METHODOLOGY

REDUCTION IN METHANE EMISSIONS FROM LANDFILLS THROUGH DECENTRALISED ORGANIC WASTE PROCESSING

SDG 13

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CONTACT DETAILS

The Gold Standard Foundation
International Environment House 2
Chemin de Balexert 7-9
1219 Châtelaine
Geneva, Switzerland
Tel: +41 22 788 70 80
Email: standards@goldstandard.org

SUMMARY

This methodology applies to mitigation activities that use on-site waste processing to avoid methane emissions caused by organic waste being sent to landfills. While solid waste is most often transported to centralised facilities, such as landfills or large-scale composting plants, a typical project applying this methodology involves decentralised, on-site waste processing and use, thus having the additional benefit of avoiding transportation of waste.

ACKNOWLEDGEMENT

Methodology Developer

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1| Introduction

1.1.1 | The following table describes the key information for the application of the methodology.

Table 1. Key information

Typical mitigation activity (project) type	Activities that involve decentralised waste processing units, thus avoiding methane emissions and the transportation of organic waste to landfills or centralised waste treatment facilities. * The terms 'Mitigation Activity', 'Activity' and 'Project' refer to project activity and are used interchangeably.
Activity requirement	Community Services Activity
Mitigation activity (project) type	Waste management and handling
Applicable GS4GG products	☒ GSVERs ☒ Certified impact statement
Geographical applicability	Global
Applicable activity (project) scale	☒ Micro scale ☒ Small scale ☐ Large scale A mitigation activity can claim emission reductions less than or equal to - 10,000 tCO_2 eq per year for Micro scale activity - 60,000 tCO_2 eq per year for Small scale activity
Mitigation type	☒ Emission reduction ☐ Emission removal
Project activity start date	The earliest date on which the project developer has committed to expenditures related to the implementation of the project
Crediting period start date	The start date of Crediting Period is the date of start of operation (start of operation of 1st waste processing units distributed as part of mitigation activity) or a maximum of two years prior to the date of Project Design Certification, whichever occurs later.
Crediting period length	Fifteen years (maximum); the mitigation activity follows five-year renewal cycle per latest version of GS4GG requirements for renewal of crediting period. Crediting for individual waste processing unit distributed in an mitigation activity is limited to its maximum technical life.

	If any legal mandate comes into force during the crediting period, the mitigation activity can be credited only until the date the legal requirements take effect.

2| Definition

2.1.1 | The definitions contained in the Glossary of Gold Standard for Global Goals (GS4GG), , along with the those provided in this methodology, apply to this methodology terms shall apply.

Table 2.Terms and Definitions

TERM	DEFINITION
On-Site Smart Waste Appliance (OSWP)	Decentralised, modular waste processing units that can process up to 10 metric tonnes of waste a day. These include household or commercial composting devices and any aerobic digestion or other waste-processing technique that allows for on-site waste management, which subsequently avoids hauling organic waste to landfills and municipal/industrial compost facilities and avoids methane emissions from landfills..
Solid Waste Disposal Site (SWDS):	Designated areas intended as the final storage place for solid waste, including material diverted as a result of the activity. A stockpile is considered an SWDS if (a) its volume to surface area ratio is 1.5 or larger and if (b) a visual inspection by a validation/verification body confirms that the material is exposed to anaerobic conditions (i.e., it has a low porosity and is moist).
Stockpile:	A pile of solid waste (not buried below ground). Anaerobic conditions are not assured in a stockpile with low volume to surface area ratios (less than 1.5) because the waste may be exposed to higher aeration.

3| Scope, Applicability, and Entry into Force

3.1 | Scope

3.1.1 | This methodology is applicable to activities that involve decentralised, on-site waste processing at the household or commercial level and that eliminate the need to transport organic waste to landfills or centralised treatment facilities. The decentralised waste processors can also produce useful products, such as natural fertiliser or compost.

3.2 | Applicability

3.2.1 | This methodology is applicable under the following conditions:

a. The activity that involves treatment of
   i. organic waste, such as kitchen and vegetable waste from households or commercial facilities like restaurants are eligible.
   ii. other waste streams, such as garden waste, animal waste, or wastewater (treatment or co-treatment) are not eligible.

b. The OSWP unit shall:
   i. treat organic waste through an aerobic decomposition process, ensuring that no methane emissions are produced during the process, and
   ii. quantify the amount and composition of waste processed for accurate determination of waste diverted from landfills.

c. The activity shall:
   i. establish appropriate procedures for the conditioning, storage, transportation, and soil application of compost or any other byproduct produced by the OSWP to avoid methane emissions during these stages,
   ii. monitor the implementation of these procedures using a sampling survey approach among representative end user groups to identify potential users who do not adhere to the prescribed procedure, such as those who handle the end product in a way that could generate methane emissions (for example, disposing of compost or byproducts into the municipal waste stream where it could end up in a landfill), and
   iii. consider the percentage of such users who do not follow the prescribed procedure as non-OSWP users and exclude these users from the eligible users.

d. If the activity involves thermal/mechanical treatment of compost, the project developer shall apply the provisions outlined in the latest version of CDM or A6.4 mechanism methodology AMS-III.E for thermal/mechanical treatment.

e. The project developer shall demonstrate that organic waste, such as food waste, is not under the purview of a legal mandate requiring organic waste sorting or treatment at the household or business establishment level; it shall be demonstrated that organic waste is sent to a landfill in the baseline scenario.

f. The necessary data required to calculate the conservative value of methane emissions per unit of organic waste diverted shall be available. This data shall:

i. include the quantity and composition of organic waste, other relevant data variables, and/or the default methane emission factor, if available,

ii. be based on the actual circumstances in the jurisdiction where the activity is implemented (whether at a national, regional, or local level); wherever applicable, the most conservative interpretation of the national or regional data shall be applied at the activity level,

iii. have a government, industry, or other relevant third-party source; if none is available, peer-reviewed studies may be referred to,

iv. be the most recent, i.e., no more than three years old at the time of activity validation.

If such data is not available, the project developer shall follow the provisions outlined in Section 5.4 of this methodology.

