Inventories*

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III.I. Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems (cont)

Type of wastewater treatment and discharge pathway or system	MCF value
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

9. Methane emissions from degradable organic carbon in treated wastewater discharged in e.g., a river, sea or lake are determined as follows:

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_o * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,discharge,BL} \quad (3)$$

Where:

$Q_{ww,y}$	Volume of treated wastewater discharged in year *y* (m^3)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[7]
$COD_{ww,discharge,BL,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in year *y* (tonnes/m^3)
$MCF_{ww,discharge,BL}$	Methane correction factor based on the discharge pathway (e.g., into sea, river or lake) of the wastewater (fraction) (MCF value as per table III.I.1)

To determine $COD_{ww,discharge,BL,y}$: as the baseline treatment system(s) is different from the treatment system(s) in the project scenario, the monitored values of the COD inflow during crediting period will be used to calculate the baseline emissions *ex post*. The outflow COD of the baseline systems will be estimated using the removal efficiency of the baseline treatment systems, estimated as per paragraphs 5 or 6.

10. Methane emissions from the baseline sludge treatment systems *j* are determined as follows:

$$BE_{s,treatment,y} = \sum_j S_{j,BL,y} * MCF_{s,treatment,j} * DOC_s * UF_{BL} * DOC_F * F * 16/12 * GWP_{CH4} \quad (4)$$

Where:

$S_{j,,BL,y}$	Amount of dry matter in the sludge that would have been treated by the sludge treatment system *j* in the baseline scenario (tonne)
j	Index for baseline sludge treatment system
DOC_s	Degradable organic content of the untreated sludge generated in the year *y* (fraction, dry basis). It shall be estimated using default values of 0.5 for domestic sludge and 0.257 for industrial sludge.[8]

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

$MCF_{s,treatment,j}$	Methane correction factor for the baseline sludge treatment system *j* (MCF values as per table III.I.1)
UF_{BL}	Model correction factor to account for model uncertainties (0.94)[9]
DOC_F	Fraction of DOC dissimilated to biogas (IPCC default value of 0.5)
F	Fraction of CH_4 in biogas (IPCC default of 0.5)

In case sludge is composted, the following equation shall be applied:

$$BE_{s,treatment,y} = \sum_j S_{j,BL,y} * EF_{composting} * GWP_{CH4} \quad \textbf{(5)}$$

Where:

$EF_{composting}$	Emission factor for composting of organic waste (t CH_4/ton waste treated). Emission factors can be based on facility/site-specific measurements, country specific values or IPCC default values (table 4.1, chapter 4, Volume 5, 2006 IPCC Guidelines for National Greenhouse Gas Inventories). IPCC default value is 0.01 t CH_4/t sludge treated on a dry weight basis.

11. Since the baseline wastewater treatment system is different from the treatment system in the project scenario, the sludge generation rate (amount of sludge generated per unit COD removed) in the baseline situation may differ significantly from the project situation. The amount of sludge generated in aerobic wastewater systems is generally larger than that in anaerobic systems, for the same COD removal efficiency. Therefore, the monitored values of the amount of sludge generated during the crediting period shall be used to estimate the amount of sludge generated in the baseline, as follows:

$$S_{j,BL,y} = S_{l,PJ,y} * \frac{SGR_{BL}}{SGR_{PJ}} \quad \textbf{(6)}$$

Where:

$S_{l,PJ,y}$	Amount of dry matter in the sludge treated by the sludge treatment system *l* in year *y* in the project scenario (tonne)
SGR_{BL}	Sludge generation ratio of the wastewater treatment plant in the baseline scenario (tonne of dry matter in sludge/tonne COD removed). This ratio will be measured *ex ante* through representative measurement campaign, or using historical records of COD removal and sludge generation in the baseline treatment systems as per the

[8] The IPCC default values of 0.05 for domestic sludge (wet basis, considering a default dry matter content of 10 percent) or 0.09 for industrial sludge (wet basis, assuming dry matter content of 35 percent), were corrected for dry basis.

