Approved Baseline Methodology AM0025

"Avoided emissions from organic waste composting at landfill sites"

Source

This baseline methodology is based on the "Organic waste composting at the Matuail landfill site Dhaka, Bangladesh," whose baseline study, monitoring and verification plan and project design document were prepared by prepared by World Wide Recycling B.V. and Waste Concern. For more information regarding the proposal and its consideration by the Executive Board, please refer to case NM0090: "Organic waste composting at the Matuail landfill site Dhaka, Bangladesh," on http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html.

This methodology also refers to the "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" (ACM0002) and the latest version of the *"tool for the demonstration and assessment of additionality"*.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Existing actual or historical emissions, as applicable"

Applicability

The methodology is applicable under the following conditions:

- The project activity involves a composting process in aerobic conditions;
- The proportions and characteristics of different types of organic waste can be determined in order to apply a multiphase landfill gas generation model in estimating the quantity of landfill gas that would have been generated in the absence of the project activity.

This baseline methodology shall be used in conjunction with the approved monitoring methodology AM0025 ("Avoided emissions from organic waste composting at landfill sites").

Summary

This methodology addresses project activities where waste originally intended for landfilling is composted. The project activity avoids methane emissions by diverting organic waste from dumping at a landfill, where methane emissions are caused by anaerobic processes, to a composting plant. Because the composting process is basically aerobic, methane generation is avoided. The GHG involved in the baseline and project emissions are CO_2, CH_4 and N_2O.

Identification of the baseline scenario

Project participants should use step 1 of the latest version of the "Tool for the demonstration and assessment of additionality", to identify all realistic and credible baseline alternatives. In doing so, relevant policies and regulations related to the management of landfill sites should be taken into account. Such policies or regulations may include mandatory landfill gas capture or destruction requirements because of safety issues or local environmental regulations.[1] Other policies could include local policies promoting productive use of landfill gas, for example for the production of renewable energy. In addition, the assessment of alternative scenarios should take into account local economic and technological circumstances.

Alternatives to be analysed should include, *inter alia*:

- The project activity (i.e. composting of organic waste) not implemented as a CDM project;
- Incineration of the waste;
- Disposal of the waste on a landfill with electricity generation using landfill gas captured from the landfill site;
- Disposal of the waste on a landfill with delivery of gas captured from the landfill site to nearby industry for heat supply;
- Disposal of the waste on a landfill with flaring of gas captured from the landfill;
- Disposal of the waste on a landfill without capture of landfill gas.

Project participants should use steps 2 and/or 3 of the latest version of the "Tool for the determination and assessment of additionality" to assess which of these alternatives should be excluded from further consideration (e.g. alternatives where barriers are prohibitive or which are clearly economically unattractive). Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario. In assessing these scenarios, any regulatory or contractual requirements should be taken into consideration.

The methodology is only applicable if the most plausible baseline scenario is identified as either the disposal of the waste in a landfill without capture of landfill gas or the disposal of the waste in a landfill where the landfill gas is partly captured and subsequently being flared.

Additionality

The additionality of the project activity shall be demonstrated and assessed using the latest version of the ***"Tool for the demonstration and assessment of additionality"*** *agreed by the CDM Executive Board*[2]*,* taking into account the added considerations noted below.

