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

TYPE III - OTHER PROJECT ACTIVITIES

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

III.AF. Avoidance of methane emissions through excavating and composting of partially decayed municipal solid waste (MSW)

Technology/measure

1. This methodology comprises measures to avoid emissions of methane to the atmosphere from MSW that is already deposited in a closed solid waste disposal site (SWDS) without methane recovery. In the project activity, methane emissions will be avoided by applying the following sequential measure/steps:

   (a) Aerobic pre-treatment by aerating the existing SWDS to achieve a safe operation environment for the subsequent excavation;

   (b) Excavating the MSW from the SWDS and separation into inert and non-inert materials; the excavation phase has to commence immediately after the pre-aeration phase, i.e., without significant time lag;

   (c) Composting the non-inert material and proper soil application of the compost.

2. For the purpose of this methodology, the following definitions apply:

   - Closed SWDS: Site that has stopped receiving waste for disposal, according to the record given by the competent authority, if applicable;
   - Aeration: Air injection (high pressure air enriched with oxygen at 20-40% (vol) or low pressure ambient air) into SWDS;
   - Gas extraction: Controlled extraction of the off-gases and treatment during the aeration phase, e.g., by means of bio-filters;
   - Excavation: Withdraw/extraction of the pre-treated MSW by diggers;
   - Separation: Segregation of the excavated material into inert and non-inert fractions by screens or sieves with mesh size of 25-60mm;
   - Non-inert: The undersize fraction which can pass through the screens/sieves used in the separation process, it is assumed this portion of MSW decomposes in the baseline (e.g., food, wood and paper);
   - Inert: The remaining oversize fraction which can not pass through the screens/sieves used in the separation process, it is assumed this portion of MSW does not decompose during crediting period (e.g., plastic, glass and metals).

3. The project activity does not recover or combust landfill gas from the disposal site (unlike AMS-III.G), does not undertake controlled combustion of the waste that is not treated biologically in a first step (unlike AMS-III.E), does not treat fresh MSW (unlike AMS-III.F), and is not aimed at emission reductions from recovery and reuse of recyclable inert material contained in the MSW.

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

5. The location, characteristics of the SWDS and proportions of the different types of organic waste disposed in the SWDS and treated by the project activity, shall be known, in such a way as to allow the estimation of its methane emissions *ex ante*, according the latest version of “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”.

6. Total amount of waste deposited in the SWDS per year, shall be obtained from recorded data of waste disposals, or estimated according to the level of activity that generated the waste (for example, considering the amount of MSW generated by the municipality and disposed in the SWDS in that year).

7. When compost is submitted to soil application, the place of compost application needs to be included into the project boundary and the proper conditions (i.e., handled aerobically) and procedures (not resulting in methane emissions) need to be ensured.

8. This methodology is applicable if the aerobic pre-treatment is realized either through high pressure air injection enriched with oxygen 20-40% (vol.) or low pressure aeration using ambient air. Both measures shall ensure aerobic conditions during the pre-treatment phase, allowing a safe MSW excavation during excavation phase. Sample based monitoring in the extraction gas pipes as well as in the monitoring wells shall be undertaken; oxygen content shall be at least 1% (v/v) and the permissible maximum methane concentration is 5 % (v/v).

9. If enriched oxygen is used for aeration in the project activity, emissions related to oxygen production shall be taken into account.

10. The use of the land after SWDS restoration shall be for non commercial purposes (e.g., municipal parks) and shall not be used for a landfill not equipped with methane recovery or flaring.

11. This methodology is not applicable in case the existing regulations require the capture and flaring of landfill gas of closed SWDS.

12. The measures are undertaken so as to comply with all local regulations, or, in the absence of such regulations, internationally accepted regulations for safety and environmental protection especially related to: fire risks, nuisance and odors control, quality of runoff water, final compost contamination and risks at workplaces shall be complied with.

13. This methodology is only applicable if the composting process is realized at enclosed chambers or roofed sites, outdoor composting is not applicable due to the possible generation of runoff water and consequently methane generation during waste treatment.

Boundary

14. The project boundary is the physical, geographical site:

(a) Where the MSW is already deposited and the methane emission occurs in the absence of the proposed project activity;

(b) Where the treatment of MSW through composting takes place;

(c) Where the compost is handled and submitted to soil application;

(d) And the itineraries between them (a, b, and c), where the transportation of waste and compost occurs.

