Template for comments

Date:	Document:

TABLE FOR COMMENTS

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0	1	2	3	4	5	6
#	**Para No./ Annex / Figure / Table**	**Line Number**	**Type of comment** **ge** = general **te** = technical **ed** = editorial	**Comment** **(including justification for change)**	**Proposed change** **(including proposed text)**	**Assessment of comment** (*to be completed by UNFCCC secretariat*)
	Inclusion of new Figure	**-**	**te**	**Please refer to letter Subject: Automatic additionality - Positive list for Small-scale. Flaring/use of landfill gas (LFG) CDM activities, AMS-III.G submitted on the 05 November 2013**	**Please refer to attached methodology AMS-III.G (in track changes)**	
	Inclusion of new Figure	**-**	**te**	**Please refer to the letter Subject: Automatic additionality - Positive list for Small-scale. Wastewater and/or sludge treatment CDM activities, AMS-III.H. submitted on the 05 November 2013**	**Please refer to attached methodology AMS-III.H (in track changes)**	

Template for comments

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TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines to SSC CDM methodologies and information on additionality (attachment A to Appendix B) provided at <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *mutatis mutandis*.

III.H. Methane recovery in wastewater treatment

Technology/measure

1. This methodology comprises measures that recover biogas from biogenic organic matter in wastewater by means of one, or a combination, of the following options:

   (a) Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion;

   (b) Introduction of anaerobic sludge treatment system with biogas recovery and combustion to a wastewater treatment plant without sludge treatment;

   (c) Introduction of biogas recovery and combustion to a sludge treatment system;

   (d) Introduction of biogas recovery and combustion to an anaerobic wastewater treatment system such as anaerobic reactor, lagoon, septic tank or an on site industrial plant;[1]

   (e) Introduction of anaerobic wastewater treatment with biogas recovery and combustion, with or without anaerobic sludge treatment, to an untreated wastewater stream;

   (f) Introduction of a sequential stage of wastewater treatment with biogas recovery and combustion, with or without sludge treatment, to an anaerobic wastewater treatment system without biogas recovery (e.g. introduction of treatment in an anaerobic reactor with biogas recovery as a sequential treatment step for the wastewater that is presently being treated in an anaerobic lagoon without methane recovery).

2. In cases where baseline system is anaerobic lagoon the methodology is applicable if:

   (a) The lagoons are ponds with a depth greater than two meters, without aeration. The value for depth is obtained from engineering design documents, or through direct measurement, or by dividing the surface area by the total volume. If the lagoon filling level varies seasonally, the average of the highest and lowest levels may be taken;

   (b) Ambient temperature above 15°C, at least during part of the year, on a monthly average basis;

   (c) The minimum interval between two consecutive sludge removal events shall be 30 days.

[1] Other technologies in Table 6.3 of Chapter 6: Wastewater Treatment and Discharge of 2006 IPCC Guidelines for National Greenhouse Gas Inventories are included.

3. The recovered biogas from the above measures may also be utilised for the following applications instead of combustion/flaring:

(a) Thermal or mechanical,[2] electrical energy generation directly;

(b) Thermal or mechanical, electrical energy generation after bottling of upgraded biogas, in this case additional guidance provided in Annex 1 shall be followed; or

(c) Thermal or mechanical, electrical energy generation after upgrading and distribution, in this case additional guidance provided in Annex 1 shall be followed:

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

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

(iii) Upgrading and transportation of biogas (e.g. by trucks) to distribution points for end users.

(d) Hydrogen production;

(e) Use as fuel in transportation applications after upgrading.

4. If the recovered biogas is used for project activities covered under paragraph 3 (a), that component of the project activity can use a corresponding methodology under Type I.

5. For project activities covered under paragraph 3 (b), if bottles with upgraded biogas are sold outside the project boundary, the end-use of the biogas shall be ensured via a contract between the bottled biogas vendor and the end-user. No emission reductions may be claimed from the displacement of fuels from the end use of bottled biogas in such situations. If however the end use of the bottled biogas is included in the project boundary and is monitored during the crediting period CO_2 emissions avoided by the displacement of fossil fuel can be claimed under the corresponding Type I methodology, e.g. AMS-I.C “Thermal energy production with or without electricity”.

6. For project activities covered under paragraph 3 (c) (i), emission reductions from the displacement of the use of natural gas are eligible under this methodology, provided the geographical extent of the natural gas distribution grid is within the host country boundaries.

7. For project activities covered under paragraph 3 (c) (ii), emission reductions for the displacement of the use of fuels can be claimed following the provision in the corresponding Type I methodology, e.g. AMS-I.C.

8. In particular, for the case of 3 (b) and (c) (iii), the physical leakage during storage and transportation of upgraded biogas, as well as the emissions from fossil fuel consumed by vehicles

[2] For example combusted in a prime mover such as an engine coupled to a machine such as grinding machine.

for transporting biogas shall be considered. Relevant procedures in paragraph 11 of Annex 1 of AMS-III.H "Methane recovery in wastewater treatment" shall be followed in this regard.

9. For project activities covered under paragraph 3 (b) and (c), this methodology is applicable if the upgraded methane content of the biogas is in accordance with relevant national regulations (where these exist) or, in the absence of national regulations, a minimum of 96% (by volume).

10. If the recovered biogas is utilized for the production of hydrogen (project activities covered under paragraph 3 (d)), that component of the project activity shall use the corresponding methodology AMS-III.O "Hydrogen production using methane extracted from biogas".

11. If the recovered biogas is used for project activities covered under paragraph 3 (e), that component of the project activity shall use corresponding methodology AMS-III.AQ "Introduction of Bio-CNG in road transportation".

12. New facilities (Greenfield projects) and project activities involving a change of equipment resulting in a capacity addition of the wastewater or sludge treatment system compared to the designed capacity of the baseline treatment system are only eligible to apply this methodology if they comply with the relevant requirements in the "General guidelines to SSC CDM methodologies". In addition the requirements for demonstrating the remaining lifetime of the equipment replaced, as described in the general guidelines shall be followed.

13. The location of the wastewater treatment plant as well as the source generating the wastewater shall be uniquely defined and described in the PDD.

14. Measures are limited to those that result in aggregate emissions reductions of less than or equal to 60 kt CO_2 equivalent annually from all Type III components of the project activity.

Boundary

15. The project boundary is the physical, geographical site where the wastewater and sludge treatment takes place, in the baseline and project situations. It covers all facilities affected by the project activity including sites where processing, transportation and application or disposal of waste products as well as biogas takes place.

16. Implementation of the project activity at a wastewater and/or sludge treatment system will affect certain sections of the treatment systems while others may remain unaffected. The treatment systems not affected by the project activity, i.e. sections operating in the project scenario under the same operational conditions as in the baseline scenario (e.g. wastewater inflow and COD content, temperature, retention time, etc.), shall be described in the PDD, but emissions from those sections do not have to be accounted for in the baseline and project emission calculations (since the same emissions would occur in both baseline and project scenarios).[3] The assessment and identification of the systems affected by the project activity will be undertaken *ex ante*, and the PDD shall justify the exclusion of sections or components of the system. The treatment systems (lagoons, reactors, digesters, etc.) that will be covered and/or equipped with biogas recovery by the project activity, but continue to operate with the same quality of feed inflow, volume (retention time), and

[3] As per EB 22, annex 2 "Guidance regarding methodological issues" section E.

temperature (heating) as in the baseline scenario, may be considered as not affected i.e. the methane generation potential[4] remains unaltered.

Baseline

17. Wastewater and sludge treatment systems equipped with a biogas recovery facility in the baseline shall be excluded from the baseline emission calculations.

18. Baseline emissions for the systems affected by the project activity may consist of:

(i) Emissions on account of electricity or fossil fuel used ($BE_{power,y}$);

(ii) Methane emissions from baseline wastewater treatment systems ($BE_{ww,treatment,y}$);

(iii) Methane emissions from baseline sludge treatment systems ($BE_{s,treatment,y}$);

(iv) 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 ($BE_{ww,discharge,y}$);

(v) Methane emissions from the decay of the final sludge generated by the baseline treatment systems ($BE_{s,final,y}$).

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

Where:

BE_y	Baseline emissions in year y (tCO_2e)
$BE_{power,y}$	Baseline emissions from electricity or fuel consumption in year y (tCO_2e)
$BE_{ww,treatment,y}$	Baseline emissions of the wastewater treatment systems affected by the project activity in year y (tCO_2e)
$BE_{s,treatment,y}$	Baseline emissions of the sludge treatment systems affected by the project activity in year y (tCO_2e)
$BE_{ww,discharge,y}$	Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake in year y (tCO_2e). The value of this term is zero for the case 1 (b)
$BE_{s,final,y}$	Baseline methane emissions from anaerobic decay of the final sludge produced in year y (tCO_2e). 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

19. Baseline emissions from electricity and fossil fuel consumption ($BE_{power,y}$) are determined as per the procedures described in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and "Tool to calculate project or leakage CO2 emissions from fossil

[4] The covering of lagoons and the installation of biogas recovery equipment may result in changes in the operational conditions (such as temperature, COD removal, etc.) of an anaerobic treatment system. These changes are considered small and hence not accounted for under this methodology.

fuel combustion", respectively. The energy consumption shall include all equipment/devices in the baseline wastewater and sludge treatment facility. If recovered biogas in the baseline is used to power auxiliary equipment it should be taken into account accordingly, using zero as its emission factor.