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

guidance in paragraph 5 or 6.

SGR_{PJ} Sludge generation ratio of the wastewater treatment plant in the project scenario (tonne of dry matter in sludge/tonne COD removed). Calculated using the monitored values of COD removal and sludge generation in the project scenario.

12. Methane emissions from anaerobic decay of the final sludge produced in the baseline situation are determined as follows:

$$BE_{s,final,y} = S_{final,BL,y} * DOC_s * UF_{BL} * MCF_{s,BL,final} * DOC_F * F * 16/12 * GWP_{CH4} \quad \textbf{(7)}$$

Where:

$S_{final,BL,y}$ Amount of dry matter in final sludge generated by the baseline wastewater treatment in the year *y* (tonnes). It will be estimated using the monitored amount of dry matter in final sludge generated by the project activity ($S_{final,PJ,y}$) corrected for the sludge generation ratios of the project and baseline systems as per equation 6 above.

$MCF_{s,BL,final}$ Methane correction factor of the disposal site that receives the final sludge in the baseline situation, estimated as per the procedures described in AMS-III.G

UF_{BL} Model correction factor to account for model uncertainties (0.94)

Project Activity Emissions

13. Project activity emissions consists of:

(i) CO_2 emissions related to the power and fossil fuel used by the project activity facilities ($PE_{power,y}$);

(ii) Methane emissions during the treatment of the wastewater in biological aerobic wastewater treatment systems ($PE_{ww,treatment,y}$);

(iii) Methane emissions from degradable organic carbon in treated wastewater discharged in sea/river or lake ($PE_{ww,discharge,y}$);

(iv) Methane emissions from sludge treatment in the project activity ($PE_{s,l,y}$);

(v) Methane emissions from the decay of the final sludge generated by the project activity, if the sludge is disposed to decay anaerobically in a landfill without methane recovery ($PE_{s,final,y}$).

$$PE_y = PE_{power,y} + PE_{ww,treatment,y} + PE_{ww,discharge,y} + PE_{s,treatment,y} + PE_{s,final,y} \quad \textbf{(8)}$$

Where:

PE_y Project activity emissions in year *y* (tCO_2e)

$PE_{power,y}$	Emissions on account of electricity or fossil fuel consumption in the year *y* (tCO_2e)
$PE_{ww,treatment,y}$	Methane emissions from the biological aerobic wastewater treatment in the year *y* (tCO_2e)
$PE_{ww,discharge,y}$	Methane emissions on account of inefficiencies in the project wastewater treatment systems and presence of degradable organic carbon in the treated wastewater discharged into river/lake/sea etc. (tCO_2e)
$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e)
$PE_{s,treatment,y}$	Methane produced in the project sludge treatment system(s) (tCO_2e)

14. Project activity emissions from electricity and fossil fuel consumption ($PE_{power,y}$) are determined as per the procedures described in AMS-I.D. The energy consumption of all equipment/devices installed by the project activity, *inter alia* all equipment to treat wastewater and sludge shall be included. For project activity 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.

15. Methane emissions during the biological aerobic treatment of wastewater are determined as follows ($PE_{ww,treatment,y}$):

$$PE_{ww,treatment,y} = \sum_k \left(Q_{ww,k,y} * COD_{removed,k,y} * MCF_{aerobic,k}\right) * B_o * UF_{PJ} * GWP_{CH4} \quad \textbf{(9)}$$

Where:

$Q_{ww,k,y}$	Volume of the wastewater treated by the aerobic system *k* during the year *y* (m^3)
k	Index for project wastewater treatment system
$COD_{removed,k,y}$	Chemical oxygen demand removed by the aerobic system *k* in year *y* (tonnes/m^3)
$MCF_{aerobic,k}$	Methane correction factor for the aerobic wastewater treatment system *k* (MCF value for well managed aerobic biological systems, or for poorly managed or overloaded systems as per table III.I.1 shall be taken)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)[10]

