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 guidelines ~~to~~ for the SSC CDM methodologies, information on additionality (attachment A to appendix B) provided at: <http://cdm.unfccc.int/methodologies/SSCmethodologies/approved.html> *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 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 be recycled in the absence of the project activity.

5. This methodology is not applicable if the management of the 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). For example, this may apply to the addition of liquids to a SWDS, pre-treating waste to seed it with bacteria for the purpose of increasing the anaerobic degradation environment of the SWDS or changing the shape of the SWDS to increase the 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 requirement or legal regulations. In addition, the effect of methane oxidation that is present in the baseline and absent in the project is 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 part 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 a LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was considered to be very small, as the operators of the SWDS have in most

~~$BE_y = BE_{CH4,SWDS,y} - MD_{reg,y} * GWP_{CH4}$~~

$$BE_y = (1 - OX_{top\_layer}) * (\eta_{PJ} * BE_{CH4,SWDS,y} - F_{CH4,BL,y} * GWP_{CH4}) \quad (1)$$

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 ~~Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site~~". The tool may be used:

- With the factor "f=0.0" ~~assuming that no methane is captured and flared~~ 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 in each year *x* ($W_{j,x}$) shall be determined by sampling (as specified in the tool), in the case wastes are 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 attended population or industrial activity, or by comparison with other landfills with similar conditions in regional or national levels

OX_{top_layer} — Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless). A default value of 0.1 can 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% can be used

~~$MD_{reg,y}$~~ $F_{CH4,BL,y}$ — 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}). Relevant procedure in ACM0001 "Flaring or use of landfill gas" may be followed

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

Project activity emissions

8. Project activity emissions consist of :

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

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

cases an incentive to achieve a high methane concentration in the LFG. For this reason, this effect is neglected as a conservative assumption.

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

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

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 AMS-I.D “Grid connected renewable electricity generation”. For project emissions from fossil fuel consumption the emission factor for the fossil fuel shall be used (tCO_2/tonne). Local values are to be used, if local values are difficult to obtain, IPCC default values may be used. If recovered landfill gas is used to power auxiliary equipment of the project it should be taken into account accordingly, using zero as its emission factor.

10. In case 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 following the procedure described in the “Tool to determine project emissions from flaring gases containing methane” for each flare respectively.

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:

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

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

~~$ER_{y,calculated} = (MD_y - MD_{reg,y}) * GWP_{CH4} - PE_y - LE_y$~~

$$ER_{y,calculated} = (1 - OX_{top\_layer}) * (MD_y - F_{CH4,BL,y}) * GWP_{CH4} - PE_y - LE_y \quad (4)$$

Where:

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

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

Where:

$LFG_{i,y}$ Landfill gas destroyed via method i (flaring, fuelling, combustion, injection in a grid, etc.) in the year *y* (m^3_{LFG}). The flow or volume measurement shall be at dry basis or at same humidity basis as $w_{CH4,y}$

$w_{CH4,y}$ Methane content in landfill gas in the year *y* (volume ~~mass~~ fraction, m^3_{CH4}/m^3_{LFG}). Landfill gas composition shall be at dry basis or at same humidity basis as $LFG_{i,y}$

$D_{CH4,y}$ Density of methane at the temperature and pressure of the landfill gas in the year *y* (tonnes/m^3). If $LFG_{i,y}$ is reported at normal conditions of temperature and pressure, the density of methane is also taken at normal conditions

13. In case of project activities which utilize the recovered methane for power generation, MD_y may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration:

$$MD_y = \frac{EG_y * 3600}{NCV_{CH4} * EE_y} * D_{CH4} * GWP_{CH4} \quad \textbf{(6)}$$

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, which is determined by adopting one of the following options:

- Specification provided by the equipment manufacture. The equipment shall be designed to utilize biogas as fuel, and efficiency specification is for this fuel. In case the specification provides a range of efficiency, the highest value of the range shall be used for the calculation
- Default efficiency of [35 or 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 method for integration of the terms in equation above to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period.

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 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 that is combusted for energy and that is flared is separately monitored, 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 ~~to~~ 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 referred by the project participants.

[2] If a fuel is defined as a start-up fuel, it should not represent more than 3% of the total fuel utilized in the process, on energy basis.

[3] ~~Conditions apply:~~ 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.

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:

~~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.~~

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

Table III.G: 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 the AMS-I.D. Electricity consumption is directly metered or alternatively be determined by assuming that all relevant electrical equipment operate at full rated capacity, plus 10% to account for distribution losses, for 8760 hours per annum
2.	$PE_{flare,y}$	Emissions from flaring or combustion of the landfill gas stream in the year *y*	tCO_2e		As per the "Tool to determine project emissions from flaring gases containing methane"
3.	$PE_{process,y}$	Emissions from the landfill gas upgrading process	tCO_2e		As per 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 a landfill gas flow, temperature and pressure measurements take place, and at the same basis (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 a location in the system where a landfill gas flow, temperature and pressure measurements take place, and at the same basis (~~wet or~~ dry or at known or measured/corrected for humidity content)
6.	*T*	Temperature of the landfill gas	°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 close to a location where 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, landfill gas pressure measurement shall be close to a location where gas flow is measured
8	EG_y	Electricity generation in year *y*	MWh		Only required in case of project activities which utilize the recovered methane for power generation as per paragraph 13

No.	Parameter	Description	Unit	Monitoring/ recording frequency	Measurement methods and procedures
9	EE_y	Energy Conversion Efficiency of the project equipment	%		As per paragraph 13 Specification provided by the equipment manufacture. The equipment shall be designed to utilize biogas as fuel, and efficiency specification is for this fuel. In case the specification provides a range of efficiency, 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
08	EB 67, Annex # 11 May 2012	To include the alignment with the large scale methodology ACM0001 “Flaring or use of landfill gas” by introducing the oxidation factor and a LFG collection efficiency factor. To include simplified requirements for case of project activities that utilize the recovered methane for power generation, in which case the amount of methane captured may be calculated, based on the amount 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.
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