20. Methane emissions from the baseline wastewater treatment systems affected by the project ($BE_{ww,treatment,y}$) are determined using the COD removal efficiency of the baseline plant:

$$BE_{ww,treatment,y} = \sum_i (Q_{ww,i,y} * COD_{\inf low,i,y} * \eta_{COD,BL,i} * MCF_{ww,treatment,BL,i}) * B_{o,ww} * UF_{BL} * GWP_{CH4} \quad \textbf{(2)}$$

Where:

$Q_{ww,i,y}$	Volume of wastewater treated in baseline wastewater treatment system *i* in year *y* (m^3). For *ex ante* estimation, forecasted wastewater generation volume or the designed capacity of the wastewater treatment facility can be used. However, the *ex post* emissions reduction calculation shall be based on the actual monitored volume of treated wastewater
$COD_{\inf low,i,y}$	Chemical oxygen demand of the wastewater inflow to the baseline treatment system *i* in year *y* (t/m^3). Average value may be used through sampling with the confidence/precision level 90/10
$\eta_{COD,BL,i}$	COD removal efficiency of the baseline treatment system *i*, determined as per the paragraphs 26, 27 or 28 below
$MCF_{ww,treatment,BL,i}$	Methane correction factor for baseline wastewater treatment systems *i* (*MCF* values as per Table III.H.1)
i	Index for baseline wastewater treatment system
$B_{o,ww}$	Methane producing capacity of the wastewater (IPCC value of 0.25 kg CH_4/kg COD)[5]
UF_{BL}	Model correction factor to account for model uncertainties (0.89)[6]
GWP_{CH4}	Global Warming Potential for methane (value of 21)

If the baseline treatment system is different from the treatment system in the project scenario, the monitored values of the COD inflow during crediting period will be used to calculate the baseline emissions *ex post*.

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[5] Project activities may use the default value of 0.6 kg CH_4/kg BOD, if the parameter $BOD_{5,20}$ is used to determine the organic content of the wastewater. In this case, baseline and project emissions calculations shall use BOD instead of COD in the equations, and the monitoring of the project activity 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] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

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

Table III.H.1. IPCC default values[7] 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	0.0
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

22. Methane emissions from the baseline sludge treatment systems affected by the project activity are determined using the methane generation potential of the sludge treatment systems:

$$BE_{treatment,s,y} = \sum_j S_{j,BL,y} * MCF_{s,treatment,BL,j} * DOC_s * UF_{BL} * DOC_F * F * 16/12 * GWP_{CH4} \quad (3)$$

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 (t). For *ex ante* estimation, forecasted sludge generation volume or the designed capacity of the sludge treatment facility can be used. However, the *ex post* emissions reduction calculation shall be based on the actual monitored volume of treated sludge
j	Index for baseline sludge treatment system
DOC_s	Degradable organic content of the untreated sludge generated in the year *y* (fraction, dry basis). Default values of 0.5 for domestic sludge and 0.257 for industrial sludge[8] shall be used
$MCF_{s,treatment,BL,j}$	Methane correction factor for the baseline sludge treatment system *j* (*MCF* values as per Table III.H.1)
UF_{BL}	Model correction factor to account for model uncertainties (0.89)
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)

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

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

If the sludge is composted, the following equation shall be applied:

$$BE_{s,treatment,y} = \sum_{j} S_{j,BL,y} * EF_{composting} * GWP_{CH4} \quad \textbf{(4)}$$

Where:

$EF_{composting}$	Emission factor for composting organic waste (t CH_4/t 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

23. If 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 of COD removed) in the baseline may differ significantly from that of the project scenario. For example, it is known that the amount of sludge generated in aerobic wastewater systems is larger than in anaerobic systems, for the same COD removal efficiency. Therefore, for these cases, the monitored values of the amount of sludge generated during the crediting period will be used to estimate the amount of sludge generated in the baseline, as follows:

$$S_{j,BL,y} = S_{l,PJ,y} * \frac{SGR_{BL}}{SGR_{PJ}} \quad \textbf{(5)}$$

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 (t)
SGR_{BL}	Sludge generation ratio of the wastewater treatment plant in the baseline scenario (tonne of dry matter in sludge/t COD removed). This ratio will be determined as per paragraphs 26, 27 or 28 below
SGR_{PJ}	Sludge generation ratio of the wastewater treatment plant in the project scenario (tonne of dry matter in sludge/t COD removed). Calculated using the monitored values of COD removal (i.e. $COD_{inflow,i}$ minus $COD_{outflow,i}$) and sludge generation in the project scenario

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

$$BE_{ww,discharge,y} = Q_{ww,y} * GWP_{CH4} * B_{o,ww} * UF_{BL} * COD_{ww,discharge,BL,y} * MCF_{ww,BL,discharge} \quad \textbf{(6)}$$

Where:

$Q_{ww,y}$	Volume of treated wastewater discharged in year *y* (m^3)
UF_{BL}	Model correction factor to account for model uncertainties (0.89)

$COD_{ww,discharge,BL,y}$	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake in the baseline situation in the year y (t/m^3). If the baseline scenario is the discharge of untreated wastewater, the COD of untreated wastewater shall be used
$MCF_{ww,BL,discharge}$	Methane correction factor based on discharge pathway in the baseline situation (e.g. into sea, river or lake) of the wastewater (fraction) (MCF values as per Table III.H.1)

To determine $COD_{ww,discharge,BL,y}$: if 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 26, 27 or 28 below.

25. Methane emissions from anaerobic decay of the final sludge produced 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 the final sludge generated by the baseline wastewater treatment systems in the year y (t). If the baseline wastewater treatment system is different from the project system, it will be estimated using the monitored amount of dry matter in the 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 5 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 the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
UF_{BL}	Model correction factor to account for model uncertainties (0.89)

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

27. For wastewater treatment plant that has been operating for at least three years and if one year of historical data is not available, the following procedures shall be followed:

(a) All the available data in determining the required parameters (COD removal efficiency, specific energy consumption and specific sludge production) shall be used to determine the baseline emissions in year y;

(b) An *ex ante* measurement campaign shall be implemented to determine the required parameters (COD removal efficiency, specific energy consumption and specific sludge production). The measurement campaign shall be implemented in the baseline wastewater systems for 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%). The parameters from the measurement campaign are used to calculate the baseline emission in year *y*;

(c) The baseline emissions in year *y* is taken as the minimum between the result of (a) and (b).

28. In the case of Greenfield and capacity addition projects, or existing plant without three year operating history, the following procedures shall be used to determine the baseline emissions:

(1) For existing plant without three year operating history, procedures in paragraph 27 shall be followed;

(2) For Greenfield and capacity addition projects, one of the following procedures shall be used:

(a) Value obtained from a measurement campaign in a comparable existing wastewater treatment plant i.e. having similar environmental and technological circumstances for example treating similar type of wastewater. 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. The treatment plant and wastewater source can be considered as similar as the baseline plant, whereby the measurement campaign can be implemented when following conditions can be fulfilled:

(i) The two sources of wastewater (wastewater treated in the selected plant and from the project activity) are of the same type, e.g. either domestic or industrial wastewater;

(ii) The selected plant and the baseline plants employ the same treatment technology (e.g. anaerobic lagoons or activated sludge), and the hydraulic retention times in their biological and physical treatment systems do not vary by more than 20%; and

(iii) For project activity treating industrial wastewater, both industries have the same raw material and final products, and apply the same industrial technology. Alternatively, different industrial wastewaters may be considered as similar if the following requirements are fulfilled:

- The ratio COD/BOD (related to the proportion of biodegradable organic matter) does not differ by more than 20%; and
- The ratio total COD / soluble COD (related to the proportion of suspended organic matter, and therefore to the sludge generation capacity) does not differ by more than 20%.

(b) Value provided by the manufacturer/designer of a Greenfield wastewater treatment plant using the same technology, demonstrated to be conservative, e.g. average values from the top 20 percent plants with lowest emission rate per ton COD removed among the plants installed in the last five years designed for the same country/region to treat the same type of wastewaters as the project activity.

