T-VER-P-METH-09-01

Municipal Solid Waste Management to Replace Landfills

Version 01

Sector 13: Waste handling and disposal

Entry into force on 1 March 2023

Thailand Greenhouse Gas Management Organization (Public Organization) (TGO)

1. Methodology	**Municipal solid waste management to replace landfills**
2. Project Type	Solid waste management
3. Sector scope	13 - Waste handling and disposal
4. Project Outline	It is a project with activities related to the installation of a new organic waste treatment system instead of landfill.
5. Applicability	It is a project with activities related to the installation of a new organic waste treatment system instead of landfill with the following alternative methods; 1) Composting process under aerobic condition and co-composting of wastewater in combination with solid waste 2) Anaerobic digestion with biogas recovery / landfill gas recovery for flaring and/or its utilization (including improving the quality of biogas for distribution to the natural gas network) 3) Mechanical/thermal treatment to produce refuse-derived fuel (RDF) or stabilized biomass (SB) that is produced within the project boundary and its utilization 4) Incineration of fresh waste for heat generation (thermal/electricity) 5) Gasification process to produce syngas and its utilization
6. Project Conditions	1. The project activity only treats fresh waste/wastewater for which emission reductions are claimed. This is not eligible for industrial waste and hazardous waste. 2. Neither the fresh waste nor the products from the project activity are stored on-site under anaerobic conditions 3. Any wastewater discharge resulting from the project activity is treated in accordance with applicable regulations 4. The project activity does not reduce the amount of waste that would be recycled in the absence of the project activity.
7. Project Starting Date	The date is that the project owner (client) and the contractor have signed to construct the project of greenhouse gas emission reduction which will be developed to the T-VER project.
8. Definition	**Anaerobic digester** - System that is used to generate biogas from liquid or solid waste through anaerobic digestion. The digester is

	covered or encapsulated to enable biogas capture for heat and/or electricity generation or feeding biogas into a natural gas network; **Anaerobic digestion** - Degradation and stabilization of organic materials by the action of anaerobic bacteria that result in production of methane and carbon dioxide. Typical organic materials that undergo anaerobic digestion are municipal solid waste (MSW), animal manure, wastewater, organic industrial effluent and biosolids from aerobic wastewater treatment plants; **Anaerobic lagoon** - a treatment system consisting of a deep earthen basin with sufficient volume to permit sedimentation of settleable solids, to digest retained sludge, and to anaerobically reduce some of the soluble organic substrate. Anaerobic lagoons are not aerated, heated, or mixed and anaerobic conditions prevail except possibly for a shallow surface layer in which excess undigested grease and scum are concentrated; **Biogas** - Gas generated from anaerobic digestion of organic matter. Typically, the composition of the gas is 50 to 70 per centCH_4 and 30 to 50 per centCO_2, with traces of H_2S and NH_3 (1 to 5 per cent); **By-products** - By-products from the waste treatment plant(s) established under the project activity. This includes, for example, aluminium or glass collected from the sorting of waste prior to subsequent treatment; **Co-composting** - a type of composting where solid wastes and wastewater containing solid biodegradable organic material are composted together; **Composting** - a process of biodegradation of waste under aerobic (oxygen-rich) conditions. Waste that can be composted must contain solid biodegradable organic material. Composting converts biodegradable organic carbon to mostly carbon dioxide (CO_2) and a residue (compost) that can be used as a fertilizer. Other outputs from composting can include, inter alia, methane (CH_4), nitrous oxide (N_2O), and wastewater discharge (in case of co-composting); **Digestate** – spent contents of an anaerobic digester. Digestate may be liquid, semi-solid or solid. Digestate may be further stabilized

	aerobically (e.g. composted) applied to land, sent to a solid waste disposal site (SWDS), or kept in a storage or evaporation pond; **Fresh waste** - solid waste that is intended for disposal in a SWDS but has not yet been disposed. This may comprise MSW and excludes old waste and hazardous waste; **Gasification** - the process of thermal decomposition of organic compounds at high temperatures, typically more than 800˚C. Gasification converts organic compounds, of both biogenic and fossil origin, into combustible gas, e.g. syngas; **Hazardous waste** - waste generated by industries or hospitals, which. may be hazardous or infectious; **Incineration** - the controlled combustion of organic compounds of both biogenic and fossil origin with or without heat recovery and utilization. Ideally, all the organic content is converted into CO_2 and H2O. Practically, as combustion is incomplete and as inert matter is also in the combusted waste, ashes are also an important by-product; **Landfill gas (LFG)** - the gas generated by decomposition of waste in a SWDS. LFG is mainly composed of methane, carbon dioxide and small fractions of ammonia and hydrogen sulphide; **LFG capture system** - a system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Active systems use mechanical equipment to capture LFG by providing pressure gradients. For the purpose of this methodology, captured LFG can be flared or used; **Municipal solid waste (MSW)** - a heterogeneous mix of different solid waste types, usually collected by municipalities or other local authorities. MSW includes household waste, garden/park waste and commercial/institutional waste; **Old waste** - solid waste that has been disposed of in a SWDS. Old waste has different characteristics than fresh waste, such as a lower organic matter content, limiting its application to some alternative