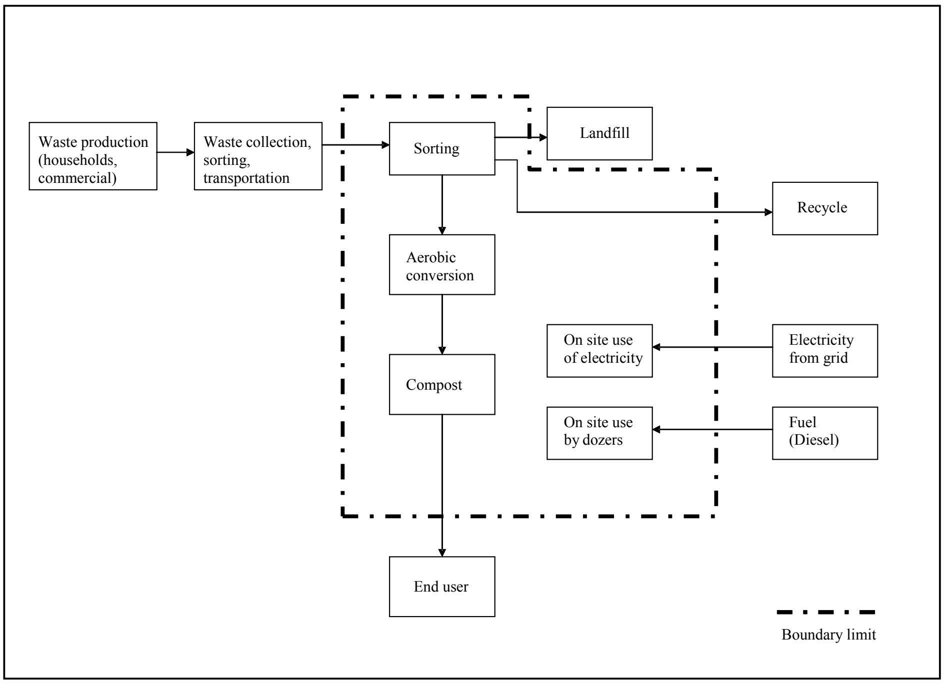
Project boundary

The spatial extent of the project boundary is the site of the project activity where the waste is composted. This includes the facilities for sorting, aerobic conversion and composting and on-site electricity transport fuel use, and the landfill site. The project boundary does not include facilities for waste collection, sorting and transport to the project site.

The flow chart in Figure 1 shows the main components of the project activity and the project boundary.

[1] The project developer must bear in mind the relevant clarifications on the treatment of national and/or sectoral policies and regulations in determining a baseline scenario in Annex 3 of the EB16 report and other forthcoming guidance on this subject.
[2] Please refer to: < http://cdm.unfccc.int/methodologies/PAmethodologies/approved.html>

Figure 1: System boundaries of composting project



The **greenhouse gases** included in or excluded from the project boundary are shown in Table 1.

Table 1: Overview of emissions sources included in or excluded from the project boundary and baseline

	Source	Gas		Justification / Explanation
Baseline	Emissions from decomposition of waste at the landfill site	CH_4	Included	The major source of emissions in the baseline
		N_2O	Excluded	N_2O emissions are small compared to CH_4 emissions from landfills. Exclusion of this gas is conservative.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.[a]
Project Activity	On-site fossil fuel consumption due to the project activity	CO_2	Included	May be an important emission source
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Emissions from on-site electricity use	CO_2	Included	May be an important emission source.
		CH_4	Excluded	Excluded for simplification. This emission source is assumed to be very small.
		N_2O	Excluded	Excluded for simplification. This emission source is assumed to be very small.
	Direct emissions from the composting process	N_2O	Included	May be an important emission source.
		CO_2	Excluded	CO_2 emissions from the decomposition of organic waste are not accounted.[a]

		CH_4	Included	The composting process may not be complete and result in anaerobic decay.

a: CO_2 emissions from the combustion or decomposition of *biomass* (see definition by the EB in Annex 8 of the EB20 report) are not accounted as GHG emissions. Where the combustion or decomposition of biomass under a CDM project activity results in a decrease of carbon pools, such stock changes should be considered in the calculation of emission reductions. This is not the case for waste treatment projects.

Project emissions

The project emissions in year y are:

$$PE_y = PE_{elec,y} + PE_{fuel,\ on\text{-}site,y} + PE_{c,N2O,y} + PE_{c,CH4,y} \quad \textbf{(1)}$$

where:

PE_y project emissions during the year y (tCO_2e)
$PE_{elec,y}$ emissions off-site from electricity consumption on-site in year y (tCO_2e)
$PE_{fuel,\ on\text{-}site,y}$ emissions on-site due to fuel consumption on-site in year y (tCO_2e)
$PE_{c,N2O,y}$ emissions during the composting process due to N_2O production in year y (tCO_2e)
$PE_{c,CH4,y}$ emissions during the composting process due to methane production through anaerobic conditions in year y (tCO_2e)

Emissions from electricity use

The project activity will involve on-site electricity consumption. Electricity may be purchased from the grid or generated on-site. The CO_2 emissions from electricity generation are calculated as follows:

$$PE_{elec,y} = kWh_{e,y} * CEF_{elec} \quad \textbf{(2)}$$

where:

$kWh_{e,y}$ is amount of electricity used for the composting process, measured using an electricity meter (MWh)
CEF_{elec} carbon emissions factor for electricity (tCO_2/MWh)

To account for emissions of electricity generation on site, project participants should use for CEF_{elec}, the default emission factor for a diesel generator with a capacity of more than 200 kW for small-scale project activities (0.8 tCO_2/MWh, see AMS 1.D.1 in the simplified baseline and monitoring methodologies for selected small-scale CDM project activity categories). For electricity consumption from the grid, emission factor calculated according to Methodology ACM0002 "Consolidated baseline methodology for grid-connected electricity generation from renewable sources" should be used.

Emissions from fuel use on-site

Project participants shall account for CO_2 emissions from any on-site fuel combustion (apart from electricity generation, e.g. vehicles used on-site, heat generation, etc). Emissions are calculated from the quantity of fuel used and the specific CO_2-emisison factor of the fuel, as follows:

$PE_{fuel, on-site,y} = F_{cons,y} * NCV_{fuel} * EF_{fuel}$ **(3)**

where:

$PE_{fuel, on-site,y}$	is CO_2 emissions due to on-site fuel combustion in year y (tCO_2)
$F_{cons,y}$	is fuel consumption on site in year y (l or kg)
NCV_{fuel}	is net caloric value of the fuel (MJ/l or MJ/kg)
EF_{fuel}	is CO_2 emissions factor of fuel (tCO_2/MJ)

Project participants may use IPCC default values for the net calorific values and CO_2 emission factors.

Emissions from composting

N_2O emissions

During storage of waste in collection containers, the composting process itself and when the compost is finished, N_2O emissions might be released. Based upon Schenk[3] and others, a total loss of 42 mg N_2O-N per kg composted dry matter can be expected (from which 26.9 mg N_2O during the composting process). The dry matter content of compost is around 50% up to 65%.

Based on these values, project participants should use a default emission factor of 0.043 kg N_2O per tonne of compost for $EF_{c,N2O}$ and calculate emissions as follows:[4]

$PE_{c,N2Oy} = M_{compost,y} * EF_{c,N2O} * GWP_{N2O}$ **(4)**

where:

$PE_{c,N2Oy}$	is N_2O emissions from composting in year y (tCO_2e)
$M_{compost,y}$	is total quantity of compost produced in year y (tonnes/a)
$EF_{c,N2O}$	is emission factor for N_2O emissions from the composting process (t N_2O / t compost)
GWP	is Global Warming Potential of nitrous oxide, (tCO_2/tN_2O)

CH_4 emissions

During the composting process, aerobic conditions are not completely reached in all areas and at all times. Pockets of anaerobic conditions – isolated areas in the composting heap where oxygen concentrations are so low that the biodegradation process turns anaerobic – may occur. The emission behaviour of such pockets is comparable with the anaerobic situation in the landfill, so anaerobia during the composting process is a potential emissions source for methane just like an unmanaged landfill is. Through pre-determined sampling procedures the percentage of waste that degrades under anaerobic circumstances can be determined. Using this percentage, project methane emissions from composting are calculated as follows:

$PE_{c,CH4} = MB_y * GWP_{CH4} * S_a$ **(5)**

[3] Manfred K. Schenk, Stefan Appel, Diemo Daum, "N2O emissions during composting of organic waste", Institute of Plant Nutrition University of Hannover, 1997

[4] Assuming 650 kg dry matter per ton of compost and 42 mg N_2O-N, and given the the molecular relation of 44/28 for N2O-N, an emission factor of 0.043 kg N_2O / tonne compost results.

where:

$PE_{c,CH4}$	is project methane emissions due to anaerobic circumstances in the composting process in year y (tCO_2e)
$S_{a,y}$	is share of the waste that degrades under anaerobic circumstances in the composting plant during year y (%)
MB_y	is quantity of methane that would be produced in the landfill in the absence of the project activity in year y (tCH_4)
GWP_{CH4}	is Global Warming Potential of methane (tCO_2e/tCH_4)

Calculation of $S_{a,y}$

S_a is determined by a combination of measurements and calculations. Bokhorst et al[5] and Richard et al[6] show that if oxygen content is below 5% - 7.5%, aerobic processes are replaced by anaerobic composting processes. To determine the oxygen content during the process, project participants shall measure the oxygen content according to a predetermined sampling scheme and frequency.