3.2.2 | Activity where following conditions apply are not eligible under this methodology:

a. Where legal mandates at the national, subnational, or local level (for example, city or municipality) require waste segregation or treatment, such as mandatory sorting, processing, or treatment at the household or business establishment level; for example:

   i. Mandatory segregation of organic waste into composting bins by households and businesses, which could lead to organic waste diversion

   ii. Mandatory treatment of organic waste through composting

b. Where organic waste is collected in a jurisdiction with legally mandated sorting and/or treatment but is transported to another jurisdiction in the baseline where no such legal mandate exists.

3.3 | Safeguards

3.3.1 | To avoid potential double-counting, the activity developer shall clearly communicate its ownership rights and intent to claim the emission reductions resulting from the project activity to OSWP users. The developer shall explicitly inform OSWP users and any end users of the byproducts of OSWP units that it cannot claim emission reductions. The project design documents shall document the steps taken to avoid double-counting.

3.3.2 | Activities applying this methodology shall adhere to the requirements of the latest version of the *Safeguarding Principles and Requirements*.[1] In particular, Principle 9—Environment, Ecology, and Land Use—requires the activity developer to ensure a precautionary approach to avoid negative environmental impacts. This includes:

a. Sub-principle 9.1 – Landscape modification and soil. Activities that involve the production, harvesting, and/or management of living natural resources by small-scale landholders and/or local communities shall adopt the appropriate and culturally sensitive sustainable resource management practices.

b. Sub-principle 9.5 – Hazardous and non-hazardous waste. Particular attention should be paid to avoiding or minimising pollution and discharge of hazardous waste from the activities. While this methodology is focused on organic waste, it is possible that OSWP units could capture hazardous waste, intentionally or not. Project developers shall have a plan to avoid any such discharges to the environment and must demonstrate an ability to dispose of any hazardous waste in a safe and sustainable manner.

3.3.3 | Confirmation of adherence to the Safeguarding Principles and the aforementioned sub-principles requires monitoring at the OSWP user level, such as a household or business establishment. The project developer shall:

a. provide necessary training and/or instructions during the delivery of OSWP to users, ensuring proper use, including clarification of the type of waste material that should or should not be fed into the OSWP units, and

b. design and implement a monitoring plan, following the sampling requirements and guidelines outlined in this methodology to ensure representation of end users.

3.3.4 | The facility manufacturing OSWP units shall demonstrate compliance with all applicable regional and national regulations.

3.4 | Entry into Force

3.4.1 | The date of entry into force of this methodology is 1st May 2024.

4| Normative References

4.1.1 | This methodology refers to the latest approved versions of the following methodologies and tool(s):

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[1] https://globalgoals.goldstandard.org/standards/103_V1.2_PAR_Safeguarding-Principles-Requirements.pdf

a. AMS-III.E.: Avoidance of methane production from decay of biomass through controlled combustion, gasification, or mechanical/thermal treatment
b. CDM Tool 04 - Emissions from solid waste disposal sites (hereinafter referred to as CDM Tool-04)
c. CDM Tool 05 - Baseline, project, and/or leakage emissions from electricity consumption and monitoring of electricity generation (hereinafter referred to as CDM Tool-05)
d. CDM Tool 07 - Tool to calculate the emission factor for an electricity system (hereinafter referred to as CDM Tool-07)
e. CDM Tool 13 - Project and leakage emissions from composting (hereinafter referred to as CDM Tool-13)

5| Baseline Methodology

5.1 | Project Boundary

5.1.1 | The project boundary includes:

a. the OSWP and physical location where it operates (home, business, etc.),
b. the transportation routes from that OSWP location to the landfill, where transport emissions would be reduced,
c. the destination of the final products if not used on-site, and
d. the designated SWDS/landfill that would have received the waste in the project scenario.
e. a typical activity may involve distribution of a large number of OSWPs and may face practical challenges in identifying the designated landfill that no longer receives the waste in the project scenario. For practicality and simplification, when calculating emission reductions from avoided transport, the landfills should be no more than 200 kilometres from the OSWP units.