	treatment processes that require waste with a minimum level of organic material (e.g. composting and anaerobic digesters); **Organic waste** - waste that contains degradable organic matter. **Refuse-derived fuel (RDF)** - a fuel which is derived from the mechanical and/or thermal treatment of waste and which is used in an incineration or co-incineration process. In which RDF production goes through a frequent chopping process. dehumidification together with waste conversion technology such as briquettes, etc. **Sludge pits** - a pit or tank where untreated liquid sludge is pumped and stored for at least one year. Anaerobic bacteria decompose the liquid sludge and decrease the organic matter content, resulting in emissions of CO_2, CH_4, hydrogen sulphide (H_2S) and ammonia. Once the pits are dried out and the sludge is stable, the solids are removed and used, e.g. as fertiliser for non-food crops; **Stabilized biomass (SB)** - a fuel which is derived from the mechanical and/or thermal treatment of waste and which is used in an incineration or co-incineration process. SB is produced from agricultural waste and is treated to prevent further degradation in the environment. Examples of SB are: pellets, briquettes and torrified wood chips. **Solid waste** - discarded and insoluble material (including gases or liquids in cans or containers) **Solid waste disposal site (SWDS)** - designated areas intended as the final storage place for solid waste. Stockpiles are considered a SWDS if: (a) their volume to surface area ratio is 1.5 or larger; and if (b) a visual inspection by the Validation and Verification Body (VVB) 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. **Syngas** - a gas mixture consisting primarily of carbon monoxide and hydrogen and small amounts of carbon dioxide. It is produced from

	gasification and may be used as a fuel for energy generation or as an intermediate for the production of other chemicals; **Wastewater discharge** - Wastewater that is generated as a by-product from a waste treatment plant established under the project activity.

Details of voluntary greenhouse gas reduction methods for

Municipal solid waste management to replace landfills

1. Greenhouse gas emission reduction activities used in the calculations

Table 1. Sources and types of greenhouse gases

Greenhouse gas emission	Source	Greenhouse Gas	Details of activities that emit greenhouse gas emissions
Baseline Emission	Landfilling community solid waste in landfills	CH_4	Organic degradation in landfills under anaerobic conditions
Project Emission	Fossil fuel consumption	CO_2	The use of fossil fuels
	Electric power consumption	CO_2	The use of electric power
	waste treatment process	CO_2	Combustion, production of synthetic fuel gas or burning fossil waste Excluded from decomposition or combustion of fresh waste.
		CH_4	Methane leaks from anaerobic digesters and incomplete combustion in biogas incineration processes, including incineration, production of synthetic fuel gas. compost production and burning RDF/SB
		N_2O	Emissions from fertilizer production, incinerator combustion, synthetic fuel gas generation and RDF/SB combustion.

Greenhouse gas emission	Source	Greenhouse Gas	Details of activities that emit greenhouse gas emissions
	wastewater treatment process	CH_4	Emissions from anaerobic wastewater treatment
Leakage Emission	Composting or Co-composting	CH_4	Emissions from the compost produced are either stored anaerobically or disposed of at a solid waste disposal facility.
	Anaerobic digestion	CH_4	Emissions from storage of compost residues and compost production from composting residues
	Production and use of RDF/SB	CO_2 , CH_4	Emissions from waste disposal from production and use of RDF/SB

2. Scope of Project

2.1 Project Characteristics

It is project activities related to the installation of a new organic waste treatment system instead of landfill with the following alternative methods;

1) Composting process under aerobic conditions/ co-composting process

2) Anaerobic digestion with biogas recovery / landfill gas recovery for flaring and/or its utilization (including improving the quality of biogas for distribution to the natural gas network)

3) Mechanical/thermal treatment process to produce refuse-derived fuel (RDF) or stabilized biomass (SB) that is produced within the project boundary and its utilization

4) Incineration of fresh waste for heat generation (thermal/electricity)

5) Gasification process to produce syngas and its utilization

2.2 Project scope

The project scope is to dispose of solid waste at a solid waste disposal facility including wastewater and sludge treatment facility in baseline. The project scope does not include activities related to solid waste collection and transportation.

3. Additionality

The project must undergo further proof of operation from normal operations. (Additionality) by using the "Proof of Operations Guidelines in addition to normal operations (Additionality) under the Thailand Voluntary Emission Reduction Program (T-VER)" standard equivalent to the international standards prescribed by the TGO.

4. Baseline Scenario

The management of municipal solid waste through landfills releases methane (CH_4) into the atmosphere. The methane gas inside the landfill is generated from the decomposition of organic waste such as food (vegetable scraps, fruit), tree branches/leaves. Under anaerobic conditions, the amount of methane generated inside a landfill depends on the nature of the landfill. When considering the guidelines for determining the base case information below normal operations (Below Business as Usual or Below BAU), the baseline data for greenhouse gas emissions from community solid waste management by landfill is the greenhouse gas emissions from community solid waste management by Semi-aerobic Landfill.