These measurements should be undertaken throughout the crediting period and recorded each year. The percentage of the measurements that show an oxygen content below 10% is presumed to be equal to the share of waste that degrades under anaerobic circumstances (i.e. degrades as if it were landfilled), hence the emissions caused by this share are calculated as project emissions ex-post on an annual basis:

$$S_a = S_{OD} / S_{total} \quad \textbf{(6)}$$

where:

S_{OD}	is number of samples per year with an oxygen deficiency (i.e. oxygen content below 10%)
S_{total}	is total number of samples taken per year, where S_{total} should be chosen in a manner that ensures estimation of S_a with 20% uncertainty at 95% confidence level.

Baseline emissions

To calculate the baseline emissions project participants shall use the following equation:

$$BE_y = (MB_y - MD_{reg,y}) * GWP_{CH4} \quad \textbf{(7)}$$

where:

$BE_{,y}$	is baseline emissions in year y (tCO_2e)
$MB_{,y}$	is methane produced in the landfill in the absence of the project activity in year y (tCH_4)
$MD_{reg,y}$	is methane that would be destroyed in the absence of the project activity in year y (tCH_4)
GWP_{CH4}	is Global Warming Potential of methane (tCO_2e/tCH_4)

[5] Jan Bokhorst. Coen ter Berg – Mest & Compost Behandelen beoordelen & Toepassen (Eng: Manure & Compost – Treatment, judgement and use), Louis Bolk Instituut, Handbook under number LD8, Oktober 2001
[6] Tom Richard, Peter B. Woodbury, Cornell composting, operating fact sheet 4 of 10, Boyce Thompson Institute for Plant Research at Cornell University Cornell University

In cases where regulatory or contractual requirements do not specify $MD_{reg,y}$, an Adjustment Factor (AF) shall be used and justified, taking into account the project context. In doing so, the project participant should take into account that some of the methane generated by the landfill may be captured and destroyed to comply with other relevant regulations or contractual requirements, or to address safety and odour concerns.

$$MD_{reg,y} = MB_y * AF \quad \textbf{(8)}$$

where:

AF	is Adjustment Factor for MB_y (%)

AF is defined as the ratio of the destruction efficiency of the collection and destruction system mandated by regulatory or contractual requirement to that of the collection and destruction system in the project activity. The ‘Adjustment Factor’ shall be revised at the start of each new crediting period taking into account the amount of GHG flaring that occurs as part of common industry practice at that point in the future.

Methane generation from the landfill in the absence of the project activity

The amount of methane that is generated each year (MB_y) is calculated for each year with a multi-phase model. The model is based on a first order decay equation. It differentiates between the different types of waste *j* with respectively different decay rates k_j (fast, moderate, slow) and fraction of degradable organic carbon (DOC_j). The model calculates the methane generation based on the actual waste streams $A_{j,x}$ disposed in the most recent year (y) and all previous years since the project start (x=1 to x=y). The amount of methane produced in the year *y* (MB_y) is calculated as follows:

$$MB_y = \varphi \cdot \frac{16}{12} \cdot F \cdot DOC_f \cdot MCF \cdot \sum_{x=1}^{y} \sum_{j=A}^{D} A_{j,x} \cdot DOC_j \cdot \left(1 - e^{-k_j}\right) \cdot e^{-k_j \cdot (y-x)} \quad \textbf{(9)}$$

where:

$MB_{,y}$	is methane produced in the landfill in the absence of the project activity in year y (tCH_4)
φ	is model correction factor (default 0.9) to correct for the model-uncertainties
F	is fraction of methane in the landfill gas
DOC_j	is per cent of degradable organic carbon (by weight) in the waste type j
DOC_f	is fraction of DOC dissimilated to landfill gas
MCF	is Methane Correction Factor (fraction)
$A_{j,x}$	is amount of organic waste type j prevented from disposal in the year x (tonnes/year)
k_j	is decay rate for the waste stream type j
j	is waste type distinguished into the waste categories (from A to D), as illustrated in Table 3 below
x	is year during the crediting period: x runs from the first year of the first crediting period (x=1) to the year for which emissions are calculated (x=y)
y	is year for which LFG emissions are calculated

Model Correction Factor (φ)

Oonk et el. have validated several landfill gas models based on 17 realized landfill gas projects.[7] 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% should be applied to the model results.