Project Activity Emissions

29. Project activity emissions from the systems affected by the project activity are:

(i) CO_2 emissions from electricity and fuel used by the project facilities ($PE_{power,y}$);

(ii) Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery in the project scenario ($PE_{ww,treatment,y}$);

(iii) Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery in the project situation ($PE_{s,treatment,y}$);

(iv) Methane emissions on account of inefficiency of the project activity wastewater treatment systems and presence of degradable organic carbon in treated wastewater ($PE_{ww,discharge,y}$);

(v) Methane emissions from the decay of the final sludge generated by the project activity treatment systems ($PE_{s,final,y}$);

(vi) Methane fugitive emissions due to inefficiencies in capture systems ($PE_{fugitive,y}$);

(vii) Methane emissions due to incomplete flaring ($PE_{flaring,y}$);

(viii) Methane emissions from biomass stored under anaerobic conditions which would not have occurred in the baseline situation ($PE_{biomass,y}$).[9]

$$PE_y = \left\{ \begin{array}{l} PE_{power,y} + PE_{ww,treatment,y} + PE_{s,treatment,y} + PE_{ww,discharge,y} + PE_{s,final,y} + \\ PE_{fugitive,y} + PE_{biomass,y} + PE_{flaring,y} \end{array} \right\} \quad (8)$$

Where:

PE_y	Project activity emissions in the year y (tCO_2e)
$PE_{power,y}$	Emissions from electricity or fuel consumption in the year y (tCO_2e). These emissions shall be calculated as per paragraph 19, for the situation of the project scenario, using energy consumption data of all equipment/devices

[9] For instance in the baseline situation Palm Kernel Shells (PKS) are used as fuel in a boiler. In the project situation PKS is replaced by biogas captured at a wastewater treatment system. The PKS will no longer be used as fuel in the boiler, but sold on the market. Before it is sold it is likely it will be stored for a period of time (few months or longer) on site which might lead to methane emissions from anaerobic decay.

used in the project activity wastewater and sludge treatment systems and systems for biogas recovery and flaring/gainful use

$PE_{ww,treatment,y}$ Methane emissions from wastewater treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e). These emissions shall be calculated as per equation 2 in paragraph 20, using an uncertainty factor of 1.12 and data applicable to the project situation ($MCF_{ww,treatment,PJ,k}$ and $\eta_{,PJ,k,y}$) and with the following changed definition of parameters:

$MCF_{ww,treatment,PJ,k}$ Methane correction factor for project wastewater treatment system *k* (*MCF* values as per Table III.H.1)

$\eta_{,PJ,k,}$ Chemical oxygen demand removal efficiency of the project wastewater treatment system *k* in year *y* (t/m^3), measured based on inflow COD and outflow COD in system *k*

$PE_{s,treatment,y}$ Methane emissions from sludge treatment systems affected by the project activity, and not equipped with biogas recovery, in year *y* (tCO_2e). These emissions shall be calculated as per equations 3 and 4 in paragraph 22, using an uncertainty factor of 1.12 and data applicable to the project situation ($S_{l,PJ,y}$, $MCF_{s,treatment,l}$) and with the following changed definition of parameters:

$S_{l,PJ,y}$ Amount of dry matter in the sludge treated by the sludge treatment system *l* in the project scenario in year *y* (t)

$MCF_{s,treatment,l}$ Methane correction factor for the project sludge treatment system l (*MCF* values as per Table III.H.1)

$PE_{ww,discharge,y}$ Methane emissions from degradable organic carbon in treated wastewater in year *y* (tCO_2e). These emissions shall be calculated as per equation 6 in paragraph 24, using an uncertainty factor of 1.12 and data applicable to the project conditions ($COD_{ww,discharge,PJ,y}$, $MCF_{ww,PJ,discharge}$) and with the following changed definition of parameters:

$COD_{ww,discharge,PJ,y}$ Chemical oxygen demand of the treated wastewater discharged into the sea, river or lake in the project scenario in year *y* (t/m^3)

$MCF_{ww,PJ,discharge}$ Methane correction factor based on the discharge pathway of the wastewater in the project scenario (e.g. into sea, river or lake) (*MCF* values as per Table III.H.1)

$PE_{s,final,y}$	Methane emissions from anaerobic decay of the final sludge produced in year *y* (tCO_2e). These emissions shall be calculated as per equation 7 in paragraph 25, using an uncertainty factor of 1.12 and data applicable to the project conditions ($MCF_{s,PJ,final}$, $S_{final,PJ,y}$). If the sludge is controlled combusted, disposed in a landfill with biogas recovery, or used for soil application in aerobic conditions in the project activity, this term shall be neglected, and the sludge treatment and/or use and/or final disposal shall be monitored during the crediting period with the following revised definition of the parameters:

$MCF_{s,PJ,final}$	Methane correction factor of the disposal site that receives the final sludge in the project situation, estimated as per the procedures described in the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"
$S_{final,PJ,y}$	Amount of dry matter in final sludge generated by the project wastewater treatment systems in the year *y* (t)

$PE_{fugitive,y}$	Methane emissions from biogas release in capture systems in year *y*, calculated as per paragraph 30 (tCO_2e)
$PE_{flaring,y}$	Methane emissions due to incomplete flaring in year *y* (tCO_2e). For *ex ante* estimation, baseline emission calculation for wastewater and/or sludge treatment (i.e. equation 2 and/or equation 3) can be used but without the consideration of GWP for CH4. However, the *ex post* emission reduction shall be calculated as per the"Tool to determine project emissions from flaring gases containing methane" by using actual monitored data
$PE_{biomass,y}$	Methane emissions from biomass stored under anaerobic conditions. If storage of biomass under anaerobic conditions takes place in the project and does not occur in the baseline , methane emissions due to anaerobic decay of this biomass shall be considered and be determined as per the procedure in the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site" (tCO_2e)

30. Project activity emissions from methane release in capture systems are determined as follows:

(a) Based on the methane emission potential of wastewater and/or sludge:

$$PE_{fugitive,y} = PE_{fugitive,ww,y} + PE_{fugitive,s,y} \quad \textbf{(9)}$$

Where:

$PE_{fugitive,ww,y}$	Fugitive emissions through capture inefficiencies in the anaerobic wastewater treatment systems in the year *y* (tCO_2e)
$PE_{fugitive,s,y}$	Fugitive emissions through capture inefficiencies in the anaerobic sludge treatment systems in the year *y* (tCO_2e)

$$PE_{fugitive,ww,y} = (1 - CFE_{ww}) * MEP_{ww,treatment,y} * GWP_{CH4} \quad \textbf{(10)}$$

Where:

CFE_{ww}	Capture efficiency of the biogas recovery equipment in the wastewater treatment systems (a default value of 0.9 shall be used)
$MEP_{ww,treatment,y}$	Methane emission potential of wastewater treatment systems equipped with biogas recovery system in year y (t)

$$MEP_{ww,treatment,y} = Q_{ww,y} * B_{o,ww} * UF_{PJ} * \sum_k COD_{removed,PJ,k,y} * MCF_{ww,treatment,PJ,k} \quad \textbf{(11)}$$

Where:

$COD_{removed,PJ,k,y}$	The chemical oxygen demand removed[10] by the treatment system k of the project activity equipped with biogas recovery in the year y (t/m^3)
$MCF_{ww,treatment,PJ,k}$	Methane correction factor for the project wastewater treatment system k equipped with biogas recovery equipment (*MCF* values as per Table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)

$$PE_{fugitive,s,y} = (1 - CFE_{s}) * MEP_{s,treatment,y} * GWP_{CH4} \quad \textbf{(12)}$$

Where:

CFE_{s}	Capture efficiency of the biogas recovery equipment in the sludge treatment systems (a default value of 0.9 shall be used)
$MEP_{s,treatment,y}$	Methane emission potential of the sludge treatment systems equipped with a biogas recovery system in year y (t)

$$MEP_{s,treatment,y} = \sum_l (S_{l,PJ,y} * MCF_{s,treatment,PJ,l}) * DOC_s * UF_{PJ} * DOC_F * F * 16/12 \quad \textbf{(13)}$$

Where:

$S_{l,PJ,y}$	Amount of sludge treated in the project sludge treatment system l equipped with a biogas recovery system (on a dry basis) in year y (t)
$MCF_{s,treatment,PJ,l}$	Methane correction factor for the sludge treatment system equipped with biogas recovery equipment (*MCF* values as per Table III.H.1)
UF_{PJ}	Model correction factor to account for model uncertainties (1.12)

(b) Optionally a default value of 0.05 m³ biogas leaked/m³ biogas produced may be used as an alternative to calculations per equation 9 to 13.

Leakage

31. If the technology is using equipment transferred from another activity, leakage effects at the site of the other activity are to be considered and estimated (LE_y).

[10] Difference between the inflow COD and the outflow COD.

Emission Reduction

32. For all scenarios in paragraph 1, i.e. 1 (a) to 1 (f), emission reductions shall be estimated *ex ante* in the PDD using the equations provided in the baseline, project and leakage emissions sections above. Emission reductions shall be estimated *ex ante* as follows:

$$ER_{y,ex\ ante} = BE_{y,ex\ ante} - \left(PE_{y,ex\ ante} + LE_{y,ex\ ante}\right) \quad \textbf{(14)}$$

Where:

$ER_{y,ex\ ante}$	*Ex ante* emission reduction in year y (tCO_2e)
$LE_{y,ex\ ante}$	*Ex ante* leakage emissions in year y (tCO_2e)
$PE_{y,ex\ ante}$	*Ex ante* project emissions in year y calculated as paragraph 29 (tCO_2e)
$BE_{y,ex\ ante}$	*Ex ante* baseline emissions in year y calculated as per paragraph 18 (tCO_2e)

33. *Ex post* emission reductions shall be determined for case 1 (a) and 1 (e) as per paragraph 36. For cases 1 (b), 1 (c), 1 (d) and 1 (f), *ex post* emission reductions shall be based on the lowest value of the following, as per paragraph 34:

(i) The amount of biogas recovered and fuelled or flared (MD_y) during the crediting period, that is monitored *ex post*;

(ii) *Ex post* calculated baseline, project and leakage emissions based on actual monitored data for the project activity.