Baseline

15. The baseline scenario is the situation where, in the absence of the project activity, MSW is left to decay within the project boundary and methane is emitted to the atmosphere. The yearly baseline emissions are the amount of methane that would have been emitted from the decay of the quantity of the waste removed and composted from the disposal site by the project activity.

16. The baseline emission is calculated as the minimum of the two values below:

(a) *Ex ante* estimation as per the method described in paragraph 17 ($BE_{y,ex-ante}$);

(b) *Ex post* calculated as per the method described in paragraph 18 ($BE_{y,ex-post}$) ;

17. To determine *ex ante* baseline emissions from MSW that has partially decayed in a SWDS, the calculation of the yearly methane generation potential of the waste excavated and composted from the beginning of the excavation (x=1) up to the year *y* will consider the age of the waste at the start of the project. One of the following options may be used:

(a) Estimate the mean age of the waste contained in the disposal site in the beginning of the project activity (“ā”). It may be estimated as the weighted average age considering the yearly amount of waste deposited in the SWDS since its beginning of operation up to the year prior to the start of the project:

$$\bar{a} = \frac{1 \cdot A_1 + 2 \cdot A_2 + 3 \cdot A_3 + ... + a \cdot A_a}{A_1 + A_2 + A_3 + ... + A_a} = \frac{\sum_{a=1}^{a\max} A_a \cdot a}{\sum_{a=1}^{a\max} A_a} \quad (1)$$

Where:

ā	Weighted mean age of the waste present in the SWDS prior to the project start
a	Years before project start, starting in the first year before project start (a=1) up to the maximal age of the waste contained in the SWDS after the waste disposal starts (a=amax.)
A_a	Total amount of waste deposited in the SWDS in each year “a”. It shall be obtained from recorded data of waste disposals

If the yearly amount of waste deposited in the SWDS cannot be estimated, then an arithmetic mean age may be used (ā = 0.5 * amax). By using this option, the baseline emissions at any *year y*

($BE_{y,ex-ante}$) during the crediting period are calculated according to the latest version of “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”, nevertheless, the exponential term for the first order decay model “exp [-k_j.(y-x)]” will be corrected for the mean age, and will be substituted by “exp[-k_j.(y-x+ā)]”.

(b) Calculate the yearly methane generation potential of the SWDS as described in the latest version of “Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site”, considering the total amount and composition of waste deposited since its start of operation. The methane generation potential of the waste removed to be composted up to the *year y* in the crediting period will be estimated as proportional to the mass fraction of these waste, relative to the initial amount:

$$BE_{y,ex-ante} = \frac{\sum_{x=1}^{y} A_x}{A} BE_{CH4,SWDS,y} \tag{2}$$

Where:

A_x	Amount of waste removed to be composted in the year “x” (tonnes)
A	Total amount of waste present in the SWDS at the beginning of the project activity (tonnes)
$BE_{CH4,SWDS,y}$	Yearly methane generation potential of the SWDS at the *year y*, considering all the waste deposited in it since its beginning of operation, and without considering any removal of waste by the project activity.

(c) Estimate the quantity and the age distribution of the waste removed each year “x” during the crediting period, and calculate the methane generation potential of the waste in the *year y*. For example, in the year x=2 of the project activity, the amount “A2” was removed to be composted, and this amount can be divided into “A2,n” parts, each part belonging to the age “n”. In the *year y* the methane generation potential of the portions removed from the SWDS may be estimated as:

$$BE_{y,ex-ante} = \sum_{n=nmin}^{nmax} BE_{CH4,SWDS,y,n} \tag{3}$$

Where:

$BE_{CH4,SWDS,y,n}$	Yearly methane generation potential of the waste removed since the beginning of the project activity “x=1” up to the *year y* during the crediting period, segregated according to its age “n” at the time of removal (tCO2e). It is calculated using the tool referred to in AMS-III.G, substituting the exponential term for the first order decay model “exp [-k_j.(y-x)]” by “exp[-k_j.(y-x+n)]”.

18. The *ex post* determination of the baseline emissions is based on laboratory analysis of a sample of non inert fraction of the excavated waste obtained after separation. The separated samples are tested for the methane generation potential (L_0, in tons CH_4/ tons waste), without any distinction for the waste types or categories, in accordance with methods described in literature[1, 2, 3]. The sampling shall ensure a confidence level/precision of 90/10 for the mean value of L_0, Standard such as EN TR 15310-3 /-4[4] or LAGA PN98[5] or an equivalent national/international standard shall be used for the purpose of sampling.