5. Baseline Emission

$$\mathbf{BE_y = \sum (BE_{CH4,y} + BE_{ww,y}) \times (1 - RATE_{Compliance})} \qquad \text{Equation (1)}$$

Where

BE_y	=	Baseline emissions in year y (tCO_2e)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year y (tCO_2e)
$BE_{ww,y}$	=	Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (tCO_2e)
$RATE_{Compliance}$	=	Discount factor to account for the rate of compliance of a regulatory requirement that mandates the use of alternative waste treatment process t

5.1 Baseline emissions of methane from the SWDS ($BE_{CH4,y}$)

Baseline methane emissions from the SWDS are determined using T-VER-P-TOOL-02-03 “Tool to calculate Emissions from solid waste disposal sites”. The following requirements shall be complied with when applying the tool:

(1) $W_{j,x}$ in the tool is the amount of organic fresh waste prevented from disposal in the baseline SWDS due to its treatment in any (combination) alternative waste treatment process

(2) Emission amounts are calculated using Application B in the tool (only fresh waste avoided from disposal after the start of the first crediting period shall be considered;

(3) Sampling to determine the fractions of different waste types is necessary (note that for the case that the waste is combusted in the project activity, then the parameter $Q_{j,c,y}$ in this methodology is equivalent to the variable $W_{j,x}$ in the tool);

(4) The tool instructs that f_y shall be determined based on historic data or contract or regulation requirements specifying the amount of methane that must be destroyed/used (if available). The following additional instruction applies:

(4.1) If the regulation requirements specify a percentage of the LFG that is required to be flared, the amount shall equal f_y.;

(4.2) If the regulation requirements do not specify the amount or percentage of LFG that should be destroyed but require the installation of a capture system, without requiring the captured LFG to be flared then f_y = 0; and

(4.3) If the requirement does not specify any amount or percentage of LFG that should be destroyed but require the installation of a system to capture and flare the LFG, then it is assumed f_y = 0.2

(5) The default value of the MCF is 0.5 with the following conditions:

5.2 Baseline emissions from organic wastewater ($BE_{ww,y}$)

Wastewater treatment which contains organic compounds produces methane gas. Use the lower value between the amount of methane produced from wastewater from project activities. and methane emissions calculated using Methane Conversion Factor as baseline greenhouse gas emission values for anaerobic wastewater treatment or sludge treatment in sludge treatment ponds.

$$BE_{ww,y} = \min (Q_{CH4,y} ; BE_{CH4,MCF,y}) \quad \text{Equation (2)}$$

Where

$BE_{ww,y}$	=	Baseline methane emissions from anaerobic treatment of the wastewater in open anaerobic lagoons or of sludge in sludge pits in the absence of the project activity in year y (tCO_2eq/year)
$Q_{CH4,y}$	=	Amount of methane produced from wastewater in year y after the implementation of the project activity (tCO_2eq/year)
$BE_{CH4,MCF,y}$	=	Baseline methane emissions determined using the Methane Conversion Factor (tCO_2eq/year)

5.2.1 Methane produced from Anaerobic Digester ($Q_{CH4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester. For large scale projects only, Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

Option 1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the T-VER-P-TOOL-02-05 “Tool to calculate the mass flow of a greenhouse gas in a gaseous stream”. When applying the tool, the following applies:

(a) The gaseous stream to which the tool is applied is the biogas collected from the digester.

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined.

(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas, as follows:

$$Q_{CH4,y} = Q_{biogas,y} \times f_{CH4,default} \times p_{CH4} \quad \text{Equation (3)}$$

Where

$Q_{CH4,y}$	=	Quantity of methane produced in the digester in year y (tCH_4/year)
$Q_{biogas,y}$	=	Amount of biogas collected at the digester outlet in year y (Nm^3 Biogas/year)
$f_{CH4,default}$	=	Default value for the fraction of methane in the biogas (m^3 CH_4/m^3 Biogas)
ρ_{CH4}	=	Density of methane atNormal conditions (tCH_4/Nm^3 CH_4)

If missing data are encountered in the course of determining amount of biogas collected at the digester outlet ($Q_{biogas,y}$), it may be substituted by following the instruction from sector 1 of Appendix to the T-VER-P-TOOL-02-05 “Tool to calculate the mass flow of a greenhouse gas in a gaseous stream”. This provision is applicable for project activities where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs).

5.2.2 Baseline methane emissions determined using the methane conversion factor ($BE_{CH4,MCF,y}$)

$BE_{CH4,MCF,y}$ is determined based on the chemical oxygen demand (COD) of the wastewater that feeds into the lagoon in the absence of the project activity ($COD_{BL,y}$), the maximum methane producing capacity (B_o) and a methane conversion factor ($MCF_{BL,y}$) which expresses the proportion of the wastewater that would decay to methane, as follows:

$$BE_{CH4,MCF,y} = GWP_{CH4} \times MCF_{BL,y} \times B_o \times COD_{BL,y} \qquad \text{Equation (4)}$$

Where

$BE_{CH4,MCF,y}$	=	Baseline methane emissions determined using the Methane Conversion Factor (tCO_2eq/year)
GWP_{CH4}	=	Global Warming Potential of methane valid for the commitment period (tCO_2e / tCH_4)
B_o	=	Maximum methane producing capacity (tCH_4/tCOD)
$MCF_{BL,y}$	=	Average baseline methane conversion factor (fraction) in year y, representing the fraction of ($COD_{BL,y}$ x B_o) that would be degraded to CH_4 in the absence of the project activity

$COD_{BL,y}$ = Quantity of chemical oxygen demand that would be treated in anaerobic lagoons or sludge pits in the absence of the project activity in year y (tCOD/year)

5.2.2.1 Determination of $COD_{BL,y}$

$COD_{BL,y}$ corresponds to the chemical oxygen demand that is treated under the project activity ($COD_{PJ,y}$). But, if there would be discharge from the lagoons or the sludge pit in the baseline, COD_{BL} should be adjusted by an adjustment factor which relates the COD supplied to the lagoon or sludge pit with the COD in the effluent.