34. For cases 1 (b), 1 (c), 1 (d) and 1 (f): it is possible that the project activity involves wastewater and sludge treatment systems with higher methane conversion factors (*MCF*) or with higher efficiency than the 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. The emission reductions achieved in any year are the lowest value of the following:

$$\begin{aligned} ER_{y,ex\ post} &= \min((BE_{y,ex\ post} - PE_{y,ex\ post} - LE_{y,ex\ post}), \\ &(MD_y - PE_{power,y} - PE_{biomass,y} - LE_{y,ex\ post})) \end{aligned} \quad \textbf{(15)}$$

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 as per paragraph 18 using *ex post* monitored values
$PE_{y,ex\ post}$	Project emissions calculated as per paragraph 29 using *ex post* monitored values
MD_y	Methane captured and destroyed/gainfully used by the project activity in the year y (tCO_2e)

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

$$MD_y = BG_{burnt,y} * w_{CH4,y} * D_{CH4} * FE * GWP_{CH4} \quad \textbf{(16)}$$

Where:

$BG_{burnt,y}$	Biogas[11] flared/combusted in year y (m^3)
$w_{CH4,y}$	Methane content[13] of the biogas in the year y (volume fraction)
D_{CH4}	Density of methane at the temperature and pressure of the biogas in the year y (t/m^3)
FE	Flare efficiency in year y (fraction). If the biogas is combusted for gainful purposes, e.g. fed to an engine, an efficiency of 100% may be applied

36. For the cases listed in paragraph 1 such as:

(a) Substitution of an aerobic wastewater or sludge treatment system with an anaerobic treatment system with methane recovery and combustion; and

(b) Introduction of an anaerobic wastewater treatment system with methane recovery and combustion to an untreated wastewater stream.

The emission reduction achieved by the project activity (*ex post*) will be the difference between the baseline emissions and the sum of the project emissions and leakage.

$$ER_y = BE_{y,ex\ post} - \left(PE_{y,ex\ post} + LE_{y,ex\ post}\right) \quad \textbf{(17)}$$

The historical records of electricity and fuel consumption, the COD content of untreated and treated wastewater, and the quantity of sludge produced by the replaced units will be used for the baseline calculation.

In case (a), if the volumetric flow and the characteristic properties (e.g. COD) of the inflow and outflow of the wastewater are equivalent in the project and the baseline scenarios (i.e. the project and baseline systems have the same efficiency for COD removal for wastewater treatment), then the higher energy consumption and sludge generation in the baseline scenario are the only significant differences contributing to emissions reductions in the project case. In this case, the emission reductions can be calculated as the difference between the historical energy consumption of the replaced unit and the recorded energy consumption of the new system, plus the difference in emissions from sludge treatment and/or disposal. Project emissions from fugitive emissions and incomplete flaring ($PE_{fugitive,y}$, $PE_{flaring,y}$) shall also be considered in the calculation of the emission reductions, however the emissions from the wastewater outflow and sludge ($PE_{ww,discharge,y}$, $PE_{s,final,y}$) may be disregarded, if they are equivalent in the baseline and project scenarios.

[11] Biogas volume and methane content measurements shall be on the same basis (wet or dry).

Monitoring

37. Relevant parameters shall be monitored as indicated in the Table III.H.2. below. The applicable requirements specified in the "General Guidelines to SSC CDM Methodologies" (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines specified below and therefore shall be referred by the project participants.

Table III.H.2. Parameters for monitoring during the crediting period

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
1	$Q_{ww,i,y}$	The flow of wastewater	m³/month	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)	Measurements are undertaken using flow meters
2	$COD_{ww,untreated,y}$, $COD_{ww,treated,y}$, $COD_{ww,discharge,PJ,y}$	The chemical oxygen demand of the wastewater before and after the treatment system affected by the project activity	t COD/m³	Samples and measurements shall ensure a 90/10 confidence/precision level	Measure the COD according to national or international standards. COD is measured through representative sampling

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
3	$S_{l,PJ,y}$, $S_{final,PJ,y,}$	Amount of dry matter in the sludge	t	Monitoring of 100% of the sludge amount through continuous or batch measurements and moisture content through representative sampling to ensure the 90/10 confidence/precision level	Measure the total quantity of sludge on a wet basis. The volume (m^3) and density or direct weighing may be used to determine the sludge amount (wet basis). Representative samples are taken to determine the moisture content to calculate the total sludge amount on dry basis. If the methane emissions from anaerobic decay of the final sludge are to be neglected because the sludge is controlled combusted, disposed of 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. If the baseline emissions include 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

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
4	$BG_{burnt,y}$	Biogas volume in year *y*	m^3	Monitored continuously (at least hourly measurements are undertaken, if less, confidence/precision level of 90/10 shall be attained)	In all cases, the amount of biogas recovered, fuelled, flared or otherwise utilized (e.g. injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored *ex post*, using continuous flow meters. If the biogas streams flared and fuelled (or utilized) are monitored separately, the two fractions can be added together to determine the total biogas recovered, without the need to monitor the recovered biogas before the separation. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place
5	$w_{CH4,y}$	Methane content in biogas in the year *y*	%		The fraction of methane in the gas should be measured with a continuous analyser or, alternatively, with periodical measurements at a 90/10 confidence/precision level. It shall be measured using equipment that can directly measure methane content in the biogas - the estimation of methane content of biogas based on measurement of other constituents of biogas such as CO_2 is not permitted. The methane content measurement shall be carried out close to a location in the system where a biogas flow measurement takes place

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
6	*T*	Temperature of the biogas	°C	Shall be measured at the same time when methane content in biogas ($w_{CH4,y}$) is measured	The temperature of the gas is required to determine the density of the methane combusted. If the biogas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of biogas, then there is no need for separate monitoring of pressure and temperature of the biogas
7	*P*	Pressure of the biogas	Pa	Shall be measured at the same time when methane content in biogas ($w_{CH4,y}$) is measured	The pressure of the gas is required to determine the density of the methane combusted. If the biogas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of biogas, then there is no need for separate monitoring of pressure and temperature of the biogas
8		The flare efficiency	%		As per the “Tool to determine project emissions from flaring gases containing Methane”. Regular maintenance shall be carried out to ensure optimal operation of flares
9		Parameters related to emissions from electricity and/or fuel consumption in year *y*			As per the procedure in the “Tool to calculate baseline, project and/or leakage emissions from electricity consumption” and/or “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”. 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

No.	Parameter	Description	Unit	Monitoring/ recording Frequency	Measurement Methods and Procedures
10		Parameters related to methane emissions from biomass stored under anaerobic conditions which does not occur in the baseline situation	tCO_2e		As per the latest version of the "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site"

Project activity under a programme of activities

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

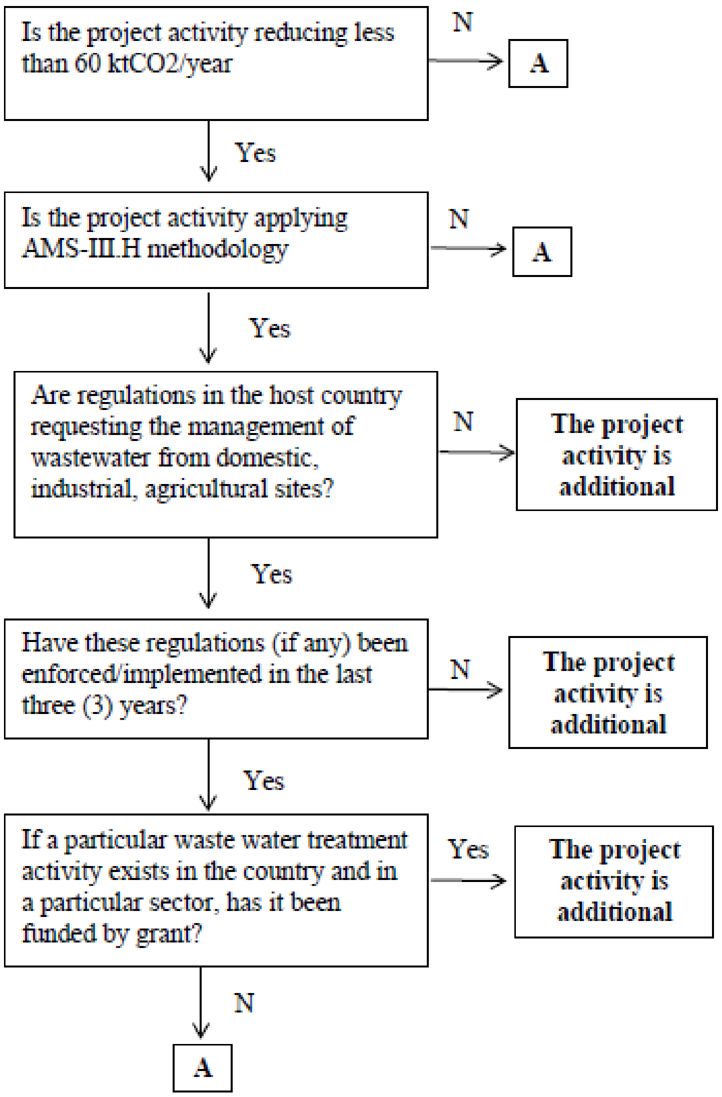
In case the project activity involves the replacement of equipment, and the leakage effect of the use of the replaced equipment in another activity is neglected, because the replaced equipment is scrapped, an independent monitoring of scrapping of replaced equipment needs to be implemented. The monitoring 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.