16. Methane emissions from degradable organic carbon in treated wastewater discharged in sea/river or lake in the project situation are determined as follows ($PE_{ww,discharge,y}$):

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

$$PE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_o * UF_{PJ} * COD_{ww,discharge,y} * MCF_{ww,discharge} \quad \textbf{(10)}$$

Where:

$Q_{ww,y}$	Volume of wastewater treated in the year y (m^3)
$COD_{ww,discharge,y}$	Chemical oxygen demand of the final treated wastewater discharged into sea, river or lake in the year y (tonnes/m^3)
$MCF_{ww,discharge}$	Methane correction factor based on discharge pathway of the wastewater (fraction) (MCF value in table III.I.1 for sea, river and lake discharge)
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)[11]

17. Methane emissions from the project sludge treatment systems l are determined as follows:

$$PE_{s,treatment,y} = \sum_{l} S_{l,PJ,y} * MCF_{s,treatment,l} * DOC_s * UF_{PJ} * DOC_F * F * 16/12 * GWP_{CH4} \quad \textbf{(11)}$$

Where:

$S_{l,PJ,y}$	Amount of dry matter in the sludge treated by the sludge treatment system l in year y (tonne)
l	Index for project sludge treatment system

In case sludge is composted, the following equation shall be applied:

$$PE_{s,treatment,y} = \sum_{l} S_{l,PJ,y} * EF_{composting} * GWP_{CH4} \quad \textbf{(12)}$$

Where:

$EF_{composting}$	Emission factor for composting of organic waste (t CH_4/ton waste treated). Emission factors can be based on facility/site-specific measurements, country specific values or IPCC default values (table 4.1, chapter 4, Volume 5, 2006 IPCC Guidelines for National Greenhouse Gas Inventories). IPCC default value is 0.01 t CH_4/t sludge treated on a dry weight basis.

18. In case of sludge is disposed on landfills without methane recovery, project emissions are determined as follows:

$$PE_{s,final,y} = S_{final,PJ,y} * DOC_s * MCF_s * UF_{PJ} * DOC_F * F * 16/12 * GWP_{CH4} \quad \textbf{(13)}$$

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

Where:

$S_{final,PJ,y}$	Amount of dry matter in final sludge generated by the project wastewater treatment systems in year *y* disposed on a landfill (tonnes)
MCF_s	Methane correction factor of the landfill that receives the final sludge, estimated as described in AMS-III.G
UF_{PJ}	Model correction factor to account for model uncertainties (1.06)[12]

If the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, project emissions from sludge disposed ($PE_{s,final,y}$) shall be neglected, and the end-use of the final sludge will be monitored during the crediting period.

Leakage

19. If the aerobic treatment technology is equipment transferred from another activity or if the existing equipment is transferred to another activity, leakage effects at the site of the other activity are to be considered.

Emission Reductions

20. The emission reduction achieved by the project activity will be calculated as the difference between the baseline emission and the sum of the project emission and leakage.

$$ER_y = BE_y - \left(PE_y + LE_y\right) \quad \textbf{(14)}$$

Where:

ER_y	Emission reduction in the year *y* (tCO_2e)
LE_y	Leakage emission in the year *y* (tCO_2e)

Monitoring

21. Monitoring shall involve:

(a) The amount of COD treated in the wastewater treatment plant(s) (COD_{in}, COD_{out}, $COD_{ww,discharge,y}$, $COD_{removed,k,y}$) shall be measured regularly in accordance to national or international standards. The amount of wastewater entering and/or exiting the project activity shall be monitored continuously and recorded to provide the total volume of wastewater treated ($Q_{ww,y}$);

(b) The yearly amount of sludge produced and sludge generation ratio ($S_{l,PJ,y}$, $S_{final,PJ,y}$ and SGR_{PJ}) shall be measured. In case of sludge extracted in a slurry phase, the volume (m^3) and dry matter content ($tonnes/m^3$) shall be used to calculate $S_{l,PJ,y}$. In

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

case of sludge removal as solids, $S_{j,PJ,y}$ is measured by direct weighing and measuring its dry matter content through sampling;

(c) The amount of fossil fuel and electricity used by the project activity facilities.