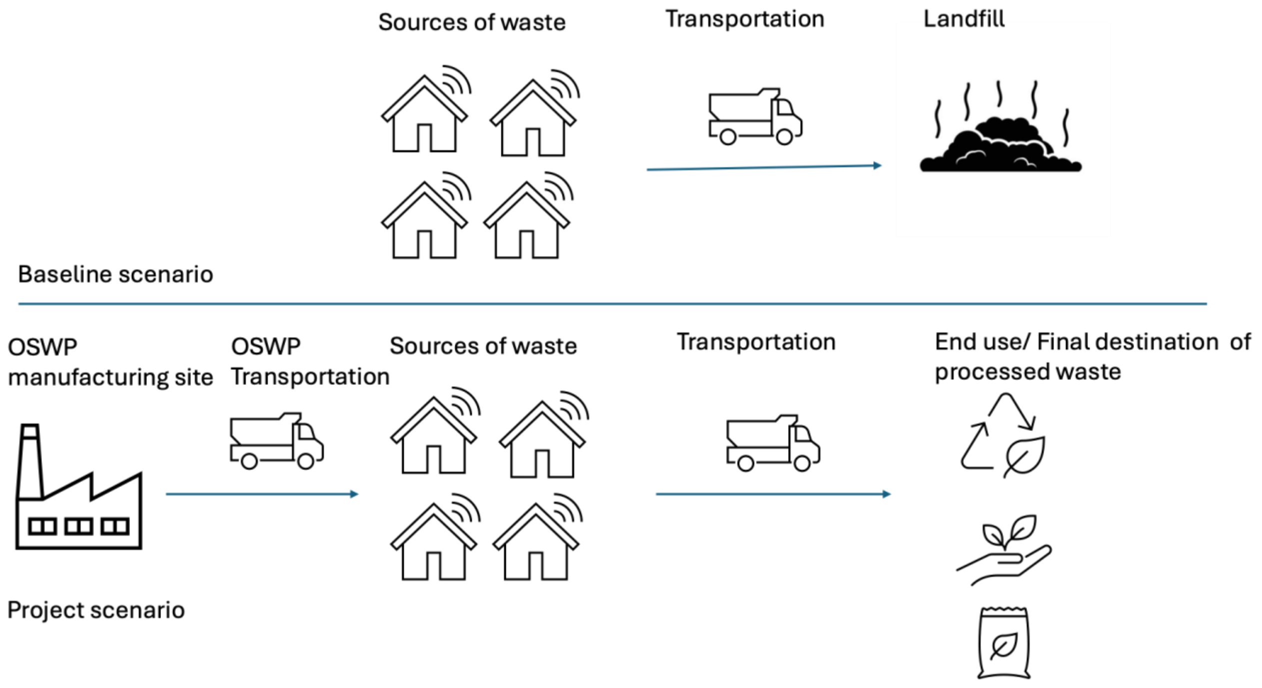

Figure 1 Schematic diagram of project boundary

5.2 | Emissions Sources Included in the Project Boundary

Table 3. Emissions Sources Included in or Excluded from the Project Boundary

Scenario	Source	Gas	Included?	Justification/Explanation
Baseline	Organic waste diversion	CO_2	No	This is excluded due to emissions being neutral and part of the natural carbon cycle.
		CH_4	Yes	Methane is the main GHG emitted when organic waste goes to a landfill.
		N_2O	No	This is excluded for simplicity.
	Transportation emissions associated with baseline waste hauling	CO_2	Yes	Carbon dioxide is the main emission associated with transportation.
		CH_4	No	Methane emissions are assumed to be very small.
		N_2O	No	Nitrous oxide emissions are assumed to be very small.
Project	GHGs from the electricity used by the OSWP units	CO_2	Yes	Decentralised composters and other OSWPs may use electricity or fossil fuels in their operation.
		CH_4	Yes	Methane emissions are assumed to be small.
		N_2O	Yes	Nitrous oxide emissions are assumed to be small.

	GHG emissions associated with composting	CO_2	No	This is not applicable as this parameter only considers methane and nitrous oxide.
		CH_4	Yes	Methane emissions could be generated if the project produces compost, as outlined in CDM Tool-13.
		N_2O	Yes	Nitrous Oxide emissions could be generated if the project produces compost, as outlined in CDM Tool-13.
	Transportation emissions associated with shipping output of OSWP if output is not used on-site	CO_2	Yes	Carbon dioxide is the main emission associated with transportation.
		CH_4	No	Methane emissions are assumed to be very small.
		N_2O	No	Nitrous oxide emissions are assumed to be very small.

5.3 | Demonstration of Additionality

5.3.1 | All activities, regardless of their scale, shall demonstrate regulatory surplus. It means showing that the proposed activity is not directly mandated by law or triggered by any legal requirements, such as legally binding agreements, covenants, consent decrees, or contracts with government agencies or private parties. If a legal mandate comes into effect during the crediting period, the project can only claim credits until the day the legal requirements become effective.

5.3.2 | The project developer shall demonstrate the additionality by conforming to additionality requirements of one of the options; these are listed in paragraph 5.3.3 | below, on a activity-by-activity basis. The project developer shall demonstrate that the proposed activity could not or would not take place without carbon finance. A possible reason for the need for carbon finance is that the initial investment or the ongoing marketing, distribution, quality control, manufacturing, and maintenance costs are unaffordable for the target population and/or project developer. Additional context can include the following:

a. Financial /investment barriers: There is capital expense on the part of OSWP users when the alternative is disposal of waste at a lower or no cost. Such up-front investment barriers can be alleviated through the additional revenue streams provided by carbon finance. While there may be revenue generation from the sale of OSWP, by-products such as compost, these revenues may be very small or insufficient to justify the expense of an OSWP.

b. Common practice or penetration rate: For the purposes of this methodology, a benchmark of 20% is set for the penetration test. The project developer may demonstrate through a penetration rate assessment that:

i. more than 80% of organic waste that can be treated by the project technology in the region is disposed of in an SWDS/landfill, and
ii. less than 20% of homes or business establishments similar to target user groups within the project boundary have OSWP units or similar technology.

The project developer shall provide evidence to support the penetration rate assessment to the Gold Standard Validation and Verification Body (VVB) at the time of validation. Such evidence of penetration rate can include the most recent studies, market analysis, or other research indicating the low penetration of OSWP technologies in the region or country.

5.3.3 | The project developer shall demonstrate additionality by conforming to additionality requirements of one of the following options:

a. CDM Tool 01 - Demonstration and assessment of additionality
b. CDM Tool 21 – Demonstration of additionality of small-scale projects
c. An approved Gold Standard Verified Emission Reduction (VER) additionality tool

5.4 | Baseline Scenario

5.4.1 | In the baseline scenario, the organic waste, such as food waste processed by the OSWP technology in the project scenario, would have been disposed of in a landfill like any similar waste stream. The project developer shall demonstrate and justify the baseline scenario following the below steps and requirements.

5.4.2 | The project developer shall outline potential baseline scenarios for proposed activity, including:

a. undertaking the proposed project without being registered as a Gold Standard activity,
b. continuing to transport and disposal of the waste to a landfill,
c. continuing to transport the waste to a centralised compost facility currently or in the future, and
d. having an alternative technology or approach that would cause the waste to be diverted from a solid waste disposal site or any plausible and credible alternative scenarios to the project which deliver the same result as the project itself.

If no investment is undertaken by the project developer, other OSWP solutions could be provided.

5.4.3 | The development of the baseline scenario shall be in line with the options in Paragraph 36 of Decision 3/CMA.3, *Rules, Modalities, and Procedures for the Mechanism Established by Article 6, Paragraph 4 of the Paris Agreement*.[2] This guidance states that the project developer shall apply one of three different approaches, taking into account any guidance by the supervisory body and recognising that a host party may determine a more ambitious level at its discretion. The most appropriate approach is based on existing actual or historical emissions, taking into account alignment with Paragraph 33[3] of this document.