Automatic Additionality

Diagram 1 – Positive list for use/flare of landfill gas, AMS-III.G

Legend:

A Means use other means to demonstrate additionality such as *Guidelines on the demonstration of additonality of small-scale project activities*


Is the project activity reducing less than 60 ktCO2/year
N
A
Yes
Is the project activity applying AMS-III.H methodology
N
A
Yes
Are regulations in the host country requesting the management of wastewater from domestic, industrial, agricultural sites?
N
The project activity is additional
Yes
Have these regulations (if any) been enforced/implemented in the last three (3) years?
N
The project activity is additional
Yes
If a particular waste water treatment activity exists in the country and in a particular sector, has it been funded by grant?
Yes
The project activity is additional
N
A

Annex 1

PROVISIONS FOR UPGRADATION AND DISTRIBUTION OF BIOGAS

Project Boundary

1. In case of project activities covered under paragraph 3 (b) and (c),[12] if the project activity involves bottling of biogas the project boundary includes the upgrade and compression installations, the dedicated piped network/natural gas distribution grid for distribution of biogas from the wastewater treatment plant to the end user sites and all the facilities and devices connected directly to it.

Baseline

2. In case of project activities covered under paragraph 3 (c) (i) the baseline emissions for upgraded biogas injection ($BE_{injection,y}$) are determined as follows:

$$BE_{injection,y} = E_{ug,y} * CEF_{NG} \tag{1}$$

Where:

$BE_{injection,y}$	Baseline emissions for injection of upgraded biogas into a natural gas distribution grid in year y (tCO_2e)
$E_{ug,y}$	Energy delivered from the upgraded biogas in the project activity to the natural gas distribution grid in year y (TJ)
CEF_{NG}	Carbon emission factor of natural gas (tCO_2e/TJ); (Accurate and reliable local or national data may be used where available, otherwise appropriate IPCC default values shall be used)

3. The energy delivered from the upgraded biogas in the project activity to the natural gas distribution grid in year y ($E_{ug,y}$) is calculated as follows:

$$E_{ug,y} = Q_{ug,y} * NCV_{ug,y} \tag{2}$$

Where:

$Q_{ug,y}$	Quantity of upgraded biogas displacing the use of natural gas in the natural gas distribution grid in year y (kg or m^3)
$NCV_{ug,y}$	Net calorific value of the upgraded biogas in year y (TJ/kg or TJ/m^3)

[12] These are references to the section "technology/measure" in the methodology including upgrading of biogas before distribution to the quality of natural gas for use as fuel or for bottling or for injection into a natural gas distribution system. The eligible biogas upgrading technologies covered in this annex include: (1) Pressure Swing Adsorption; (2) Absorption with/without water circulation; (3) Absorption with water, with or without water recirculation (with or without recovery of methane emissions from discharge). For those technologies, please refer to annex 1 of the approved methodology AM0053 "Biogenic methane injection to a natural gas distribution grid"/Version 01.1 regarding the description of these technologies Project proponent may submit a request for revision to include more technology options.

4. The quantity of upgraded biogas displacing the use of natural gas in the natural gas distribution grid in year y is calculated as follows:

$$Q_{ug,y} = \min(Q_{ug,in,y}, Q_{cap,CH4,y}) \tag{3}$$

Where:

$Q_{ug,in,y}$	Quantity of upgraded biogas injected into the natural gas distribution grid in year y (kg or m^3)
$Q_{cap,CH4,y}$	Quantity of methane captured at the wastewater treatment source facility(ies) in year y (kg or m^3)

5. The quantity of methane captured at the waste water treatment source facility(ies) is calculated as follows:

$$Q_{cap,CH4,y} = w_{CH4,ww} * Q_{cap,biogas,y} \tag{4}$$

Where:

$w_{CH4,ww}$	Methane fraction of biogas as monitored at the outlet of the wastewater treatment source facility(ies) (kg or m^3 CH_4/kg or m^3 of biogas)
$Q_{cap,biogas,y}$	Monitored amount of biogas captured at the source facility(ies) in year y (kg or m^3)

Project activity emission

6. In case of project activities covered under paragraph 3 (b) and 3 (c) the following project emissions related to the upgrading and compression of the biogas ($PE_{process,y}$) shall be included:

(i) CO_2 emissions from electricity and fuel used by the upgrading facilities (tCO_2e);

(ii) Methane emissions from the discharge of the upgrading equipment (tCO_2e);

(iii) Fugitive methane emissions from leaks in compression equipment (tCO_2e);

(iv) Emissions on account of vent gases from upgrading equipment (tCO_2e).

$$PE_{process,y} = PE_{power,upgrade,y} + PE_{ww,upgrade,y} + PE_{CH4,equip,y} + PE_{ventgas,y} \tag{5}$$

Where:

$PE_{process,y}$	Project emissions related to the upgrading and compression of the biogas in year y (tCO_2e)
$PE_{power,upgrade,y}$	CO2 emissions from electricity and fuel used by the upgrading facilities (tCO_2e), as per paragraph 19 of AMS-III.H
$PE_{ww,upgrade,y}$	Emissions from methane contained in any waste water discharge of upgrading installation in year y (tCO_2e)
$PE_{CH4,equip,y}$	Emissions from compressor leaks in year y (tCO_2e)
$PE_{ventgas,y}$	Emissions from venting gases retained in upgrading equipment in year y (tCO_2e)

7. Project activity emissions from methane contained in waste water discharge of upgrading installation are determined as follows:

$$PE_{ww,upgrade,y} = Q_{ww,upgrade,y} * [CH_4]_{ww,upgrade,y} * GWP_{CH4} \quad \textbf{(6)}$$

Where:

$Q_{ww,upgrade,y}$	Volume of wastewater discharge from upgrading installation in year y
$[CH_4]_{ww,upgrade,y}$	Dissolved methane contained in the wastewater discharge in year y

8. Project activity emissions from compressor leaks are determined as follows:

$$PE_{CH4,equip,y} = GWP_{CH4} * (\frac{1}{1000}) * \sum_{equipment} w_{CH4,stream,y} * EF_{equipment} * T_{equipment,y} \quad \textbf{(7)}$$

Where:

$w_{CH4,stream,y}$	Average methane weight fraction of the gas (kg-CH_4/kg) in year y
$T_{equipment,y}$	Operation time of the equipment in hours in year y (in absence of detailed information, it can be assumed that the equipment is used continuously, as a conservative approach)
$EF_{equipment}$	Leakage rate for fugitive emissions from the compression technology as per specification from the compressor manufacturer in kg/hour/compressor. If no default value from the technology provider is available, the approach below shall be used

Fugitive methane emissions occurring during the recovery and processing of gas may in some projects be small, but should be estimated as a conservative approach. Emission factors may be taken from the 1995 Protocol for Equipment Leak Emission Estimates, published by EPA.[13]

Emissions should be determined for all relevant activities and all equipment used for the upgrading of biogas (such as valves, pump seals, connectors, flanges, open-ended lines, etc.).

The following data needs to be obtained:

(1) The number of each type of component in a unit (valve, connector, etc.);

(2) The methane concentration of the stream;

(3) The time period each component is in service.

The EPA approach is based on average emission factors for Total Organic Compounds (TOC) in a stream and has been revised to estimate methane emissions. Methane emissions are calculated for each single piece of equipment by multiplying the methane concentration with the appropriate emission factor from Table III.H.2 below.

[13] Please refer to the document US EPA-453/R-95-017 at: <http://www.epa.gov/ttn/chief/efdocs/equiplks.pdf>, accessed on 23/10/2007.

Table III.H.2. Methane emission factors for equipment[14]

Equipment type	Emission Factor (kg/hour/ source) for methane
Valves	4.5E-0.3
Pump seals	2.4E-0.3
Others[15]	8.8E-0.3
Connectors	2.0E-0.4
Flanges	3.9E-0.4
Open ended lines	2.0E-0.3

9. Project activity emissions from venting gases retained in upgrading equipment do not have to be considered if vent gases ($PE_{vent\ gas,y}$) are channeled to storage bags. In case vent gases are flared, emissions due to the incomplete or inefficient combustion of the gases will be calculated using the "Tool to determine project emissions from flaring gases containing methane", as follows:

$$PE_{ventgas,y} = \sum_{h=1}^{8760} TM_{RG,h} * (1 - \eta_{flare,h}) * \frac{GWP_{CH4}}{1000} \quad \textbf{(8)}$$

Where:

$TM_{RG,h}$ Mass flow rate of methane in the residual gas in hour *h* (kg/h)

$\eta_{flare,h}$ Flare efficiency in hour *h*

In case vent gases are not flared the "Tool to determine project emissions from flaring gases containing methane" will be used, without considering measurements and calculations for the flare efficiency, which will be assumed to be zero. In this case, emissions due to the vent gases will be:

$$PE_{y,ventgas} = \sum_{h=1}^{8760} TM_{RG,h} * \frac{GWP_{CH4}}{1000} \quad \textbf{(9)}$$

Alternatively, in case vent gases are directly vented to the atmosphere, it may also be calculated by conservatively calculating the mass of the gases vented based on the volume, pressure and temperature of gas retained in upgrading equipment. This mass should be multiplied with the frequency with which it is vented and assuming that the vented gas is pure methane.

