Methodological tool

"Tool to determine methane emissions avoided from disposal of ~~dumping~~ waste at a solid waste disposal site"

(Version 04)~~[1]~~

I. SCOPE, APPLICABILITY AND PARAMETERS

Scope and applicability

This tool calculates baseline emissions of methane from waste that would in the absence of the project activity be disposed at solid waste disposal sites (SWDS). The tool is not applicable to stockpiles.[2] Emission reductions are calculated with a first order decay model. The tool is applicable in cases where the solid waste disposal site where the waste would be dumped can be clearly identified. The tool is not applicable to hazardous wastes.

Parameters

This tool provides procedures to determine the following parameters:

Parameter	SI Unit	Description
$BE_{CH4,SWDS,y}$	tCO_2e	Methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site during the period from the start of the project activity to the end of the year y (tCO_2e)

II. BASELINE METHODOLOGY PROCEDURE

The amount of methane that would in the absence of the project activity be generated from disposal of waste at the solid waste disposal site ($BE_{CH4,SWDS,y}$) is calculated with a multi-phase model. The calculation is based on a first order decay (FOD) model. The model differentiates between the different types of waste j with respectively different decay rates k_j and different fractions of degradable organic carbon (DOC_j). The model calculates the methane generation based on the actual waste streams $W_{j,x}$ disposed in each year x, starting with the first year after the start of the project activity until the until the end of the year y, for which baseline emissions are calculated (years x with x = 1 to x = y).

In cases where at the SWDS methane is captured (e.g. due to safety regulations) and flared, combusted or used in another manner, the baseline emissions are adjusted for the fraction of methane captured at the SWDS.

~~[1] The version of this methodology was changed from 02.1 to 03 on 23 May 2008, due to incorrect numbering.~~

[2] In this context, stockpiles are solid waste disposal sites where anaerobic conditions are not ensured because they are exposed to higher aeration due to a larger surface area to volume ratio, or because their permanence cannot be ensured, for example waste can be easily moved from one place to another or is subject to the risk of incidental fires. The approach to determine emissions from stockpiles as described in AMS-III.E cannot be used for large-scale project activities.

The amount of methane produced in the year *y* ($BE_{CH4,SWDS,y}$) is calculated as follows:

$$BE_{CH4,SWDS,y} = \varphi \cdot (1-f) \cdot GWP_{CH4} \cdot (1-OX) \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j} W_{j,x} \cdot DOC_j \cdot e^{-k_j \cdot (y-x)} \cdot \left(1 - e^{-k_j}\right) \quad \textbf{(1)}$$

Where:

$BE_{CH4,SWDS,y}$ = Methane emissions avoided during the year *y* from preventing waste disposal at the solid waste disposal site (SWDS) during the period from the start of the project activity to the end of the year y (tCO_2e)
φ = Model correction factor to account for model uncertainties (0.9)
f = Fraction of methane captured at the SWDS and flared, combusted or used in another manner
GWP_{CH4} = Global Warming Potential (GWP) of methane, valid for the relevant commitment period
OX = Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste)
F = Fraction of methane in the SWDS gas (volume fraction) (0.5)
DOC_f = Fraction of degradable organic carbon (DOC) that can decompose
MCF = Methane correction factor
$W_{j,x}$ = Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
DOC_j = Fraction of degradable organic carbon (by weight) in the waste type *j*
k_j = Decay rate for the waste type *j*
j = Waste type category (index)
x = Year during the crediting period: x runs from the first year of the first crediting period (x = 1) to the year y for which avoided emissions are calculated (x = y)
y = Year for which methane emissions are calculated

Where different waste types *j* are prevented from disposal, determine the amount of different waste types ($W_{j,x}$) through sampling and calculate the mean from the samples, as follows:

$$W_{j,x} = W_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z} \quad \textbf{(2)}$$

Where:

$W_{j,x}$ = Amount of organic waste type *j* prevented from disposal in the SWDS in the year *x* (tons)
W_x = Total amount of organic waste prevented from disposal in year *x* (tons)
$p_{n,j,x}$ = Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
z = Number of samples collected during the year *x*

Changes required for methodology implementation in 2nd and 3rd crediting periods

At the renewal of the crediting period, the following data should be updated according to default values suggested in the most recently published IPCC Guidelines for National Greenhouse Gas Inventories:

- Oxidation factor (*OX*);
- Fraction of methane in the SWDS gas (*F*);
- Fraction of degradable organic carbon (*DOC*) that can decompose (DOC_f);
- Methane correction factor (*MCF*);
- Fraction of degradable organic carbon (by weight) in each waste type *j* (*DOCj*);
- Decay rate for the waste type *j* (k_j).

Respectively, if the most recent IPCC Guidelines suggest different categorization of waste types, solid waste disposal sites or climate conditions, these should be applied respectively.