$$COD_{BL,y} = p \times \left(\frac{1 - COD_{out,x}}{COD_{in,x}} \right) \times COD_{PJ,y} \qquad \text{Equation (5)}$$

Where

$COD_{BL,y}$ = Quantity of chemical oxygen demand that would be treated in anaerobic lagoons or sludge pits in the absence of the project activity in year y (tCOD/year)

$COD_{PJ,y}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year y (tCOD/year)

$COD_{out,x}$ = COD of the effluent in the period x (tCOD)

$COD_{in,x}$ = COD directed to the anaerobic lagoons or sludge pits in the period x (tCOD)

x = Representative historical reference period

p = Discount factor to account for the uncertainty

1) $COD_{PJ,y}$ is determined as follows:

$$COD_{PJ,y} = \sum_{m=1}^{12} F_{PJ,AD,m} \times COD_{AD,m} \qquad \text{Equation (6)}$$

Where

$COD_{PJ,y}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in year y (tCOD/year)

$F_{PJ,AD,m}$ = Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (m^3)

$COD_{AD,m}$ = Chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (tCOD / m^3)

m = Months of year y of the crediting period

2) Determination of $MCF_{BL,y}$

The quantity of methane generated from COD disposed of in the baseline in open anaerobic lagoons or sludge pits depends mainly on the temperature and the depth of the lagoon or sludge pit. Accordingly, the methane conversion factor is calculated based on a factor f_d, expressing the influence of the depth of the lagoon or sludge pit on methane generation, and a factor ($f_{T,y}$) expressing the influence of the temperature on the methane generation. In addition, a conservativeness factor of 0.89 is applied to account for the uncertainty associated with this approach. $MCF_{BL,y}$ is calculated as follows:

$$\mathbf{MCF_{BL,y} = f_d \times f_{T,y} \times 0.89} \qquad \text{Equation (7)}$$

Where

$MCF_{BL,y}$ = Average baseline methane conversion factor (fraction) in year y

f_d = Factor expressing the influence of the depth of the anaerobic lagoon or sludge pit on methane generation

$f_{T,y}$ = Factor expressing the influence of the temperature on the methane generation in year y

0.89 = Conservativeness factor

2.1) Determination of f_d

f_d represents the influence of the average depth (D) of the anaerobic lagoons or sludge pits on methane generation

$$f_d = \begin{cases} 0; & \text{for } D < 1 \text{ m} \\ 0.5; & \text{for } 1 \text{ m} \leq D < 2 \text{ m} \\ 0.7; & \text{for } D \geq 2 \text{ m} \end{cases}$$ Equation (8)

Where

f_d = Factor expressing the influence of the depth of the anaerobic lagoon or sludge pit on methane generation

D = Average depth of the anaerobic lagoons or sludge pits used in the baseline scenario (m)

2.2) Determination of $f_{T,y}$

$$\mathbf{COD_{available,m} = COD_{BL,m} + (1 - f_{T,m-1}) \times COD_{available,m-1}}$$ Equation (9)

with

$$\mathbf{COD_{BL,m} = \left(1 - \frac{COD_{out,x}}{COD_{in,x}}\right) \times COD_{PJ,m}}$$ Equation (10)

and

$$\mathbf{COD_{PJ,m} = F_{PJ,AD,m} \times COD_{AD,m}}$$ Equation (11)

Where

$COD_{available,m}$ = Quantity of chemical oxygen demand available for degradation in the anaerobic lagoon or sludge pit in month m (tCOD)

$COD_{BL,m}$ = Quantity of chemical oxygen demand that would be treated in anaerobic lagoons or sludge pits in the absence of the project activity in month m (tCOD)

$COD_{PJ,m}$ = Quantity of chemical oxygen demand that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (tCOD)

$F_{PJ,AD,m}$ = Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (m^3)

$COD_{AD,m}$ = Chemical oxygen demand in the wastewater or sludge that is reated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m (tCOD / m³)

$f_{T,m-1}$ = Factor expressing the influence of the temperature on the methane generation in month m-1

m = Months of year y of the crediting period

$COD_{out,x}$ = COD of the effluent in the period x (tCOD)

$COD_{in,x}$ = COD directed to the open lagoons or in sludge pits in the period x (tCOD)

x = Representative historical reference period

In case of emptying the anaerobic lagoon or sludge pit, the accumulation of organic matter restarts with the next inflow and the COD available from the previous month should be set to zero.

The monthly factor to account for the influence of the temperature on methane generation is calculated based on the following "van't Hoff-Arrhenius" approach:

$$f_{T,m} = \begin{cases} 0.104 & \text{if } T_{2,m} < 278\text{ K} \\ e^{\left(\frac{E \times (T_{2,m} - T_1)}{R \times T_1 \times T_{2,m}}\right)} & \text{if } 278\text{ K} \leq T_{2,m} \leq 302.5\text{ K} \\ 0.95 & \text{if } T_{2.m} > 302.5\text{ K} \end{cases} \quad \text{Equation (12)}$$

Where

$f_{T,m}$ = Factor expressing the influence of the temperature on the methane generation in month m

E = Activation energy constant (15,175 cal/mol)

$T_{2,m}$ = Average temperature at the project site in month m (K)

T_1 = 303.15 K (273.15 K + 30 K)

R = Ideal gas constant (1.986 cal /K-mol)

m = Months of year y of the crediting period

1) The annual value $f_{T,y}$ is calculated as follows:

$$f_{T,y} = \frac{\sum_{m=1}^{12} f_{T,m} \times COD_{available,m}}{\sum_{m=1}^{12} COD_{BL,m}} \qquad \text{Equation (13)}$$