Methane correction factor (MCF)

The methane correction factor (MCF) accounts for the fact that unmanaged landfills produce less methane from a given amount of waste than managed landfills, because a larger fraction of waste decomposes aerobically in the top-layers of unmanaged landfills. The proposed default values for MCF are listed in Table 2 below.

Table 2: Solid Waste Disposal Site (SDWS) Classification and Methane Correction Factors

Type of site	**MCF default values**
Managed site	1.0
Unmanaged site – deep (> 5 m waste)	0.8
Unmanaged site – shallow (< 5 m waste)	0.4
Note: Managed SWDS 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 some of the following: cover material, mechanical compacting or levelling of waste.	

Source: Table 5.1 in the 2000 IPCC Good Practice Guidance

Project participants should use 0.4 as default MCF, unless they can demonstrate that the baseline-scenario would be disposal of the waste at an unmanaged site- with a wastepile of more than 5m depth (MCF in that case would be 0.8) or a managed landfill (MCF in that case would be 1.0).

Fraction of degradable organic carbon dissimilated (DOC_f)

The decomposition of degradable organic carbon does not occur completely and some of the potentially degradable material always remains in the site even over a very long period of time. The revised IPCC Guidelines propose a default value of 0.77 for DOC_f. A lower value of 0.5 should be used if lignin-C is included in the estimated amount of degradable organic carbon.[8]

Degradable carbon content in waste (DOC_j) and decay rates (k_j)

In the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (module 6), default values for degradable organic carbon are presented, as shown in Table 3 below. These values should be used by project participants.[9]

[7] Oonk, Hans et al.:Validation of landfill gas formation models. TNO report. December 1994

[8] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories – chapter 5

[9] For the categories of waste considered as well as the values of DOC, project participants should consider any revisions to the Revised 1996 IPCC Guidelines and the 2000 IPCC Good Practice Guidance.

Table 3: Waste stream decay rates (k_j) and associated IPCC default values for DOC_j

Waste stream A to E	Per cent DOC_j (by weight)	Decay-rate (k_j)
A. Paper and textiles	40	0.023
B. Garden and park waste and other (non-food) putrescibles	17	0.023
C. Food waste	15	0.231
D. Wood and straw waste [1)]	30	0.023
E. Inert material	0	0

[1)] Excluding lignin-C

The most rapid decay rates are associated with high moisture conditions and rapidly degradable material such as food waste. The slower decay rates are associated with dry site conditions and slowly degradable waste such as wood or paper. For this methodology, food waste (C) is considered as fast degradable waste, while paper and textiles (A), Garden and park waste and other (non-food) putrescibles (B), Wood and straw waste (D) are considered as slow degradable waste. Inert materials (E) are assumed not to degrade (k=0).

If local measurements have been undertaken for decay rates and if these are documented, and can be considered as more reliable, these may be used instead of the default-values of table 3. Project participants should consider future revisions to the decay-rate constants (k_j) when available, including revisions to IPCC guidelines.

The composition of the waste shall be determined by sampling. The composition of the waste must be defined in accordance with the waste type categories in Table 3, measuring the fractions of each of the following waste types: paper and textile (A); garden and park waste and other (non-food) organic putrescibles (B); food waste (C); wood and straw (D) and; inert/inorganic waste (E). The size and frequency of sampling should be statistically significant with an maximum uncertainty range of 20% at a 95% confidence level. As a minimum, sampling should be undertaken four times per year.