The project developer shall take into consideration this guidance when developing the baseline scenario. The project developer shall examine the Nationally Determined Contribution (NDC) of the host country and other relevant national or regional policies that might cause actions that lead to reductions in emissions from organic waste, specifically improvement in rate of collection of organic waste from homes or businesses that were previously not being collected from. If implementation of such policies can quantitatively reduce emissions in the same manner as the project, the project developer shall transparently and conservatively adjust the baseline.

5.4.4 | The project developer shall assess the potential scenarios and provide analysis, as well as appropriate evidence, to demonstrate that the baseline scenario—disposal in an SWDS/landfill—is the most plausible scenario when considering cost, technology development, local laws, and other factors.

5.4.5 | The project developer shall take into account any law or policy in the region or country that requires on-site waste processing or diversion of organic waste to a centralised composting facility while defining the baseline scenario.

a. For example, some jurisdictions may have mandated that organic waste be placed in specific collection bins, which are then transported to a composting plant. In these situations, the project developer shall not account for the methane avoidance from the organic waste unless clear evidence suggests that laws are not being followed. However, the project may qualify for the avoided transportation of that waste.

[2] https://unfccc.int/sites/default/files/resource/cma2021_10a01E.pdf#page=25

[3] Paragraph 33 states the following: Mechanism methodologies shall encourage ambition over time; encourage broad participation; be real, transparent, conservative, credible, below "business as usual"; avoid leakage, where applicable; recognise suppressed demand; align with the long-term temperature goal of the Paris Agreement; contribute to the equitable sharing of mitigation benefits between the participating parties; and, in respect of each participating party, contribute to reducing emission levels in the host party; and align with its NDC, if applicable, its long-term low GHG emission development strategy if it has submitted one, and the long-term goals of the Paris Agreement.

b. Another example is that the project boundary may encompass an entire state or region, where an individual city may require waste treatment such as composting. In this situation, the project developer shall monitor the development of such regulations and remove devices from the project if they are located in these jurisdictions.

5.4.6 | Project developer shall also consider the waste management practices being followed by OSWP users in the baseline scenario, when the baseline or project scenario would have the same level of emissions. One example is end users who were composting their waste prior to the introduction of the OSWP, either through another on-site means or by sending the waste to a composting facility. In this case, the level of methane emissions between the baseline and project shall be considered the same.

5.4.7 | The project developer shall specify in the project design document whether the end users practice organic waste composting in the baseline scenario. If applicable, a baseline adjustment factor shall be determined. This can be done by conducting a survey within statistically significant sample groups of individual target user groups following the guidelines Sampling and Surveys for CDM Project Activities and Programme of Activities. The survey shall determine the level of composting practices by the users prior to using the OSWP unit. For example, if the survey reveals that 10% of the OSWP users were composting their waste in the baseline scenario, the baseline emissions would be discounted by 10%. This is reflected in the formula below. As another example, if the survey indicated that half of this 10% sent the waste to composting plants (instead of on-site composting), the project developer may account for avoided transport emissions for this half since on-site composting would not alter the transport-related emissions.

5.5 | Baseline Emissions

5.5.1 | Baseline emissions are determined separately for the following two eligible components:

a. The avoided methane emissions from the diversion of waste that would have been sent to a SWDS in the absence of this project.

b. The avoided GHGs emissions resulting from no longer needing to transport that waste. Note that if the outputs of the OSWP are not used on-site and are instead transported to another location for beneficial use or final disposal, no baseline emissions from transport are considered. It can be assumed that the avoided transport to the SWDS and the project-related transport of the OSWP output cancel each other out.

5.5.2 | Baseline emissions in year y (BEy) are calculated as follows:

$$BEy = (BE_{AM,y} + BE_{AT,y}) \times (1 - BAF) \quad \text{Eq. 1}$$

Where:

$BE_{AM,y}$	=	Baseline emissions from avoided methane from waste, in year y (tCO_2eq)
$BE_{AT,y}$	=	Baseline emissions from avoided transportation of waste, in year y (tCO_2eq)
BAF	=	Baseline adjustment factor (percentage) as described in 5.4.4 and 5.4.7

5.5.3 | Baseline emissions for Component 'a' ($BE_{AM,y}$) are calculated as follows:

$$BE_{AM,y} = \sum_i \sum_j \left(Q_{waste,i,j,y} \times EF_j\right) \quad \textit{Eq. 2}$$

Where:

$Q_{waste,i,j,y}$	=	Quantity of waste from OSWP unit i using waste type j in year y (tons of waste)
$\mathrm{EF_j}$	=	Emissions factor of waste type j

5.5.4 | The emission factor ($\mathrm{EF_j}$) is determined following the options below (listed in the order of preference).

- **a. Option 1:** When it is practically possible to identify the SWDSs where the waste would have ended up in the absence of the project, the project manager shall determine the emission factors for these sites in accordance with the latest version of CDM Tool-04.
- **b. Option 2:** When it is practically not possible to identify the SWDSs where the waste would have ended up in the absence of the project, the project developer may use regional default values as described in 5.5.6 | below. If regional default values are unavailable, national default values, as shown in Appendix A, may be used.

5.5.5 | For Option 1, the project developer shall take the following into consideration to determine the emissions factors for the project region or country:

- a. The project developer shall use Application B of CDM Tool-04 to determine the amount of methane avoided by diverting organic waste.
- b. If the projects cover too large an area to identify a particular destination landfill or landfills, the project developer may use the quantification approach as outlined in CDM Tool-04, i.e., to "sample" landfills. In this situation, the project developer shall obtain data from a representative sample of SWDS locations within the project boundary, which could be a region or an entire country.
  - i. The landfills of the sample group shall represent at least 40% of the total solid waste disposal by quantity within the project boundary. The project developer shall ensure that the sample group of landfills is representative of the region or country and that any potential bias is avoided. For example, the project developer shall not select only SWDS locations that have no landfill gas (LFG) collection if other landfills in the project boundary have such systems.

ii. For each selected landfill, the project developer shall collect necessary data to determine the methane-generating potential of specific waste types (W_j in CDM Tool-04). For many of the parameters in the First Order Decay (FOD) model, default values are applied based on the type of waste; however, certain landfill-specific data is also required, for example, mean average temperature and precipitation, depth of SWDS, and height of water table. In addition, a key parameter is an estimation of the amount of LFG already captured by this sample of SWDS locations.

iii. The project developer shall gather the requisite data and apply Equations 1 or 2 in CDM Tool-04 to determine tCH_4 potential per ton of waste type j processed by the OSWP units across the sample of landfills.