Where

$f_{T,y}$	=	Factor expressing the influence of the temperature on the methane generation in year y
$f_{T,m}$	=	Factor expressing the influence of the temperature on the methane generation in month m
$COD_{available,m}$	=	Quantity of chemical oxygen demand available for degradation in the anearobic lagoon or sludge pit in month m (tCOD)
$COD_{BL,m}$	=	Quantity of chemical oxygen demand that would be treated in anaerobic lagoons or sludge pits in the absence of the project activity in month m (tCOD)
m	=	Months of year y of the crediting period

6. Project Emission

Greenhouse gas emissions from the implementation of that project It is calculated based on the greenhouse gas emissions from the production of compost or co-compost. Anaerobic treatment and biogas incineration from the production of synthetic fuel gas from the use of RDF/SB and combustion in the incinerator by greenhouse gas emissions from project implementation can be calculated as follows:

$$PE_y = PE_{COMP,y} + PE_{AD,y} + PE_{GAS,y} + PE_{RDF\_SB,y} + PE_{INC,y} + PE_{EC,y} + PE_{FC,y} \qquad \text{Equation (14)}$$

Where

PE_y	=	Project emissions in year y (tCO_2eq/year)
$PE_{COMP,y}$	=	Project emissions from composting or co-composting in year y (tCO_2eq/year)
$PE_{AD,y}$	=	Project emissions from anaerobic digestion and biogas combustion in year y (tCO_2eq/year)

$PE_{GAS,y}$ = Project emissions from gasification in year y (tCO_2eq/year)

$PE_{RDF\_SB,y}$ = Project emissions associated with RDF/SB in year y (tCO_2eq/year)

$PE_{INC,y}$ = Project emissions from incineration in year y (tCO_2eq/year)

$PE_{EC,y}$ = Project emissions from electricity consumption (tCO_2eq/year)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption (tCO_2eq/year)

6.1 Project emissions from composting or co-composting ($PE_{COMP,y}$)

Project emissions from composting or co-composting can be calculated as follows;

$$PE_{COMP,y} = PE_{CH4,y} + PE_{N2O,y} + PE_{RO,y} \qquad \text{Equation (15)}$$

Where

$PE_{COMP,y}$ = Project emissions associated with composting in year y (tCO_2eq/year)

$PE_{CH4,y}$ = Project emissions of methane from the composting process in year y (tCO_2eq/year)

$PE_{N2O,y}$ = Project emissions of nitrous oxide from the composting process in year y (tCO_2eq/year)

$PE_{RO,y}$ = Project emissions of methane from run-off wastewater associated with co-composting in year y (tCO_2eq/year)

6.1.1 Determination of project emissions of methane ($PE_{CH4,y}$)

Project emissions of methane can be calculated as follows;

$$PE_{CH4,y} = Q_y \times EF_{CH4,y} \times GWP_{CH4} \qquad \text{Equation (16)}$$

Where

$PE_{CH4,y}$ = Project emissions of methane from the composting process in year y (tCO_2eq/year)

Q_y = Quantity of waste composted in year y (t / year)

$EF_{CH4,y}$ = Emission factor of methane per tonne of waste composted valid for year y (tCH_4 / t)

GWP_{CH4} = Global Warming Potential of CH_4 (tCO_2eq / tCH_4)

1) Determination of the quantity of waste composted (Q_y)

The quantity of waste composted is a parameter required in the determination of emissions associated with each source of project emissions. There are two options to determine the quantity of waste composted in year y (Q_y). In case of co-composting, wastewater is not accounted for in the estimation of Q_y.

Option 1: Procedure using a weighing device

Monitor the weight of waste delivered to the composting installation using an on-site weighbridge or any other applicable and calibrated weighing device (e.g. belt-scales).

Option 2: Procedure without using a weighing device

This procedure shall only be applied in the case that there is no weighbridge or any other applicable and calibrated weighing device available on site. Under this procedure, Q_y is calculated based on the carrying capacity of each truck delivering waste to the composting installation in year y ($CT_{t,y}$), as follows:

$$Q_y = \sum_t CT_{t,y} \qquad \text{Equation (17)}$$

Where

Q_y	=	Quantity of waste composted in year y (t / year)
$CT_{t,y}$	=	Carrying capacity of truck t used in year y to deliver waste to the composting installation (t)
t	=	Waste deliveries in trucks to the composting installation in year y

2) Determining of emission factor of methane per tonne of waste composted ($EF_{CH4,y}$)

Option 1: Procedure using monitored data

$EF_{CH4,y}$ is determined based on measurements of the methane emissions during a composting cycle ($ECC_{CH4,c}$), as follows:

$$EF_{CH4,y} = \frac{\sum_{C=1}^{x} ECC_{CH4,c}/Q_c}{x} \qquad \text{Equation (18)}$$

Where

$EF_{CH4,y}$	=	Emission factor of methane per tonne of waste composted valid for year y (tCH_4/t)
$ECC_{CH4,c}$	=	Methane emissions from composting during the composting cycle c (tCH_4)
Q_c	=	Quantity of waste composted in composting cycle c (t)
c	=	Composting cycles for which measurements were undertaken
x	=	Number of composting cycles c for which emissions were measured in year y (at least three)

Option 2: Procedure using default values

A default value is used: $EF_{CH4,y} = EF_{CH4,default}$ (The default value is equal to 0.002).