The amount of organic waste type *j* ($A_{j,x}$) is calculated based on the total amount of waste collected in the year x (A_x) and the fraction of the waste type in the samples ($p_{n,j,x}$), as follows:

$$A_{j,x} = A_x \cdot \frac{\sum_{n=1}^{z} p_{n,j,x}}{z} \quad \textbf{(10)}$$

where:

$A_{j,x}$	is amount of organic waste type j prevented from disposal in the year x (tonnes/year).
A_x	is amount of total organic waste collected during the year x (tonnes/year).
$p_{n,j,x}$	is fraction of the waste type j in the sample n collected during the year x
z	is number of samples taken during the year x

Calculation of F

The project participant shall determine *F* with the following preferences**:**

1. Measure *F* on an annual basis as a monitoring parameter, at a landfill in the proximity of the composting plant, receiving comparable waste as the composting plant receives.
2. Measure *F* once prior to the start of the project activity at a landfill in the proximity of the composting plant, receiving comparable waste as the composting plant will receive.
3. In case there is no access to a landfill, the project participants should apply the conservative default value of 0.5, being the lower end of IPCC range of 0.5 – 0.6.

Leakage

The only source of leakage considered in the methodology is CO_2 emissions from off-site transportation of waste materials.

The composting project may result in a change in transport emissions. This would occur when the waste is transported from waste collecting points in the collection area to the composting facility, instead of to existing landfills. When it is likely that the transport emissions will increase significantly, such emissions should be incorporated as leakage. In this case, project participants shall document the following data in the CDM-PDD: an overview of collection points from where the waste will be collected, their approximate distance (in km) to the composting facility, existing landfills and their approximate distance (in km) to the nearest end-user.

For calculations of the emissions, IPCC default values for fuel consumption and emission factors may be used. The CO_2 emissions are calculated from the quantity of fuel used and the specific CO_2-emission factor of the fuel for vehicles i to n, as follows:

$$L_y = \sum_{i}^{n} NO_{vehicles,i,y} * km_{i,y} * VF_{cons,i} * CV_{fuel} * D_{fuel} * EF_{fuel} \quad \textbf{(11)}$$

where:

$NO_{vehicles,i,y}$	is number of vehicles for transport with similar loading capacity
$Km_{i,y}$	is average additional distance travelled by vehicle type i compared to baseline in year y
VF_{cons}	is vehicle fuel consumption in litres per kilometre of vehicle type i (l/km)
CV_{fuel}	is Calorific value of fuel (MJ/Kg)
D_{fuel}	is density of fuel (kg/l)
EF_{fuel}	is Emission factor of fuel (tCO_2/MJ)

For transport of compost to the users, the same formula applies.

Emission Reductions

To calculate the emission reductions the project participant shall apply the following equation:

$$ER_y = BE_y – PE_y – L_y \quad \textbf{(12)}$$

where:

ER_y	is emissions reductions in year y (t CO_2e)
BE_y	is emissions in the baseline scenario in year y (t CO_2e)
PE_y	is emissions in the project scenario in year y (t CO_2e)
L_y	is leakage in year y (t CO_2e)

If the sum of PE_y and L_y is smaller than 1% of BE_y in the first full operation year of a crediting period, the project participant may assume a fixed percentage of 1% for PE_y and L_y combined for the remaining years of the crediting period.

Approved Monitoring Methodology AM0025

"Avoided emissions from organic waste composting at landfill sites"

Sources

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Applicability

The methodology is applicable under the following conditions:

- The project activity involves a composting process in aerobic conditions;
- The proportions and characteristics of different types of organic waste can be determined in order to apply a multiphase landfill gas generation model in estimating the quantity of landfill gas that would have been generated in the absence of the project activity.

This monitoring methodology shall be used in conjunction with the approved baseline methodology AM0025 ("Avoided emissions from organic waste composting at landfill sites").