5.5.6 | For Option 2:

a. The most conservative values among various waste treatment technologies practiced in the region (such as landfill without flaring, landfill with flaring, composting, anaerobic digestion, and electricity generation) shall be applied to align with Article 6.4, Principles of Setting a Baseline Below Business as Usual.

b. When selecting the source of data, priority shall be given to most recent, reliable, and credible third-party data sources, such as government publications and peer-reviewed literature. If data from these sources is unavailable, other sources like those from industry groups may be used. This data shall provide an average level of methane avoidance per ton of organic waste processed by the project. The data shall not be more than three years old. Two illustrative examples are provided in Appendix A.

5.5.7 | Quantification of baseline emissions for Component ‘b’, i.e., avoided GHG emissions from transportation of waste to a landfill, is optional and can be ignored. This emission source is considered only if the project developer can demonstrate that compost or other byproducts from the OSWP are the final products and are used on-site, eliminating the need for incremental transport in the project scenario.

5.5.8 | Where $BE_{AT,y}$ is quantified and considered, the following equation shall be applied:

$$BE_{AT,y} = \sum_i \left(Q_{waste,i,j,y} \times D_i \times EF_{TK,k}\right) \qquad \textit{Eq. 3}$$

Where:

$Q_{waste,i,j,y}$	=	Quantity of waste from OSWP unit i using waste type j in year y (tons of waste)
D_i	=	Distance between the OSWP unit i and the landfill the waste would have gone to in the absence of the project (kilometres)

$EF_{TK,k}$ = Emissions factor of transport mode k in tCO_2/ton-kilometre; note that ton-kilometre accounting shall use metric tons

5.5.9 | The project developer shall do the following:

a. Calculate the distance from each OSWP unit to the nearest landfill using the data from where the waste was directed in the baseline or using other available data on locations of nearby landfills

b. Provide to the VVB a clear justification for choice of data source and analysis of distances

c. Calculate the total distance (D_i in kilometres) between the locations of OSWP units and the baseline destination of the waste. A ton-kilometre accounting approach shall be applied, differentiating between modes of transport. While it is assumed that organic waste is transported by truck, other transport modes can be considered when calculating emissions per ton-kilometre, depending on the project situation.

5.5.10 | In cases where there are too many OSWPs to practically determine a distance between an OSWP site and a landfill, the project developer may either not count this source of baseline emissions or develop a default based on a statistically significant sample of OSWPs across the project boundary. These estimations shall follow the guidelines Sampling and Surveys for CDM Project Activities and Programme of Activities.

5.5.11 | The project developer can use third-party sources for emissions factors ($EF_{TK,k}$) as long as the emission factor value is conservative, the source is publicly available, and the source can be verified by the VVB. In Europe, for example, 137 grams of CO_2 are emitted for every tonne of weight moved one kilometre.[4] In the United States, the Environmental Protection Agency (EPA) has a figure of 211 grams of CO_2 emitted per short ton-mile, or 190 grams of CO_2 emitted per metric ton-mile.[5]

5.6 | Project Emissions

5.6.1 | Project emissions occur primarily from the emissions generated by the OSWP units. Most of these units simply use electricity or a combination of electricity and natural gas, which must be accounted for as project emissions.

5.6.2 | Project emissions in year y (PE_y) can be calculated as follows:

$$PEy = (PE_{elec,y} + PE_{ff,c} + PE_{comp,y} + PE_{trans,y}) \quad \textit{Eq. 4}$$

[4] https://www.statista.com/statistics/1282257/average-ghg-emissions-in-the-eu-by-freight-transport-mode/

[5] https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf

Where:

$PE_{elec,y}$	=	Project emissions from the use of electricity in year y (tCO_2eq)
$PE_{ff,c}$	=	Project emissions from fossil fuel combustion in year y (tCO_2eq)
$PE_{comp,y}$	=	Project emissions (nitrous oxide and methane) from composting if that is the waste product produced, in year y (tCO_2eq)
$PE_{trans,y}$	=	Project emissions from transport of output of OSWP units if the product (e.g., compost) is shipped and not used on-site, in year y (tCO_2eq)

5.6.3 | Project emissions from electricity use ($PE_{elec,y}$) at the processing facility(ies) are calculated as follows:

$$PE_{elec,y} = \sum_i \left[Q_{elec,i,y} \times EF_{elect,i} \times (1 + TDL_{elec})\right] \qquad \textit{Eq. 5}$$

Where:

$Q_{elec,i,y}$	=	Quantity of electricity used by OSWP unit i in year y (MWh)
$EF_{elect,i}$	=	Emissions factor of the grid (tCO_2/MWh) where OSWP unit i is located
TDL_{elec}	=	Transmission and distribution losses associated with the electricity use (%)

5.6.4 | Project emissions from the use of fossil fuels ($PE_{ff,c}$) at the processing facility(ies) are calculated as follows:

$$PE_{ff,c} = \sum_i \sum_f (Q_{f,i,y} \times NCV_f \times EF_f) \qquad \textit{Eq. 6}$$

Where:

$Q_{f,i,y}$	=	Quantity of fossil fuel f combusted by OSWP unit i in year y
NCV_f	=	Net calorific value of fossil fuel f (TJ/fuel units)
EF_f	=	Emission factor of fossil fuel f (tCO_2/TJ)

5.6.5 | Project emissions from the composting ($PE_{comp,y}$) shall be quantified per CDM Tool-13. Project emissions from the energy needs of the composting facility are already included in the formulas above, but composting-related methane and nitrous oxide emissions are not. For this source of emissions, the project developer shall sample a number of OSWPs to measure methane and nitrous oxide emissions, as outlined in CDM Tool-13, or shall use the defaults.