22. In case a MCF value of zero is adopted for the project wastewater treatment system assuming that it is a well managed aerobic system, its operation shall be documented in a quality control program. This shall include monitoring of the operating conditions of the treatment system ~~and procedures~~ to verify if they are within the specified range so as ~~that~~ to ensure the aerobic condition of the reactors. One of the two options below shall be used:

(a) ~~, and that~~ The acceptable range of operational parameters (e.g., running time of aerators, flows, COD loads) are defined for continuous aerobic operation of the treatment system ~~kept within the limits of the~~ in accordance with the engineering design ~~parameters~~ of the wastewater treatment system and reported in the PDD. The operational parameters are then continuously monitored to ensure that they are always kept in the design range of operating conditions.

(b) Dissolved oxygen (DO) shall be monitored either continuously or on a sample basis (use 90/10 precision for sampling) to demonstrate that there are no anaerobic pockets (DO level shall be 1 mg/L or above) in the reactor during operation.

In case the operational parameters are not within the limits for a period of time, a MCF value of 0.3 shall be taken for that period.

In case existence of anaerobic pockets is indicated by a measurement of low DO value (less than 1 mg/L) then a MCF value of 0.3 shall be taken for the period of time between the previous measurement and this current measurement.

23. If the methane emissions from anaerobic decay of the final sludge were to be neglected because the sludge is controlled combusted, disposed in a landfill with methane recovery, or used for soil application, then the end-use of the final sludge will be monitored during the crediting period.

24. If the baseline emissions included the anaerobic decay of final sludge generated by the baseline treatment systems in a landfill without methane recovery, the baseline disposal site shall be clearly defined, and verified by the DOE.

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:

25. 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.

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History of the document

Version	Date	Nature of revision
08	EB 48, Annex 22 17 July 2009	To include additional guidance on the determination of baseline methane generation potential based on Biochemical Oxygen Demand ($BOD_{5,20}$) with a view to maintain consistency between AMS-III.I and AMS-III.H. Additional guidelines on monitoring of aerobic conditions.
07	EB 42, Annex 18 26 September 2008	Include additional guidance on baseline determination and project emission calculations; The methodology restructured, provisions related to methane correction factor and related uncertainties have been revised.
06	EB 33, Annex 36 27 July 2007	Additional leakage guidance to allow for application under a programme of activities (PoA).
05	EB 31, Annex 23 04 May 2007	Clarifies how the number of months with average lagoon temperature above 15°C in AMS III.I is to be determined. Scope 15 excluded.
04	EB 28, Annex 27 15 December 2006	Revised AMS III.I, analogous to AMS III.H, based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Expand applicability to activities in geographic locations where lagoon temperature is above 15°C for only a part of the year.
03	EB 25, Annex 27 21 July 2006	Clarify the applicability condition relating to residence time of wastewater being treated.
02	EB 24, 10 May 2006, paragraph 64 of the report	The Board at its twenty-fourth meeting noted that type III project activities might be able to achieve significant emission reductions, without exceeding the direct emissions limits i.e.,15 kilo tonnes CO_2e applicable at the time. As an interim solution, the Board agreed to include the following text in all Type III categories: "This category is applicable for project activities resulting in annual emission reductions lower than 25,000 tonnes CO_2e. If the emission reduction of a project activity exceeds the reference value of 25,000 tonnes CO_2e in any year of the crediting period, the annual emission reduction for that particular year is capped at 25,000 tonnes CO_2e."
01	EB 23, Annex 24 24 February 2006	Initial adoption.

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