Project emissions parameters

ID number	Data Variable	Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic / paper)	Comment
1. kWh_e	Electricity consumption	Electricity meter	kWh	M	Continuous	100%	Electronic	
2. CEF_{elec}	Electricity emissions factor	Official utility documents	tCO2e/Mwh	C	Annually		Electronic	Calculated according to ACM0002 or as diesel default factor
3. F_{cons}	Fuel consumption	Purchase invoices	Liters	C	Continuous	100%	Electronic	
4. $M_{compost,y}$	Compost produced	Plant records	Tonnes	M	Discontinue	100%	Electronic	The produced compost will be trucked off from site. All trucks leaving site will be weighed. Possible temporary storage of compost will be weighed as well or not taken into account for calculated carbon credits.
5. S_a	Share of samples anaerobic		%	C	Weekly	See S_{total}		Used to determine percentage of material that behaves anaerobically.
6. S_{OD}	Number of samples with oxygen deficiency	Oxygen measurement device	Number	M	Weekly	See S_{total}		Samples with oxygen content <10%. Weekly measurements throughout the year but accumulated once per year only
7. S_{total}	Number of samples	Oxygen measurement device	Number	M	Weekly	statistically significant	Electronic	Total number of samples taken per year, where S_{total} should be chosen in a manner that ensures estimation of S_a with 20% uncertainty at 95% confidence level.

Baseline emission parameters

ID number	Data Variable	Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	Comment
8. MD_{reg} or AF	Methane destroyed due to regulatory or other requirements	Local and/or national authorities	% or tonnes	E	Annually	100%	Electronic	Changes in regulatory requirements, relating to the baseline landfill(s) need to be monitored in order to update the adjustment factor (AF), or directly MD_{reg}. This is done at the beginning of each crediting period.
9. A_x	Total quantity of waste supplied to compost plant in the year x	Weighbridge	Tonnes	M	Discontinu e	100%	Electronic	Wastes entering composting plant
10. $P_{j,x}$	Share of different types of organic waste	Sampling/ Sorting/ weighing	% of waste	M	Quarterly	see note below	Electronic	Determine fraction of each waste stream of total waste input to the composting facility
11. F	Methane fraction of landfill gas	Calculated	% by weight	M	Annually	1 measurem ent/year	Electronic	Monitoring depends of the accessibility of this data coming from landfill in proximity of the composting plant. If no suitable landfill-data is available, then a default value of 0.5 should be applied.

$P_{j,}$: To adequately determine the share of each fraction of waste, the project proponent should start with 4 samples per year (once every quarter). The size and frequency of sampling should result in a statistically significant mean with a maximum uncertainty range of 20% at a 95% confidence level.

Leakage

ID number	Data Variable	Source of data	Data unit	Measured (m) calculated (c) estimated (e)	Recording frequency	Pro-portion of data monitored	How will data be archived? (electronic/ paper)	Comment
12. $NO_{vehicles}$	Vehicles per carrying capacity per year	Counting	Number	M	Discontinue	100%	Electronic	Counter should accumulate the number of trucks per carrying capacity
13. KM_v	Additional distance travelled	Expert estimate	km	E	Annually	100%	Electronic	

Quality Control (QC) and Quality Assurance (QA) Procedures

All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning. QA/QC procedures for the parameters to be monitored are illustrated in the following table.

Data	Uncertainty Level of Data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary
1 kWh_e	Low	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company.
2 CEF_{elec}	Low	Calculated as per ACM0002 at start of crediting period.
3 F_{cons}	Low	The amount of fuel will be derived from the paid fuel invoices (administrative obligation).
4 $M_{compost,y}$	Medium	Weighed on calibrated scale; also cross check with sales of compost.
5 S_a	Medium	O_2-measurement-instrument will be subject to periodic calibration (in accordance with stipulation of instrument-supplier). Measurement itself to be done by using a standardised mobile gas detection instrument. A statistically significant sampling procedure will be set up that consists of multiple measurements throughout the different stages of the composting process according to a predetermined pattern (depths and scatter) on a daily basis.
6 S_{OD}	Medium	
7 S_{total}	Medium	
8 MD_{reg}	Medium	Data are derived from or based upon local or national guidelines, so QA/QC-procedures for these data are not applicable.
9 A_y	Low	Weighbridge will be subject to periodic calibration (in accordance with stipulation of the weighbridge supplier).
10 P_{jx}	Low	Regular sorting & weighing of waste (initially quarterly) by project proponent will be carried out. Procedures will be checked regularly by a certified institute/ DOE.
11 F	Low	Analyser will be calibrated regularly (in accordance with stipulation of the meter supplier) by a certified institute.
12 $NO_{vehicles}$	Medium	Number of vehicles must match with total amount of sold compost. Procedures will be checked regularly by DOE.
13 KM	Medium	Assumption to be approved by DOE.