The annual average value of $L_{0,x}$ for any year "x" during the excavation phase is used to calculate the baseline emissions as follows:

$$BE_{y,ex-post} = \varphi * (1-f) * GWP_{CH4} * (1-OX) * MCF * \sum_{x=1}^{y} A_{lf,x} * L_{0,x} * e^{-k_{CH4}(y-x)} * (1-e^{-k_{CH4}}) \quad \textbf{(4)}$$

Where all the terms are defined and determined according to the latest version of "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site", except the following:

$BE_{y,ex-post}$	Baseline methane emissions that would be produced in the landfill in absence of the project activity in year y (t CO_2/y)
$A_{lf,x}$	Amount of non inert waste separated and aerobically composted in year "x", (tons)
$L_{0,x}$	Annual average methane generation potential of the non-inert fraction of the partially decayed waste separated during the year "x" (tons CH_4/tons waste)
k_{CH4}	Decay rate of the excavated waste, see table 1 below
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

[1] Ryan J. Kelly, Bradley D. Shearer, Jongmin Kim, C. Douglas Goldsmith, Gary R. Hater, John T. Novak (2006): Relationships between analytical methods utilized as tools in the evaluation of landfill waste stability, Waste Management, 26, p.1349–1356, download at <http://www.scsengineers.com/Papers/Kelly_WMAnalytical_Tools_LF_Waste_Stability.pdf>.

[2] J.M. Owens, J.M., D.P. Chynoweth, (1993): Biochemical methane potential of municipal solid waste (MSW) components. Water Science and Technology 27 (2), p. 1–14.

[3] Train L. Hansen, Jens Ejbye Schmidt, Irini Angelidaki, Emilia Marca, Jes la Cour Jansen, Hans Mosbaek, Tomas H. Christensen (2004): Method for determination of methane potential of solid organic waste, Waste Management, 24, p. 393-400.

[4] EN TR 15310 "Characterization of waste - Sampling of waste materials"; Part 3 "guidance on procedures for subsampling in the field, Part 4 "Guidance on procedures for sample packaging, storage, preservation, transport and delivery.

[5] LAGA – Länderarbeitsgemeinschaft Abfall, PN 98 "Richtline für das Vorgehen bei physikalischen, chemischen und biologischen Untersuchungen im Zusammenhang mit der Verwertung/Beseitigung von Abfällen" available in German at <http://www.laga-online.de/mitteilungen/docs/LAGA%20PN%2098.pdf>.

The value for the decay rate of the excavated waste (k_{CH4}) is taken from the following table referenced from AM0083. The local climate conditions and the average age of the waste within the landfill at the project starts (calculated according to paragraph 17(a)) are used for the selection of the appropriate decay rate.

Table 1 Decay rate of the excavated waste

Waste age	MAT ≤ 20°C; boreal		MAT > 20°C; tropical	
	Dry (MAP/PET <1)	Wet (MAP/PET >1)	Dry	Wet
≤ 2a	0.045	0.100	0.055	0.170
>2a ≤ 10a	0.035	0.060	0.045	0.100
> 10a	0.030	0.045	0.035	0.050

Leakage

19. If the project technology is the equipment transferred from another activity leakage effects are to be considered.

Project activity emissions

20. Project activity emissions consist of:

(a) CO_2 emissions from transportation;

(b) CO_2 emissions from electricity and/or fossil fuel consumption by the project activity facilities;

(c) Emissions from the oxygen consumption during aeration process, if applicable;

(d) Methane emissions during composting process.

$$PE_y = PE_{y,transp} + PE_{y,power} + PE_{y,O2} + PE_{y,compCH4} \quad \textbf{(5)}$$

Where:

PE_y	Project activity emissions in the year y (tCO_2e)
$PE_{y,transp}$	Emissions from transportation in the year y (tCO_2e)
$PE_{y,power}$	Emissions from electricity or fossil fuel consumption in the year y (tCO_2e)
$PE_{y,O2}$	Emissions from the oxygen consumption during high pressure aeration process (enriched oxygen), if applicable. In the absence of project specific data a default value of 0.64 tCO_2e/Nm^3 O_2 (normal volume) shall be used.
$PE_{y,compCH4}$	Methane emissions during composting process in the year y (tCO_2e)