In order to account for emissions that occur when the upgrade facility is shut down due to maintenance, repair work or emergencies one of the alternatives proposed above should be used to calculate and include emissions from flaring or venting.

10. In case of project activities covered under paragraph 3 (c) (ii) emissions due to physical leakage of upgraded biogas from the dedicated piped network ($PE_{leakage,pipeline,y}$) shall be determined as follows:

[14] Please refer to the document US EPA-453/R-95-017 Table 2.4, page 2-15, accessed on 23/10/2007.

[15] The emission factor for "other" equipment type was derived from compressors, diaphragms, drains, dump arms, hatches, instruments, meters, pressure relief valves, polished rods, relief valves and vents. This "other" equipment type should be applied for any equipment type other than connectors, flanges, open-ended lines, pumps or valves.

$$PE_{leakage,pipeline,y} = Q_{methane,pipeline,y} * LR_{pipeline} * GWP_{CH4} \quad \textbf{(10)}$$

Where:

$PE_{leakage,pipeline,y}$	Emissions due to physical leakage from the dedicated piped network in year *y* (tCO_2e)
$Q_{methane,pipeline,y}$	Total quantity of methane transported in the dedicated piped network in year *y* (m^3)
$LR_{pipeline}$	Physical leakage rate from the dedicated piped network (if no project-specific values can be identified a conservative default value of 0.0125 Gg per 10^6 m^3 of utility sales shall be applied[16])

Leakage emissions

11. In case of project activities covered under paragraph 3 (b) and the users of the bottles filled with upgraded biogas are not included in the project boundary then the following leakage emissions shall be included and calculated as follows:

(a) Emissions due to physical leakage of biogas from the bottles during storage, transport etc. until final end use (tCO_2e);

(b) Emissions due to fossil fuel use for transportation of bottles; biogas filled bottles to the end users and the return of empty bottles to the filling site (tCO_2e).

$$LE_{bottling,y} = LE_{leakage,bb,y} + LE_{trans,y} \quad \textbf{(11)}$$

Where:

$LE_{bottling,y}$	Leakage emissions project activities involving bottling of biogas in year *y* (tCO_2e)
$LE_{leakage,bb,y}$	Emissions due to physical leakage from biogas bottles in year *y* (tCO_2e)
$LE_{trans,y}$	Emissions due to fossil fuel use for transportation of bottles; biogas filled bottles to the end users and the return of empty bottles to the filling site in year *y* (tCO_2e)

12. Leakage emissions due to physical leakage from biogas bottles are determined as follows:

$$LE_{leakage,bb,y} = Q_{methane,bb,y} * LR_{bb} * GWP_{CH4} \quad \textbf{(12)}$$

Where:

$Q_{methane,bb,y}$	Total quantity of methane bottled in year *y* (m^3)
LR_{bb}	Physical leakage rate from biogas bottles (if no project-specific values can be

[16] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, chapter 4, Table 4.2.5 provides default values for fugitive emissions from gas operations in developing countries. The default values provided for fugitive emissions for the distribution of natural gas to end users range from 1.1 E-3 to 2.5 E-3 Gg per 10^6 m^3 of utility sales. The uncertainty in this value is -20% to 500%. A conservative value of 2.5 E-3 * 500% = 0.0125 Gg per 10^6 m^3 of utility sales shall be taken.

identified a default value of 1.25% shall be applied)[17]

13. Leakage emissions due to fossil fuel use for transportation of bottles (biogas filled bottles to the end users and the return of empty bottles to the filling site) are determined as below. If some of the locations of the end-users are unknown a conservative approach assuming transport emissions of 250 km, shall be used.

$$PE_{trans,y} = \left(\frac{Q_{bb,y}}{CT_{bb,y}} \right) * DAF_{bb} * EF_{CO2} \qquad \textbf{(13)}$$

Where:

$Q_{bb,y}$	Total freight volume of upgraded biogas in bottles transported in year y (m^3)
$CT_{bb,y}$	Average truck freight volume capacity for the transportation of bottles with upgraded biogas (m^3/truck)
DAF_{bb}	Aggregated average distance for bottle transportation; biogas filled bottles to the end users and the return of empty bottles to the filling site (km/truck)
EF_{CO2}	CO_2 emission factor from fuel use due to transportation (tCO_2/km)

Monitoring

14. The project proponents shall maintain a biogas (or methane) balance based on:

(a) Continuous measurement of the amount of biogas captured at the wastewater treatment system;

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

15. In case of project activities covered under paragraph 3 (c) the quantity of biogas, temperature, pressure and concentration of methane in the biogas injected into the natural gas grid/distributed via the dedicated piped network shall be measured continuously using certified equipment. The net calorific value (NCV) shall be measured directly from the gas stream using an online Heating Value Meter or calculated based on the measured methane content using the NCV of methane. This measurement must be in mass or volume basis and the project participants shall ensure that units of the measurements of the amount of biogas injected and of the net calorific value are consistent. The methane content of the injected or transported biogas shall always be in accordance with national regulations or, in absence of national regulations, 96% (by volume) or higher. Biogas injected or transported with inferior methane content shall be excluded from the emission reduction calculations.

[17] Victor (1989) Leaking Methane from Natural Gas Vehicles: Implication for Transportation Policy in the Greenhouse Era, in Climatic Change 20: 113-141, 1992 and American Gas Association (1986), 'Lost and Unaccounted for Gas', Planning and Analysis issues, issue brief 1986-28, p. 3.

16. In case of project activities covered under paragraph 3 (b) and 3 (c), the following parameters shall be monitored and recorded:

(a) The volume of discharge into the desorption pond from the upgrading installation ($Q_{ww,upgrade,y}$), monitored continuously;

(b) The methane content ($[CH_4]_{ww,upgrade,y}$) of the discharge water from the upgrade facility, samples are taken at least every six months during normal operation of the facility;

(c) The annual operation time of the compressor and each piece of equipment in the biogas upgrading and compression installations in hours ($T_{equipment,y}$). In case this information is not available it shall be assumed that the upgrading installation and compressor is used continuously;

(d) The quantity, pressure and composition of the bottled biogas, biogas injected into a natural grid or transported via a dedicated piped network; monitored continuously using flow meters and regularly calibrated methane monitors. The pressure of the biogas shall be regulated and monitored using a regularly calibrated pressure gauge. The methane content of the biogas shall always be in accordance with national regulations or, in absence of national regulations, 96% (by volume) or higher in order to ensure that biogas could readily be used as a fuel, inferior methane content shall be excluded from the emission reduction calculations;

(e) In case vent gases are calculated using the “Tool to determine project emissions from flaring gases containing methane”, the monitoring criteria contained in this tool shall be used. In case this tool is not used and the alternative approach in paragraph 9 of this annex is used, then temperature and pressure of gas retained in upgrading equipment shall be measured continuously and their values before the venting process are used, together with the volume capacity of the installation, to estimate the amount of methane released during the venting process;

(f) During the periods when the biogas upgrading facility is closed due to scheduled maintenance or repair of equipment or during exigencies, project participants should ensure that the captured biogas is flared at the site of its capture using an (emergency) flare. Appropriate monitoring procedures should be established to monitor this emergency flare;

(g) In case of project activities covered under paragraph 3 (b) the number and volume of biogas bottles produced and transported, the average truck capacity ($CT_{bb,y}$) and the average aggregated distance for transporting the bottled biogas (DAF_{bb}).

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History of the document

Version	Date	Nature of revision
16	EB 58, Annex 22 26 November 2010	To include additional guidelines pertaining to transport of biogas (e.g. by trucks) and biogas application for transportation; To clarify the conditions under which the measurement campaign can

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III.H. Methane recovery in wastewater treatment (cont)

Version	Date	Nature of revision
		be used for baseline emissions determination.
15	EB 55 Annex 34 30 July 2010	To clarify the criteria to be satisfied for the baseline lagoon treatments systems under the methodology; To include the monitoring table with the required frequency of measurements and options for collection and recording of data.
14	EB 53, Annex 17 26 March 2010	To include additional clarification on the monitoring requirements of biogas.
13	EB 48, Annex 21 17 July 2009	To include additional eligible technologies for upgrading biogas for bottling or feeding to natural gas distribution grid. Include an option to use the calculated net calorific value (NCV) of biogas based on methane content measurement instead of directly monitoring NCV using a NCV meter.
12	EB 47, Annex 26 28 May 2009	To include additional guidance on use of methane generation potential based on Biochemical Oxygen Demand ($BOD_{5,20}$).
11	EB 46, Annex 22 25 March 2009	To clarify the methods for determination of baseline for Greenfield projects; To specify minimum requirements concerning sludge removal interval in the baseline anaerobic lagoon; Further guidance on measuring equipment for biogas pressure, temperature and flow rate.
10	EB 42, Annex 17 26 September 2008	Additional guidance on baseline determination and project emission calculations; Restructured, provisions related to methane correction factor and related uncertainties were revised.
09	EB 38, Annex 10 14 March 2008	Expand applicability to include pipeline transport of the recovered and upgraded biogas; Additional guidance on sequential treatment of wastewater in anaerobic lagoons.
08	EB 36, Annex 24 30 November 2007	Expand applicability to bottling of recovered biogas; Additional guidance on emissions from dissolved methane in the treated wastewater; Guidance on use of IPCC default factors for the degradable organic content of sludge.
07	EB 35, Annex 29 19 October 2007	Expand the applicability to allow recovered biogas to be used for hydrogen production.
06	EB 33, Annex 35 27 July 2007	Additional leakage guidance to allow for application under a programme of activities (PoA).
05	EB 31, Annex 27 04 May 2007	To exclude scope 15 from the methodology
04	EB 28, Annex 26 15 December 2006	Broaden the applicability to include sequential stage of anaerobic wastewater treatment; Additional guidance based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories on the following: (a) Methane correction factor (*MCF*) determined by wastewater discharge pathways or type of treatment; (b) Default values for sludge treatment, particularly for degradable organic carbon (DOC) and methane correction factor (*MCF*).
03	EB 25, Annex 28 21 July 2006	Clarify the inclusion of methane emission factor in the equation for baseline calculations.
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 CO2e. If the emission reduction of a project activity exceeds the reference value of 25,000 tonnes CO2e in any

Version	Date	Nature of revision
		year of the crediting period, the annual emission reduction for that particular year is capped at 25,000 tonnes CO2e."
01	EB 23, Annex 23 24 February 2006	Initial adoption.