$$PEcomp,y = (Q_{comp,y} \times EF_{CH4} \times GWP_{CH4}) + (Q_{comp,y} \times EF_{N2O} \times GWP_{N2O}) \qquad \textit{Eq. 7}$$

Where:

$Q_{comp,y}$	=	Quantity of waste composted across all OSWP units in year y

EF_{CH4}	=	Emissions factor of methane per ton of waste composted, as determined in CDM Tool-13, or default value 0.002 tCH_4/t of waste composted
GWP_{CH4}	=	Global warming potential of methane (latest as allowed by Gold Standard requirements)
EF_{N2O}	=	Emissions factor of nitrous oxide per ton of waste composted, as determined in CDM Tool-13, or default value 0.0002 tN_2O/t of waste composted
GWP_{N2O}	=	Global warming potential of nitrous oxide (latest as allowed by Gold Standard requirements)

5.6.6 | Project emissions from the transportation ($PE_{trans,y}$) are calculated as follows:

$$PE_{trans,y} = \sum_{i,ship}\left(Q_{output,i,shipped,y} \times D_{i,ship} \times EF_{TK,k}\right) \quad \text{Eq. 8}$$

Where:

$Q_{output,i,shipped,y}$	=	Quantity of output from OSWP unit i that is shipped off-site (whether compost or other byproduct) in year y (tons); note that project developer shall monitor which OSWP units ship output off-site and where
$D_{i,ship}$	=	Distance between the OSWP unit i shipping the output off-site and the location of that output (kilometres)
$EF_{TK,k}$	=	Emissions factor of transport mode k in tonne-kilometre; note that ton-mile accounting shall use metric tons, not short tons

5.6.7 | Upstream emissions from the production of OSWP units shall be taken in account, as follows

a. If upstream emissions are less than 5% of total estimated emission reductions generated by the OSWP units per year, then these upstream emissions can be considered de minimis and thus disregarded.

b. If the emissions are estimated to be greater than 5% of total estimated emission reductions generated by the OSWP units per year then the upstream emissions shall be calculated and added as a project emission. Project developer may use a third-party, certified life-cycle analysis to calculate OSWP production emissions on a per-unit basis or use actual data from the facility producing the OSWP units (electricity, gas usage, etc.) and transportation in a same manner as in Equations 5,6 and 8 above.

5.7 | Leakage Emissions

5.7.1 | No material source of leakage emissions have been identified from this activity type.

5.8 | Emission Reductions

5.8.1 | The emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Eq. 9}$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e/yr)
BE_y	=	Baseline emissions in year y (t CO_2e/yr)
PE_y	=	Project emissions in year y (t CO_2e/yr)

5.9 | Changes Required for Second and Third Crediting Periods

5.9.1 | When the project developers apply for crediting period renewal, the following shall apply:

a. The baseline situation with regard to on-site waste processing, in addition to other relevant methodological parameters, shall be reassessed, per the latest version of the methodology available at the time of submission of renewal of crediting period.

b. Laws and regulations that require treatment of organic waste may have been implemented since the start of the previous crediting period. If such policies have been implemented in a specific jurisdiction, emission credits from OSWP units in that jurisdiction shall no longer be eligible for carbon credits.

5.10 | General Requirements for Data and Information Sources

5.10.1 | In the following tables of data and parameters that are monitored and not monitored, there are cases in which a variety of source documents or studies may be applied to determine a parameter or to cross-check a parameter.

5.10.2 | When multiple sources are available and fulfil the requirements for defining or cross-checking a parameter, the most relevant source shall be chosen. Criteria for relevance include geographical (e.g., more specific to the project boundary location), temporal (e.g., more recent), and others. The VVB shall assess the relevance of the source applied compared with the other sources available. While conservativeness is a guiding principle for selecting data, the source applied to define or cross-check the parameter may not be the most conservative if it can be shown to be the most relevant.

5.11 | Data and Parameters Not Monitored

Parameter ID	**1**
Data/Parameter:	EF_j
Data unit:	tCO_2eq/ton of organic waste type j
Description:	Emissions factor of organic waste type j processed by the project
Source of data:	Third-party or government data relevant to all waste processed within the project boundary; data shall be no more than three years old
Measurement procedures (if any):	-
Any comment:	-

Parameter ID	**2**
Data/Parameter:	EF_f
Data unit:	tCO2/TJ
Description:	Emission factor of fossil fuel f
Source of data:	Any of the following sources may be applied: - Intergovernmental Panel on Climate Change (IPCC) defaults - Fuel-specific value from invoice/fuel supplier - National defaults
Measurement procedures (if any):	-
Any comment:	To determine the emission intensity of any fossil fuels used by the OSWP

Parameter ID	**3**
Data/Parameter:	$EF_{elect,i}$
Data unit:	tCO2/MWh
Description:	Emission factor associated with the electricity use of OSWP unit i
Source of data:	Determined by applying CDM Tool-05 or CDM Tool-07. In countries where reliable grid emissions data is available (such as U.S. EPA eGrid data), those factors may be used. Data should be no more than three years old.

Measurement procedures (if any):	-
Any comment:	-

Parameter ID	4
Data/Parameter:	TDL_{elec}
Data unit:	%
Description:	Transmission and distribution losses associated with the electricity use
Source of data:	To be based on data as obtained from national, regional, or local authorities, not more than three years old. In addition, default data as listed in CDM Tool-05 is an acceptable data source.
Measurement procedures (if any):	
Any comment:	

Parameter ID	5
Data/Parameter:	NCV_f
Data unit:	TJ/unit of fuel
Description:	Net calorific value of any fuel used by OSWP unit i
Source of data:	Any of the following sources may be applied: - IPCC defaults - Fuel-specific value from invoice/fuel supplier - National defaults
Measurement procedures (if any):	
Any comment:	To determine the energy content of any fossil fuels used by the OSWP

Parameter ID	6
Data/Parameter:	BAF
Data unit:	Percentage
Description:	Baseline adjustment factor to take into account that baseline activities by the OSWP users may yield the same level of emissions as in the project scenario

Source of data:	Project developer
Measurement procedures (if any):	
Any comment:	See Sections 3.5.4 and 3.5.5.