Data and parameters not monitored

Data / parameter:	φ
Data unit:	-
Description:	Model correction factor to account for model uncertainties
Value to be applied:	0.9
Any comment:	Oonk et el. (1994) have validated several landfill gas models based on 17 realized landfill gas projects. The mean relative error of multi-phase models was assessed to be 18%. Given the uncertainties associated with the model and in order to estimate emission reductions in a conservative manner, a discount of 10% is applied to the model results.

Data / parameter:	OX
Data unit:	-
Description:	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
Source of data:	Conduct a site visit at the solid waste disposal site in order to assess the type of cover of the solid waste disposal site. Use the IPCC 2006 Guidelines for National Greenhouse Gas Inventories for the choice of the value to be applied.
Value to be applied:	Use 0.1 for managed solid waste disposal sites that are covered with oxidizing material such as soil or compost. Use 0 for other types of solid waste disposal sites.
Any comment:	

Data / parameter:	F
Data unit:	-
Description:	Fraction of methane in the SWDS gas (volume fraction)
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comment:	This factor reflects the fact that some degradable organic carbon does not degrade, or degrades very slowly, under anaerobic conditions in the SWDS. A default value of 0.5 is recommended by IPCC.

Data / parameter:	DOC_f
Data unit:	-
Description:	Fraction of degradable organic carbon (DOC) that can decompose
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	0.5
Any comment:	

Data / parameter:	MCF
Data unit:	-
Description:	Methane correction factor
Source of data:	IPCC 2006 Guidelines for National Greenhouse Gas Inventories
Value to be applied:	Use the following values for MCF: • 1.0 for **anaerobic managed solid waste disposal sites**. These must have controlled placement of waste (i.e., waste directed to specific deposition areas, a degree of control of scavenging and a degree of control of fires) and will include at least one of the following: (i) cover material; (ii) mechanical compacting; or (iii) leveling of the waste; • 0.5 for **semi-aerobic managed solid waste disposal sites**. These must have controlled placement of waste and will include all of the following structures for introducing air to waste layer: (i) permeable cover material; (ii) leachate drainage system; (iii) regulating pondage; and (iv) gas ventilation system; • 0.8 for **unmanaged solid waste disposal sites – deep and/or with high water table**. This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of greater than or equal to 5 meters and/or high water table at near ground level. Latter situation corresponds to filling inland water, such as pond, river or wetland, by waste; • 0.4 for **unmanaged-shallow solid waste disposal sites.** This comprises all SWDS not meeting the criteria of managed SWDS and which have depths of less than 5 metres.
Any comment:	The methane correction factor (MCF) accounts for the fact that unmanaged SWDS produce less methane from a given amount of waste than managed SWDS, because a larger fraction of waste decomposes aerobically in the top layers of unmanaged SWDS.

<table>
<tr><td>Data / parameter:</td><td>DOC_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Fraction of degradable organic carbon (by weight) in the waste type <i>j</i></td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Tables 2.4 and 2.5)</td></tr>
<tr><td>Values to be applied:</td><td>Apply the following values for the different waste types <i>j</i>:
<table>
<tr><th>Waste type <i>j</i></th><th>DOC_j (% wet waste)</th><th>DOC_j (% dry waste)</th></tr>
<tr><td>Wood and wood products</td><td>43</td><td>50</td></tr>
<tr><td>Pulp, paper and cardboard (other than sludge)</td><td>40</td><td>44</td></tr>
<tr><td>Food, food waste, beverages and tobacco (other than sludge)</td><td>15</td><td>38</td></tr>
<tr><td>Textiles</td><td>24</td><td>30</td></tr>
<tr><td>Garden, yard and park waste</td><td>20</td><td>49</td></tr>
<tr><td>Glass, plastic, metal, other inert waste</td><td>0</td><td>0</td></tr>
</table>
If a waste type, prevented from disposal by the proposed CDM project activity, can not clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.
In the case of empty fruit bunches (EFB), as their characteristics are similar to garden waste, the parameter value correspondent of garden shall be used.</td></tr>
<tr><td>Any comment:</td><td></td></tr>
</table>