Decision Class: Regulatory
Document Type: Standard
Business Function: Methodology

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TYPE III - OTHER PROJECT ACTIVITIES

Project participants shall apply the general guidelines to small-scale (SSC) clean development mechanism (CDM) methodologies and the "Guidelines on the demonstrating of additionality of SSC project activities" at <http://cdm.unfccc.int/Reference/Guidclarif/index.html#meth> *mutatis mutandis.*

III.G. Landfill methane recovery

Technology/measure

1. This methodology comprises measures to capture and combust methane from landfills (i.e. solid waste disposal sites) used for the disposal of residues from human activities including municipal, industrial, and other solid wastes containing biodegradable organic matter.

2. Different options to utilise the recovered landfill gas as detailed in paragraph 3 of AMS-III.H "Methane recovery in wastewater treatment" (version 16) are eligible for use under this methodology. The relevant procedures in AMS-III.H shall be followed in this regard.

3. 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.

4. The proposed project activity does not reduce the amount of organic waste that would have been recycled in the absence of the project activity.

5. This methodology is not applicable if the management of the Solid Waste Disposal Site (SWDS) in the project activity is deliberately changed in order to increase methane generation compared to the situation prior to the implementation of the project activity (e.g. other than to meet a technical or regulatory requirement). Such changes may include, for example, the addition of liquids to a SWDS, pre-treating waste to seed it with bacteria for the purpose of increasing the rate of anaerobic degradation of the SWDS or changing the shape of the SWDS to increase methane production.

Boundary

6. The project boundary is the physical, geographical site of the landfill where the gas is captured and destroyed/used.

Baseline

7. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary, and methane is emitted to the atmosphere. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirements or legal regulations. In addition, the effect of methane oxidation that is present in the baseline and absent in the project shall be taken into account:[1]

[1] $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a portion of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool "Emissions from solid waste disposal sites". In addition to this effect, the installation of an LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, for example when the suction pressure is high, this air may cause a reduction in the amount of methane that is generated under the project activity. However, in most

$$BE_y = \eta_{PJ} * BE_{CH4,SWDS,y} - (1\text{-}OX) * F_{CH4,BL,y} * GWP_{CH4} \quad \textbf{(1)}$$

Where:

$BE_{CH4,SWDS,y}$ Methane emission potential of a solid waste disposal site (in tCO_2e), calculated using the methodological tool "Emissions from solid waste disposal sites". This tool may be used:

- With the factor "f=0.0"because the amount of LFG that would have been captured and destroyed is already accounted for in this equation;
- With the definition of year *x* as 'the year since the landfill started receiving wastes, *x* runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)'.

The amount of waste type *j* deposited each year *x* ($W_{j,x}$) shall be determined by sampling (as specified in the above-mentioned tool), in the case that waste is generated during the crediting period. Alternatively, for existing *SWDS*, if the pre-existing amount and composition of the wastes in the landfill are unknown, they can be estimated by using parameters related to the serviced population or industrial activity, or by comparison with other landfills with similar conditions at regional or national level

OX Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) (dimensionless). A default value of 0.1 may be used

η_{PJ} Efficiency of the LFG capture system that will be installed in the project activity. It is used for ex ante estimation only. A default value of 50% may be used

$F_{CH4,BL,y}$ Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year *y* (t_{CH4}). The relevant procedures in ACM0001 "Flaring or use of landfill gas" may be followed, as well as taking into account the compliance with the relevant local laws and regulation if such laws and regulations exist

GWP_{CH4} Global Warming Potential for methane (value of 21)

Project activity emissions

8. Project activity emissions consist of :

(a) CO_2 emissions from fossil fuel or electricity used by the project activity facilities ($PE_{power,y}$);

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

(c) Emissions from the landfill gas upgrading process ($PE_{process,y}$), where applicable.

$$PE_y = PE_{Power,y} + PE_{flare,y} + PE_{process,y} \quad \textbf{(2)}$$

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circumstances where the LFG is captured and used, this effect is considered to be very small, as the operators of SWDS have an incentive in most cases to achieve a high methane concentration in the LFG. For this reason, this effect is neglected for conservativeness.

Where:

PE_y	Project emissions in 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)
$PE_{flare,y}$	Emissions from flaring or combustion of the landfill gas stream in the year *y* (tCO_2e)
$PE_{process,y}$	Emissions from the landfill gas upgrading process in the year *y* (tCO_2e), determined by following the relevant procedures described in annex 1 of AMS-III.H

9. Project emissions from electricity consumption are determined as per the procedures described in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption", AMS-I.D "Grid connected renewable electricity generation". For project emissions from fossil fuel consumption, the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" shall be used. 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 landfill gas is used to power auxiliary equipment of the project activities (e.g. landfill gas extraction, cleaning, compression) it should be taken into account accordingly, using zero as its emission factor and energy used for such purpose is not eligible for a SSC CDM Type I project component.

10. If flaring (single or multiple) is used to destroy all or part of the recovered landfill gas, project emissions from flaring in year *y* ($PE_{flare,y}$ in tCO_2e) shall be determined for each flare following the procedure described in the methodological tool "Project emissions from flaring".

Leakage

11. If the methane recovery technology is equipment transferred from another activity, leakage effects are to be considered.

Emission reductions

12. The emission reduction achieved by the project activity can be estimated ex ante in the PDD by:

$$ER_{y,estimated} = BE_y - PE_y - LE_y \quad \textbf{(3)}$$

The actual emission reduction achieved by the project activity during the crediting period will be calculated using the amount of methane recovered and destroyed/gainfully used by the project activity, calculated as:

$$ER_{y,calculated} = (1\text{ - OX}) * (F_{CH4,PJ,y} - F_{CH4,BL,y}) * GWP_{CH4} - PE_y - LE_y \quad \textbf{(4)}$$

Where:

$F_{CH4,PJ,y}$	Methane captured and destroyed/gainfully used by the project activity in the year *y* (t_{CH4})

$$F_{CH4,PJ,y} = D_{CH4,y} * w_{CH4,y} * \sum_i LFG_{i,y} \quad \textbf{(5)}$$

Where:

$LFG_{i,y}$	Landfill gas destroyed via method i (flaring, fuelling, combustion, injection to a grid, etc.) in year y (m^3_{LFG}). The flow or volume measurement shall be made either on a dry basis or at the same humidity as $w_{CH4,y}$
$w_{CH4,y}$	Methane content in landfill gas in year y (volume fraction, m^3_{CH4}/m^3_{LFG}). Landfill gas composition shall be measured either on a dry basis or at the same humidity as used to determine $LFG_{i,y}$
$D_{CH4,y}$	Density of methane at the temperature and pressure of the landfill gas in year y (tonnes/m^3). If $LFG_{i,y}$ is reported at normal conditions of temperature and pressure, the density of methane is also determined at normal conditions

13. For project activities that utilize the recovered methane for power generation, $F_{CH4,PJ,y}$ may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration:

$$F_{CH4,PJ,y} = \frac{EG_y * 3600}{NCV_{CH4} * EE_y} * D_{CH4} * GWP_{CH4} \quad \textbf{(6)}$$

Where:

EG_y	Electricity generation in year y (MWh)
3600	Conversion factor (1 MWh = 3600 MJ)
NCV_{CH4}	NCV of methane (MJ/Nm^3) use default value: 35.9 MJ/Nm^3
EE_y	Energy Conversion Efficiency of the project equipment determined from one of the following options: - Specification provided by the equipment manufacturer specifically for biogas fuel only if the equipment is designed to utilize biogas as fuel. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation - Default efficiency of 40%

14. Project proponents shall provide evidence to a validating DOE that only the landfill gas recovered in the project is used for power generation; no other gas or fuels except a start-up fuel[2] are used.

15. The methods to be used for the integration of the values calculated from the above in equations 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.

[2] If a fuel is defined as a start-up fuel, it should not represent more than 1% of the total fuel utilized in the process, on energy basis.