6.1.2 Determination of project emissions of nitrous oxide ($PE_{N2O,y}$)

Project emissions of nitrous oxide from composting are determined as follows:

$$PE_{N20} = Q_y \times EF_{N2O,y} \times GWP_{N2O}$$ Equation (19)

Where

PE_{N20}	=	Project emissions of nitrous oxide from composting in year y (tCO_2e/year)
Q_y	=	Quantity of waste composted in year y (t/ year)
$EF_{N2O,y}$	=	Emission factor of nitrous oxide per tonne of waste composted valid for year y (tN_2O / t)
GWP_{N2O}	=	Global Warming Potential of N_2O (tCO_2e / tN_2O)

There are two options which project participants may choose for determining $EF_{N2O,y}$

Option 1: Procedure using monitored data

$EF_{N2O,y}$ is determined based on measurements of the emissions during a composting cycle ($ECC_{N2O,c}$), as follows:

$$EF_{N2O,y} = \frac{\sum_{C=1}^{x} ECC_{N2O,c}/Q_c}{x}$$ Equation (20)

Where

$EF_{N2O,y}$	=	Emission factor of nitrous oxide per tonne of waste composted valid for year y (tN_2O/t)
$ECC_{N2O,c}$	=	Nitrous oxide emissions from composting during the composting cycle c (tN_2O)
Q_c	=	Quantity of waste composted in composting cycle c (t)
c	=	Composting cycles for which measurements were undertaken
x	=	Number of composting cycles c for which emissions were measured in year y (at least three)

Option 2: Procedure using default values

A default value is used: $EF_{N2O,y} = EF_{N2O,default}$. (The default value is equal to 0.0002).

6.1.3 Determination of project emissions from run-off wastewater ($PE_{RO,y}$)

Project emissions of methane from run-off wastewater ($PE_{RO,y}$) are calculated only for the case of co-composting. Moreover, if run-off wastewater is collected and re-circulated to the composting process, then $PE_{RO,y}$ is assumed to be zero (for example, this is the case for tunnel co-composting technology). Otherwise, $PE_{RO,y}$ is calculated based on the quantity and chemical oxygen demand (COD) of run-off wastewater as follows:

$$PE_{RO,y} = Q_{COD,y} \times B_{0,ww} \times MCF_{ww,treatment} \times \varphi \times GWP_{CH4} \qquad \text{Equation (21)}$$

Where

$PE_{RO,y}$	=	Project emissions of methane from run-off wastewater associated with co-composting in year y (tCO_2eq/year)
$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year y (tCOD / year)
$B_{0,ww}$	=	Default methane producing capacity of the run-off wastewater (tCH_4 / tCOD)
$MCF_{ww,treatment}$	=	Default methane correction factor for the wastewater treatment system where the run-off wastewater is treated
φ	=	Default model correction factor to account for model uncertainties of methane emissions from run-off wastewater

GWP_{CH4} = Global Warming Potential of methane (tCO_2eq / tCH_4)

1) Determination of quantity of COD of the run-off wastewater from the co-composting ($Q_{RO,y}$)

In this option, $Q_{COD,y}$ is determined as follows:

Option 1: Procedure monitoring quantity and COD of the run-off wastewater

Quantity of COD of the run-off wastewater from the co-composting ($Q_{COD,y}$) is calculated using the quantity and COD of the wastewater co-composted as follows.

$$Q_{COD,y} = Q_{RO,y} \times COD_{RO,y}$$ Equation (22)

Where

$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year y (tCOD / year)
$Q_{RO,y}$	=	Volume of run-off wastewater from the co-composting installation in year y (m^3/ year)
$COD_{RO,y}$	=	Average COD of the run-off wastewater from the co-composting installation valid for year y (tCOD / m^3)

Option 2: Procedure monitoring quantity and COD of the wastewater co-composted

In this option, $Q_{COD,y}$ is estimated using a default factor and monitoring the quantity and COD of the wastewater co-composted. This option is given as a potential simplification because the quantity and COD of the wastewater may already be monitored due to requirements in the methodology that is referring to this tool.

$$Q_{COD,y} = Q_{wastewater,y} \times COD_{wasterwater,y} \times DF_{COD,RO}$$ Equation (23)

Where

$Q_{COD,y}$	=	Quantity of COD of the run-off wastewater from the co-composting installation in year y (tCOD / year)
$Q_{wastewater,y}$	=	Volume of wastewater co-composted in year y (m^3 / year)

$COD_{wasterwater,y}$ = Average COD of the wastewater co-composted valid for year y (tCOD / m^3)

$DF_{COD,RO}$ = Default factor for the ratio of the amount of COD in run-off wastewater and wastewater co-composted

6.2 The project emissions associated with the anaerobic digester ($PE_{AD,y}$)

Calculation of greenhouse gas emissions from anaerobic digestion and biogas incineration due to project implementation. It is sourced from the use of electricity and fossil fuels. including improving the quality and distribution of biogas into the natural gas network (In the case of being part of project activities) can be calculated as follows:

$$PE_{AD,y} = PF_{CH4,y} + PE_{flare,y} \qquad \text{Equation (24)}$$

Where

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year y (tCO_2eq/year)

$PF_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year y (tCO_2eq/year)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (tCO_2eq/year)

6.2.1 Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. These emissions are calculated using a default emission factor ($EF_{CH4,default}$), as follows:

$$PE_{CH4} = Q_{CH4} \times EF_{CH4,default} \times GWP_{CH4} \qquad \text{Equation (25)}$$

Where

PE_{CH4} = Project emissions of methane from the anaerobic digester in year y (tCO_2eq/year)

Q_{CH4} = Quantity of methane produced in the anaerobic digester in year y (tCH_4/year)

$EF_{CH4,default}$ = Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester (fraction)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2 / tCH_4)

1) Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). For large scale projects only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

Option 1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the T-VER-P-TOOL 02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". When applying the tool, the following applies:

(a) The gaseous stream to which the tool is applied is the biogas collected from the digester.