Parameter ID	**7**
Data/Parameter:	$EF_{TK,k}$
Data unit:	tCO_2/tonne-kilometre (note that tonne-kilometre accounting shall use metric tons)
Description:	Emissions factor of transport mode k in tCO_2/tonne-kilometre
Source of data:	See the following: https://www.statista.com/statistics/1282257/average-ghg-emissions-in-the-eu-by-freight-transport-mode/ https://www.epa.gov/sites/default/files/2021-04/documents/emission-factors_apr2021.pdf
Measurement procedures (if any):	-
Any comment:	-

Parameter ID	**8**
Data/Parameter:	D_i and $D_{i,ship}$
Data unit:	Miles or kilometres
Description:	Distance between OSWP unit i and the landfill the waste would have gone to in the absence of the project, as well as distance between OSWP unit and location where output of that unit (e.g., compost) is shipped to
Source of data:	Project developer
Measurement procedures (if any):	
Any comment:	See Sections 3.6.7-3.6.10. Note that if the number of OSWPs change substantially during the crediting period (e.g., more are added), it is possible that this will become a monitored parameter.

6| Uncertainty Quantification

6.1.1 | Potential sources of uncertainty, along with the associated Quality Assurance/Quality Control (QA/QC) requirements to minimize them, are summarized in monitoring parameter tables below.

6.1.2 | The uncertainties associated with the parameters would be aggregated into uncertainty estimates for emission reductions. A 95% confidence interval will be employed for quantifying uncertainty due to random errors, following the statistical approaches provided in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories and 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (propagation of errors method), unless otherwise required in the applied tool or guidelines. When the uncertainty in the estimated value of emission reductions or removal is expected to be at a 95% confidence interval (within +/-10% range when applicable), the activity may exclude such random errors; while, in case of being outside +/-10% range at a 95% confidence interval, the activity should include such random errors.

7| Monitoring Methodology

7.1 | Data and Parameters Monitored

Parameter ID	**9**
Data/Parameter:	$Q_{waste,i,j,y}$, $Q_{output,i,shipped,y}$, and $Q_{comp,y}$
Data unit:	Metric tons
Description:	Quantity of waste going into OSWP unit i using waste type j in year y. Where relevant, the project developer would also measure quantity of waste output that is composted (thus generating some project emissions) and quantity of output that is shipped off-site.
Source of data:	Project developer
Measurement procedures (if any):	-
Monitoring frequency:	Continuous (can be annual if surveys are used)
QA/QC procedures:	Calibration must be conducted according to the equipment manufacturer’s specifications. The measurement of the waste may likely be within the OSWP unit. If there are too many units to individually calibrate, the project developer shall use a sampling approach (i.e., testing the accuracy of the electricity measurement devices within the units) to obtain a 90/10 confidence level.
Any comment:	For OSWP units that are widely distributed across the project boundary, weighing devices within the units may be used to

	determine quantity of waste entered into the device. Project proponents must be clear in terms of what types of wastes can be processed by the OSWP. If multiple waste types are used, with different Default Emission Factors (DEFs), the project developer must be able to provide evidence as to the different composition of these waste types across OSWP units. For large populations of OSWP units, a sampling process may be used in compliance with the latest version of the tool *Sampling and Surveys for CDM Project Activities and Programme of Activities*. In addition, if the project is using OSWPs that are not equipped to weigh the waste and send it back to a centralised data management system through an Internet of Things (IoT)-enabled device, the project developer may undertake sampling and surveys, following the guidelines in the tool *Sampling and Surveys for CDM Project Activities and Programme of Activities*. The achieved level of precision should be a 90/10 confidence factor. For example, in the case of clean cooking methodologies, surveys are conducted on a sample of customers to determine wood or charcoal use before a stove is installed; post-project surveys are also conducted to estimate the decline in the use of these fuels due to the new stove (or use of alternative fuels). In this case, the project developer shall undertake a sampling campaign to measure the amount of waste processed in a sample of OSWP users that is representative of the entire population and/or stratified according to differences within the population of devices (family size, geography/climate differences, and other relevant factors). The project developer shall develop a stratification plan for presentation to the VVB. The length of the sampling campaign shall be determined by the project developer but again shall be representative across the entire year and justified in the sampling plan. The sampling process can be done through direct weight measurements or through extrapolation by tracking the frequency of use of the OSWP and the size of the unit. For example, if a user operates the OSWP device X times per day and the size is Y liters, defaults can be used to determine the mass of waste processed based on the density of waste. Food waste, for example, typically has a density on the order of 650 kg/m3, so 650 g/litre. Such data must come from independent sources and must be presented to the VVB. This sampling data may be supplemented with other data, if

	available. Again, cooking stove methodologies allow the use of other data for determining fuel usage: • Credible published literature for project region • Studies by academia, nongovernmental organizations, or multilateral institutions • Official government publications or statistics

Parameter ID	**10**
Data/Parameter:	$Q_{f,i,y}$
Data unit:	Mass or volume units (e.g., kilograms, litres, standard m3)
Description:	Quantity of fossil fuel f used by OSWP unit i in year y
Source of data:	Project developer, using: - Direct measurement with meter, scales - Fuel invoice or purchase receipt
Measurement procedures (if any):	
Monitoring frequency:	Continuous
QA/QC procedures:	Use calibrated flow or gas meters, or use gas utility bills and/or supply records and receipts from other fuel suppliers (e.g., diesel). Calibration must be conducted according to the equipment manufacturer's specifications. All bills/records are to be archived in a central database and made available to the verifier.
Any comment:	

Parameter ID	**11**
Data/Parameter:	$Q_{elec,i,y}$
Data unit:	MWh
Description:	Quantity of electricity used by OSWP unit i in year y
Source of data:	Project developer, backed up by data from the electric utility
Measurement procedures (if any):	
Monitoring frequency:	Continuous or based on monthly utility bills
QA/QC procedures:	Use calibrated electricity meters, which may or may not be located within the OSWP, or utility bills. Calibration must be conducted according to the equipment manufacturer's specifications.