16. Project activities where a portion of the recovered landfill gas is destroyed through flaring and the other portion is used for energy may consider applying the flare efficiency value to the portion of the landfill gas used for energy if separate measurements of the respective flows are not performed. When the amount of methane combusted for energy and the amount that is flared are monitored separately, or when only the landfill gas flow to the flare is monitored and the landfill gas used for energy is calculated based on electricity generation, a destruction efficiency of 100% can be used for the amount that is combusted for energy.[3]

Monitoring

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

18. Relevant parameters shall be monitored as indicated in the table below. The applicable requirements specified in the "General guidelines for SSC CDM methodologies" (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines specified below and therefore shall be applied by the project participants.

Project activity under a Programme of Activities

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

The methodology is applicable to a programme of activities. No additional leakage estimations are necessary other than that indicated under the leakage section above.

Automatic Additionality

Diagram 1 – Positive list for use/flare of landfill gas, AMS-III.G

Legend:

A Means use other means to demonstrate additionality such as *Guidelines on the demonstration of additonality of small-scale project activities*

[3] The energy component shall be either developed under a Type I SSC methodology or included in the project boundary with the energy output being monitored.

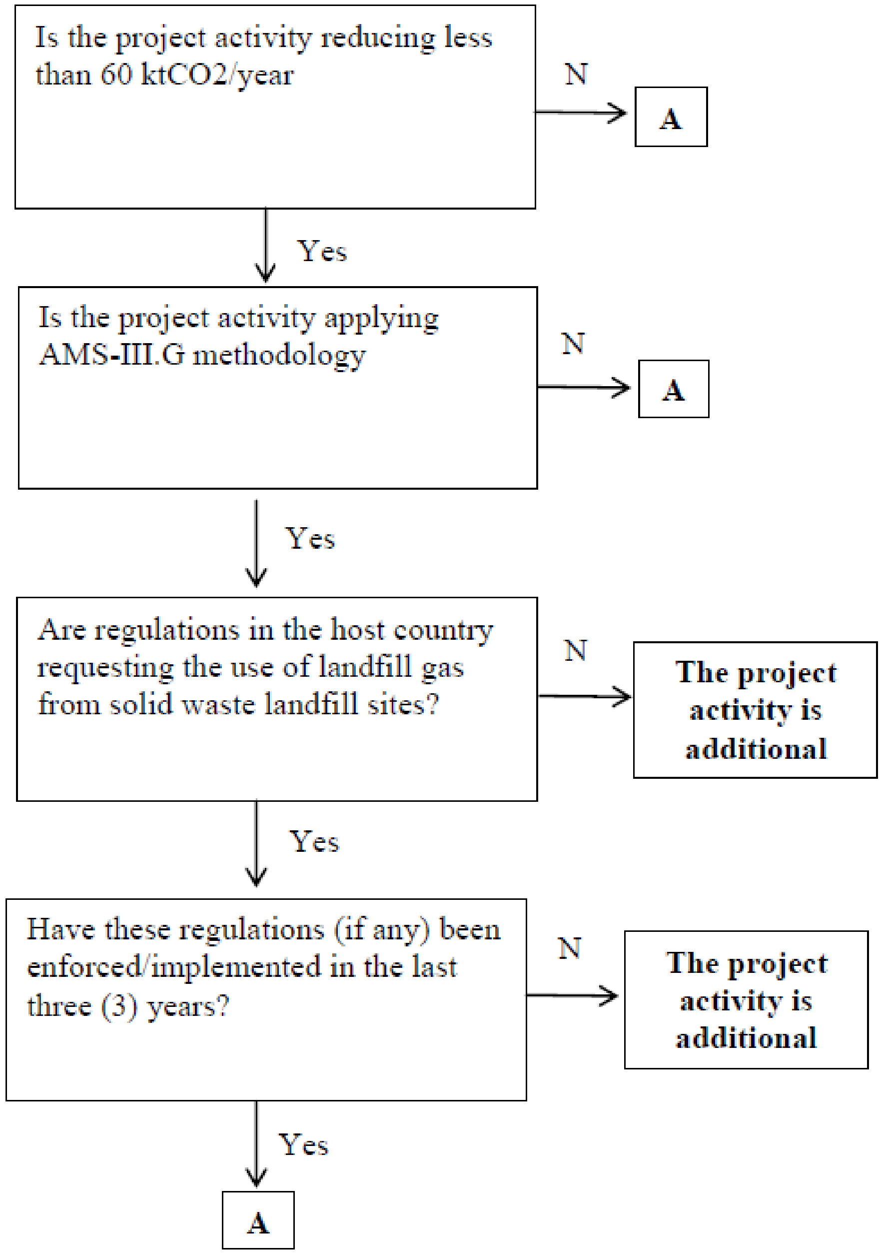
Is the project activity reducing less than 60 ktCO2/year
N
A
Yes
Is the project activity applying AMS-III.G methodology
N
A
Yes
Are regulations in the host country requesting the use of landfill gas from solid waste landfill sites?
N
The project activity is additional
Yes
Have these regulations (if any) been enforced/implemented in the last three (3) years?
N
The project activity is additional
Yes
A

Table I: Parameters for monitoring during the crediting period

No.	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
1.	$PE_{power,y}$	Parameters related to emissions from electricity and/or fuel consumption	tCO_2e		As per the procedure in AMS-I.D. Electricity consumption is directly metered, or alternatively is determined by assuming that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per year
2.	$PE_{flare,y}$	Emissions from flaring or combustion of the landfill gas stream in the year *y*	tCO_2e		As per the methodological tool “Project emissions from flaring”
3.	$PE_{process,y}$	Emissions from the landfill gas upgrading process	tCO_2e		As per the relevant provisions in AMS-III.H
4.	$LFG_{i,y}$	Landfill gas destroyed via method *i* in year *y*	m^3	Continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)	In all cases, the amount of landfill gas recovered, fuelled, flared or otherwise utilized (e.g. injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored ex post, using continuous flow meters. The methane content measurement shall be carried out close to a location in the system where the landfill gas flow, temperature and pressure measurements are carried out, and at the same humidity content (dry or at known or measured/corrected for humidity content)

No.	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
5.	$w_{CH4,y}$	Methane content in landfill gas in the year *y*	%, volume basis		The fraction of methane in the gas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or, alternatively, with periodical measurements at a 90/10 confidence/precision level. It shall be measured using equipment that can directly measure methane content in the landfill gas - the estimation of methane content of landfill gas based on measurement of other constituents of landfill gas such as CO_2 is not permitted. The methane content measurement shall be carried out close to the location in the system where the landfill gas flow, temperature and pressure measurements are carried out, and at the same humidity content (dry or at known or measured/corrected for humidity content)
6.	T	Temperature of the landfill gas	^{o}C	Shall be measured at the same time when methane content in landfill gas ($w_{CH4,y}$) is measured	The temperature of the gas is required to determine the density of the methane combusted. If the landfill gas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of landfill gas, then there is no need for separate monitoring of pressure and temperature of the landfill gas. Otherwise, landfill gas temperature measurement shall be made close to where the gas flow is measured
7.	P	Pressure of the landfill gas	Pa	Shall be measured at the same time when methane content in landfill gas ($w_{CH4,y}$) is measured	The pressure of the gas is required to determine the density of the methane combusted. If the landfill gas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of landfill gas, then there is no need for separate monitoring of pressure and temperature of the landfill gas. Otherwise, the landfill gas pressure measurement shall be made close to where the gas flow is measured

No.	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
8.	EG_y	Electricity generation in year *y*	MWh		Only required for project activities which utilize the recovered methane for power generation as per paragraph 13
9.	EE_y	Energy Conversion Efficiency of the project equipment	%		As per paragraph 13. Specification provided by the equipment manufacturer. The equipment shall be designed to utilize biogas as fuel, and the efficiency specification is for biogas. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation

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History of the document

Version	Date	Nature of revision(s)
08.0	13 September 2012	EB 69, Annex 24 To include: (i) oxidation factor and a landfill gas collection efficiency factor in line with ACM0001 "Flaring or use of landfill gas"; and (ii) an alternative method for determining methane destruction through monitoring of electricity generation.
07	EB 63, Annex 21 29 September 2011	To cover among others, more types of gainful use of landfill gas.
06	EB 38, Annex 12 14 March 2008	To exclude the consideration of landfill gas collection efficiency in the ex ante calculation of emission reduction; To include the possibility for pipeline transport of the recovered landfill gas.
05	EB 33, Annex 20 27 July 2007	To include emissions from the pre-existing waste in the baseline calculations.
04	EB 28, Annex 21 15 December 2006	To take into account the 2006 IPCC Guidelines for National Greenhouse Gas Inventories as well as to include a revision of the parameters of the first order decay (FOD) model as per the Methodological Tool titled "Tool to determine methane emissions avoided from dumping waste at a solid waste disposal site".
03	EB 25, Annex 26 21 July 2006	To clarify the procedure for estimating the baseline emissions as well as the procedure for estimating ex-ante emission reductions to be provided in the Project Design Document (CDM-SSC-PDD)
02	EB 24, Meeting Report, Para. 64 12, May 2006	Introduced the interim applicability condition i.e. 25 ktCO_2e/y limit from all Type III categories.
01	EB 23, Annex 21 24 February 2006	Initial adoption.
Decision Class: Regulatory **Document Type**: Standard **Business Function**: Methodology		