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and

(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas using the equation (3).

If missing data are encountered in the course of determining amount of biogas collected at the digester outlet ($Q_{biogas,y}$), it may be substituted by following the instruction from sector 1 of Appendix to the T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". This provision is applicable for project activities where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs).

6.2.2 Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the T-VER-P-TOOL-02-04 "Tool to calculate project emissions from flaring". The following conditions are applied.

(a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH4,default}$) in applying the tool; and

(b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

6.3 Project emissions from gasification ($PE_{GAS,y}$)

$$PE_{GAS,y} = PE_{COM,GAS,y} + PE_{ww,GAS,y} \quad \text{Equation (26)}$$

Where

$PE_{GAS,y}$	=	Project emissions from gasification in year y (tCO_2eq/year)
$PE_{COM,GAS,y}$	=	Project emissions from combustion associated with gasification in year y (tCO_2eq/year)
$PE_{ww,GAS,y}$	=	Project emissions from the wastewater treatment associated with gasification in year y (tCH_4/year)

6.3.1 Project emissions from combustion associated with gasification ($PE_{COM,GAS,y}$)

$PE_{COM,GAS,y}$ will be equal to $PE_{COM,c,y}$ from the combustor c is the gasifier or the syngas burner, as follows:

$$PE_{COM,C,y} = PE_{COM,CO2,c,y} + PE_{COM,CH4,N2O,c,y} \quad \text{Equation (27)}$$

Where

$PE_{COM,C,y}$	=	Project emissions from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$PE_{COM,CH4,N2O,c,y}$	=	Project emissions of CH_4 and N_2O from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
c	=	Combustor used in the project activity: gasifier or syngas burner, incinerator or RDF/SB combustor

6.3.1.1 Project emissions of CO_2 from combustion within the project boundary ($PE_{COM\_CO2,c,y}$)

$PE_{COM\_CO2,c,y}$ are calculated based either on the fossil carbon content of the fresh waste or RDF/SB combusted, or on the fossil carbon content of the stack gas. There are 3 options for calculating the details as follows.

Option 1: Waste sorted into waste type fractions

$$PE_{COM,CO2,c,y} = EFF_{COM,c,y} \times (44/22) \times \sum_{j} Q_{j,c,y} \times FCC_{j,y} \times FFC_{j,y} \qquad \text{Equation (28)}$$

Where

$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{j,c,y}$	=	Quantity of fresh waste type j fed into combustor c the in year y (t)
$FCC_{j,y}$	=	Fraction of total carbon content in waste type j in year y (tC/t)
$FFC_{j,y}$	=	Fraction of fossil carbon in total carbon content of waste type j in year y (weight fraction)
$EFF_{COM,c,y}$	=	Combustion efficiency of combustor c in year y (fraction)
44/22	=	Conversion factor (tCO_2 / tC)
c	=	Combustor used in the project activity is gasifier
j	=	Waste type

1) Quantity of fresh waste type j fed into combustor c ($Q_{j,c,y}$)

Quantity of waste type j fed into combustor c is calculated as follows:

$$Q_{j,c,y} = Q_{waste,c,y} \times \frac{\sum_{n=1}^{z} P_{n,j,y}}{z} \qquad \text{Equation (29)}$$

Where

$Q_{j,c,y}$	=	Quantity of waste type j fed into combustor c in year y (t)
$Q_{waste,c,y}$	=	Quantity of fresh waste or RDF/SB fed into combustor c in year y (t)
$P_{n,j,y}$	=	Fraction of waste type j in the sample n collected during the year y (weight fraction)
Z	=	Number of samples collected during the year y

n = Samples collected in year y

j = Waste type

Option 2: Based on unsorted waste

$$PE_{COM,CO2,c,y} = (44/22) \times FF_{COM,c,y} \times Q_{waste,c,y} \times FFC_{waste,c,y} \qquad \text{Equation (30)}$$

Where;

$PE_{COM,CO2,c,y}$ = Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

$Q_{waste,c,y}$ = Quantity of fresh waste or RDF/SB fed into combustor c in year y (t)

$FFC_{waste,c,y}$ = Fraction of fossil-based carbon in waste or RDF/SB fed into combustor c in year y (tC / t)

$FF_{COM,c,y}$ = Combustion efficiency of combustor c in year y (fraction)

44/22 = Conversion factor (tCO_2 / tC)

c = Combustor used in the project activity is gasifier.

j = Waste type, including RDF/SB

Option 3: Based on stack gas measurement

$$PE_{COM,CO2,c,y} = (44/22) \times SG_{c,y} \times FFC_{stack,c,y} \qquad \text{Equation (31)}$$

Where

$PE_{COM,CO2,c,y}$ = Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

$SG_{c,y}$ = Volume of stack gas from combustor c in year y (Nm^3/year)

$FFC_{stack,c,y}$ = Concentration of fossil-based carbon in the stack gas of the combustor c in year y (tC/ Nm^3)

44/22 = Conversion factor (t CO_2 / tC)

c = Combustor used in the project activity is gasifier and syngas burner.