<table>
<tr><td>Data / parameter:</td><td>k_j</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Decay rate for the waste type <i>j</i></td></tr>
<tr><td>Source of data:</td><td>IPCC 2006 Guidelines for National Greenhouse Gas Inventories (adapted from Volume 5, Table 3.3)</td></tr>
<tr><td>Values to be applied:</td><td>Apply the following default values for the different waste types <i>j</i>
<table>
<tr><th colspan="2" rowspan="2">Waste type <i>j</i></th><th colspan="2">Boreal and Temperate (MAT≤20°C)</th><th colspan="2">Tropical (MAT>20°C)</th></tr>
<tr><th>Dry (MAP/PET <1)</th><th>Wet (MAP/PET >1)</th><th>Dry (MAP< 1000mm)</th><th>Wet (MAP> 1000mm)</th></tr>
<tr><td rowspan="2">Slowly degrading</td><td>Pulp, paper, cardboard (other than sludge), textiles</td><td>0.04</td><td>0.06</td><td>0.045</td><td>0.07</td></tr>
<tr><td>Wood, wood products and straw</td><td>0.02</td><td>0.03</td><td>0.025</td><td>0.035</td></tr>
<tr><td>Moderately degrading</td><td>Other (non-food) organic putrescible garden and park waste</td><td>0.05</td><td>0.10</td><td>0.065</td><td>0.17</td></tr>
<tr><td>Rapidly degrading</td><td>Food, food waste, sewage sludge, beverages and tobacco</td><td>0.06</td><td>0.185</td><td>0.085</td><td>0.40</td></tr>
</table>
NB: MAT – mean annual temperature, MAP – Mean annual precipitation, PET – potential evapotranspiration. MAP/PET is the ratio between the mean annual precipitation and the potential evapotranspiration.

If a waste type, prevented from disposal by the proposed CDM project activity, can not clearly be attributed to one of the waste types in the table above, project participants should choose among the waste types that have similar characteristics that waste type where the values of DOC_j and k_j result in a conservative estimate (lowest emissions), or request a revision of / deviation from this methodology.
In the case of empty fruit bunches (EFB), as their characteristics are similar to garden waste, the parameter values correspondent of garden waste shall be used.</td></tr>
<tr><td>Any comment:</td><td>Document in the CDM-PDD the climatic conditions at the SWDS site (temperature, precipitation and, where applicable, evapotranspiration). Use long-term averages based on statistical data, where available. Provide references.</td></tr>
</table>

III. MONITORING METHODOLOGY PROCEDURE

Monitoring procedures

Monitoring involves an annual assessment of the conditions at the solid waste disposal site (SWDS) where the waste would in the absence of the project activity be dumped. Methane emissions from preventing disposal of waste at the SWDS can only be claimed if there is no gas from the SWDS being captured and flared or combusted.

Data and parameters monitored

Data / parameter:	f
Data unit:	-
Description:	Fraction of methane captured at the SWDS and flared, combusted or used in another manner
Source of data:	Written information from the operator of the solid waste disposal site and/or site visits at the solid waste disposal site
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	

Data / parameter:	GWP_{CH4}
Data unit:	tCO_2e / t CH_4
Description:	Global Warming Potential (GWP) of methane, valid for the relevant commitment period
Source of data:	Decisions under UNFCCC and the Kyoto Protocol (a value of 21 is to be applied for the first commitment period of the Kyoto Protocol)
Monitoring frequency:	Annually
Any comment:	

Data / parameter:	W_x
Data unit:	tons
Description:	Total amount of organic waste prevented from disposal in year *x* (tons)
Source of data:	Measurements by project participants
Measurement procedures (if any):	
Monitoring frequency:	Continuously, aggregated at least annually
QA/QC procedures:	
Any comment:	

Data / parameter:	$p_{n,j,x}$
Data unit:	-
Description:	Weight fraction of the waste type *j* in the sample *n* collected during the year *x*
Source of data:	Sample measurements by project participants.
Measurement procedures (if any):	Sample the waste prevented from disposal, using the waste categories *j*, as provided in the table for DOC_j and k_j, and weigh each waste fraction.
Monitoring frequency:	The size and frequency of sampling should be statistically significant with a maximum uncertainty range of 20% at a 95% confidence level. As a minimum, sampling should be undertaken four times per year.
QA/QC procedures:	
Any comment:	This parameter only needs to be monitored if the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for DOC_j and k_j.

Data / parameter:	z
Data unit:	-
Description:	Number of samples collected during the year *x*
Source of data:	Project participants
Monitoring frequency:	Continuously, aggregated annually
QA/QC procedures:	
Any comment:	This parameter only needs to be monitored if the waste prevented from disposal includes several waste categories *j*, as categorized in the tables for DOC_j and k_j.

IV. REFERENCES AND ANY OTHER INFORMATION

Oonk H., Weenk A., Coops O., Luning L. (1994) Validation of landfill gas formation models; EWAB 9427; NOVEM, Utrecht, The Netherlands.

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History of the document

Version	Date	Nature of revision(s)
04	EB 41, Annex 10 02 August 2008	The title was changed to read “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”. Clarified that the tool is not applicable to stockpiles.
03[3]	EB 39, Annex 9 16 May 2008	Specified that k and DOC values for EFB shall be those corresponding to garden waste
02	EB 35, Annex 10 19 October 2007	Added: a) Example of how specific values of k & DOC should be chosen. b) k value of sewage sludge.
01	EB 26, Annex 14 29 September 2006	Initial adoption

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[3] The version was changed from 02.1 to 03 on 23 May 2008, due to incorrect numbering.