21. Project emissions from transportation ($PE_{y,transp}$) are calculated based on distances:

(a) The SWDS and the treatment site where composting process takes place;

(b) The treatment site and the site for soil application.

$$PE_{y,transp} = (Q_y / CT_y) * DAF_w * EF_{CO2} + (Q_{y,treatment,i} / CT_{y,treatment,i}) * DAF_{treatment,i} * EF_{CO2} \quad \textbf{(6)}$$

Where:

Q_y	Quantity of raw waste treated in the year *y* (tons)
CT_y	Average truck capacity for transportation (tons/truck)
DAF_w	Average incremental distance for raw solid waste transported (km/truck)
EF_{CO2}	CO_2 emission factor from fuel use due to transportation (kgCO_2/km, IPCC default values or local values may be used)
i	Type of compost
$Q_{y,treatment,i}$	Quantity of compost *i* produced in year *y* (tons)
$CT_{y,treatment,i}$	Average truck capacity for compost *i* transportation (tons/truck)
$DAF_{treatment,i}$	Average distance for compost *i* transportation (km/truck)

22. For the calculation of project emissions from electricity and/or fossil fuel consumption by the project activity facilities ($PE_{y,power}$) all the energy consumption of all equipment/devices installed by the project activity shall be included e.g., energy used for aerobic pre-treatment, SWDS excavation, MSW separation, turning of compost piles/heaps, screening, drying of the final compost product. Emission factors for grid electricity used shall be calculated as per procedures described in AMS-I.D. Project activity emissions from fossil fuel consumption shall be calculated as per the latest version of the "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". Local values are to be used, if local values are difficult to obtain, IPCC default values may be used.

23. Methane emissions during composting ($PE_{y,compCH4}$) shall be calculated as follows:

$$PE_{y,compCH4} = Q_{y,treatment} * EF_{composting} * GWP_{CH4} \quad \textbf{(7)}$$

Where:

$Q_{y,treatment}$	Quantity of waste treated by composting in year *y* (tonnes)
$EF_{composting}$	Emission factor for composting of organic waste (t CH_4/ton waste treated). Emission factors can be based on facility/site-specific measurements, country specific values or IPCC default values (table 4.1, chapter 4, Volume 5, 2006 IPCC

Guidelines for National Greenhouse Gas Inventories). IPCC default values are 10 g CH_4/kg waste treated on a dry weight basis and 4 g CH_4/kg waste treated on a wet weight basis.

$EF_{composting}$ can be set to zero for the portions of $Q_{y,treatment}$ for which the monitored oxygen content of the composting process is above 8%. This can be done via sampling with a maximum margin of error of 10% at a 90% confidence level. For this purpose a portable oxygen meter can be used with lancets of at least 1 m length. In the case of forced aerated in-vessel and forced aerated pile composting systems continuous measurements may also be done using online sensors

Monitoring

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

$$ER_y = BE_y - (PE_y + Leakage_y) \quad \textbf{(8)}$$

Where:

ER_y Emission reduction in the year *y* (tCO_2e)

The following parameters shall be monitored and recorded annually during the crediting period:

- Quantity of raw waste removed (Q_y) and quantity of compost produced ($Q_{y,treatment,i}$);
- Quantity of oxygen consumed for high pressure aeration process, if applicable;
- Parameters related to ($PE_{y,transp}$) described above such as: (CT_y), (DAF_w), ($CT_{y,treatment,i}$), ($DAF_{treatment,i}$);
- Parameters related to *ex post* determination of baseline emissions: $L_{0,x}$;
- Amount of non inert waste excavated and aerobically composted in year x ($A_{lf,x}$).

25. The annual amount of fossil fuel or electricity used to operate the facilities or power auxiliary equipment shall be monitored, e.g., energy/fossil fuels used for aeration, excavation, separation, turning of compost piles and where relevant drying of the final compost product. 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.

In case of composting facilities, its operation shall be documented in a quality control program, monitoring the conditions and procedures that ensure the aerobic condition of the waste during the composting process.

Soil application of the compost in agriculture or related activities will be monitored. This includes documenting the sales or delivery of the compost final product. It shall also include an in situ verification of the proper soil application of the compost to ensure aerobic conditions for further decay. Such verification shall be done at representative sample of user sites.

Project activity under a programme of activities

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

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

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History of the document

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01	EB 50, Annex # 16 October 2009	To be considered at EB 50.
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