	Alternatively, utility billing data can be used. If there are too many units to individually calibrate, the project developer shall use a sampling approach (testing the accuracy of the electricity measurement devices within the units) to obtain a 90/10 confidence level.
Any comment:	All bills/records are to be archived in a central database and made available to the verifier.

Parameter ID	**12**
Data/Parameter:	Policies regarding organic waste treatment in a jurisdiction located within the project boundary
Data unit:	N/A
Description:	It is possible that some jurisdictions within the project boundary may institute such laws and regulations (e.g., the project boundary covers an entire state or region, and an individual city passes a composting regulation). In these cases, the project developer needs to monitor the development of such regulations and remove devices from the project if they are located in such jurisdictions.
Source of data:	Project developer
Monitoring frequency:	Annual
QA/QC procedures:	N/A
Any comment:	

7.2 | General Requirements for Sampling

7.2.1 | When conducting such sampling, the project developer shall follow the guidelines provided in the tool Sampling and Surveys for CDM Project Activities and Programme of Activities.

APPENDIX A

1. This methodology provides two illustrative examples, one from the United States and one from the United Kingdom. Project developers should obtain this data and provide it to the VVB upon project validation. Interpretation of this data should be conservative.

United Kingdom			Landfill
Activity	Waste type	Unit	Total kg CO_2e per unit
Refuse	Household residual waste	tonnes	446.204
	Organic: food and drink waste	tonnes	626.856
	Organic: garden waste	tonnes	578.940
	Organic: mixed food and garden waste	tonnes	587.326
	Commercial and industrial waste	tonnes	467.008

Source UK Government GHG Conversion Factors for Company Reporting

2. As in the example below, the U.S. EPA has calculated default methane avoidance factors for different kinds of waste and provides different numbers depending on whether a typical landfill collects methane. Given that many landfills in the United States have LFG collection systems, a conservative interpretation of the data would be to use the DEF, assuming LFG collection, as indicated below using the example of food waste. Again, this number can be used across the United States, and DEF_j (with j being food waste) would be 0.50 tCO_2eq. (*Source: U.S. EPA Waste Reduction Model.)*

3. Note that in the chart below, the figures are in metric tons of CO_2 per ***short*** ton of waste. The figures below shall be converted to metric tons. This, the 0.50 tCO_2eq per short ton would be calculated as 0.50 divided by 0.907 (short ton/metric ton), which equals 0.551 tCO_2eq/metric ton of waste.

Exhibit 1-49: Components of the Landfill Emission Factor for the Three Different Methane Collection Systems Typically Used In Landfills ($MTCO_2E$/Short Ton)

(a)	(b) Net GHG Emissions from CH_4 Generation			(c)	(d)	(e) Net GHG Emissions from Landfilling (e = b + c + d)		
Material	Landfills without LFG Recovery	Landfills with LFG Recovery and Flaring	Landfills with LFG Recovery and Electric Generation	Net Landfill Carbon Storage	GHG Emissions From Transportation	Landfills without LFG Recovery	Landfills with LFG Recovery and Flaring	Landfills with LFG Recovery and Electricity Generation
Food Waste	1.62	0.63	0.52	(0.09)	0.02	1.39	0.54	0.42

Note: Negative values denote GHG emission reductions or carbon storage.

Per Ton Estimates of GHG Emissions for Baseline and Alternative Management Scenarios

Material	GHG Emissions per Ton of Material Produced ($MTCO_2E$)	GHG Emissions per Ton of Material Source Reduced ($MTCO_2E$)	GHG Emissions per Ton of Material Recycled ($MTCO_2E$)	GHG Emissions per Ton of Material Landfilled ($MTCO_2E$)	GHG Emissions per Ton of Material Combusted ($MTCO_2E$)	GHG Emissions per Ton of Material Composted ($MTCO_2E$)	GHG Emission per Ton of Material Anaerobically Digested ($MTCO_2E$)
Corrugated Containers	5.58	(5.58)	(3.14)	0.18	(0.49)	NA	NA
Magazines/third-class mail	8.57	(8.57)	(3.07)	(0.43)	(0.35)	NA	NA
Newspaper	4.68	(4.68)	(2.71)	(0.85)	(0.56)	NA	NA
Office Paper	7.95	(7.95)	(2.86)	1.13	(0.47)	NA	NA
Phonebooks	6.17	(6.17)	(2.62)	(0.85)	(0.56)	NA	NA
Textbooks	9.02	(9.02)	(3.10)	1.13	(0.47)	NA	NA
Mixed Paper (general)	6.07	(6.07)	(3.55)	0.07	(0.49)	NA	NA
Mixed Paper (primarily residential)	6.00	(6.00)	(3.55)	0.02	(0.49)	NA	NA
Mixed Paper (primarily from offices)	7.37	(7.37)	(3.58)	0.11	(0.45)	NA	NA
Food Waste	3.66	(3.66)	NA	0.50	(0.13)	(0.12)	(0.04)
Food Waste (non-meat)	0.76	(0.76)	NA	0.50	(0.13)	(0.12)	(0.04)
Food Waste (meat only)	15.10	(15.10)	NA	0.50	(0.13)	(0.12)	(0.04)
Beef	30.09	(30.09)	NA	0.50	(0.13)	(0.12)	(0.04)
Poultry	2.45	(2.45)	NA	0.50	(0.13)	(0.12)	(0.04)
Grains	0.62	(0.62)	NA	0.50	(0.13)	(0.12)	(0.04)
Bread	0.66	(0.66)	NA	0.50	(0.13)	(0.12)	(0.04)
Fruits and Vegetables	0.44	(0.44)	NA	0.50	(0.13)	(0.12)	(0.04)
Dairy Products	1.75	(1.75)	NA	0.50	(0.13)	(0.12)	(0.04)

A second example can be drawn from the United Kingdom, where the numbers are relatively similar to the United States. This example, again, is broken down by waste type and emphasises that the project developer needs to provide justification in the monitoring plan for the OSWP units to differentiate and quantify the different kinds of waste.

DOCUMENT HISTORY

Version	Date	Description
1.0	01/05/2024	First version