6.3.1.2 Project emissions of CH_4 and N_2O from combustion within the project boundary ($PE_{COM\_CH4,N2O,c,y}$)

For the case of gasification, project participants may choose either Option 1 or Option 2 to estimate emissions of N_2O and CH_4 from combustion within the project boundary.

Option 1: Monitoring the N_2O and CH_4 content in the stack gas

$$PE_{COM\_CH4,N2O,c,y} = SG_{c,y} \times (C_{N2O,SG,c,y} \times GWP_{N2O} + C_{CH4,SG,c,y} \times GWP_{CH4}) \qquad \text{Equation (32)}$$

Where

$PE_{COM\_CH4,N2O,c,y}$	=	Project emissions of CH_4 and N_2O from combustion within the project boundary of fossil carbon in combustor c in year y (tCO_2eq/year)
$SG_{c,y}$	=	Volume of stack gas from combustor c in year y (Nm^3)
$C_{N2O,SG,c,y}$	=	Concentration of nitrous oxide in the stack gas from combustor c in year y (tN_2O / Nm^3)
GWP_{N2O}	=	Global Warming Potential of nitrous oxide (tCO_2e / tN_2O)
$C_{CH4,SG,c,y}$	=	Concentration of methane in the stack gas from combustor c in year y (tCH_4/Nm^3)
GWP_{CH4}	=	Global Warming Potential of methane (tCO_2eq / tCH_4)
c	=	Combustor used in the project activity is gasifier.

Option 2: Using default emission factors

$$PE_{COM\_CH4,N2O,c,y} = Q_{waste,c,y} \times (EF_{N2O,t} \times GWP_{N2O} + EF_{CH4,t} \times GWP_{CH4}) \qquad \text{Equation (33)}$$

Where:

$PE_{COM\_CH4,N2O,c,y}$	=	Project emissions of CH_4 and N_2O from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{waste,c,y}$	=	Quantity of fresh waste or RDF/SB fed into combustor c in year y (t)
$EF_{N2O,t}$	=	Emission factor for N_2O associated with waste treatment process t (tN_2O / t waste)

$EF_{CH4,t}$	=	Emission factor for CH_4 associated with treatment process t (tCH_4 / t waste)
GWP_{N2O}	=	Global Warming Potential of nitrous oxide (tCO_2eq / tN_2O)
GWP_{CH4}	=	Global Warming Potential of methane (tCO_2eq / tCH_4)
c	=	Combustor used in the project activity is gasifier.
t	=	Type of alternative waste treatment processes is gasification.

6.3.2 Project emissions from the wastewater treatment associated with gasification ($PE_{ww,GAS,y}$)

$PE_{ww,GAS,y}$ is equal to $PE_{ww,t,y}$ from the alternative waste treatment process t, There are three options for determination as follows:

6.3.2.1 In case 1, If the wastewater discharge generated by the project activity is treated using an aerobic treatment process, such as by co-composting, then project emissions from wastewater treatment are assumed to be zero.

6.3.2.2 In case 2, If the wastewater discharge is treated in an anaerobic digester, then the associated emissions can be calculated as follows;

$$PE_{AD,y} = PF_{CH4,y} + PE_{flare,y} \qquad \text{Equation (34)}$$

Where

$PE_{AD,y}$	=	Project emissions associated with the anaerobic digester in year y (tCO_2eq/year)
$PF_{CH4,y}$	=	Project emissions of methane from the anaerobic digester in year y (tCO_2eq/year)
$PE_{flare,y}$	=	Project emissions from flaring of biogas in year y (tCO_2eq/year)

1) Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. The methane emissions are calculated using the equation (25).

1.1) Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). For large scale projects only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

Option 1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream" When applying the tool, the following applies:

(a) The gaseous stream to which the tool is applied is the biogas collected from the digester.

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and

(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas using the equation (3).

If missing data are encountered in the course of determining amount of biogas collected at the digester outlet ($Q_{biogas,y}$), it may be substituted by following the instruction from sector 1 of Appendix to the T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". This provision is applicable for project activities where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs).

2) Project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the T-VER-P-TOOL-02-04 "Tool to calculate project emissions from flaring". The following applies;

(a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH4,default}$) in applying the tool; and

(b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

6.3.2.3 In case 3, If the project activity generates wastewater discharge that is treated anaerobically (through other than in an anaerobic digester that is part of the project activity), stored anaerobically or released without further treatment in accordance with applicable regulations, then project participants shall determine $PE_{ww,t,y}$ as follows:

1) For cases without flaring/combustion of the methane

$$PE_{ww,t,y} = Q_{ww,y} \times P_{COD,y} \times B_o \times MCF_{ww} \times GWP_{CH4} \qquad \text{Equation (35)}$$

2) For cases with partial flaring/combustion of the methane

$$PE_{ww,t,y} = Q_{ww,y} \times P_{COD,y} \times B_o \times MCF_{ww} \times GWP_{CH4} + \left(\frac{PE_{flare,ww,y}}{GWP_{CH4}} - F_{CH4,flare,y} \right) \qquad \text{Equation (36)}$$

3) For cases with complete flaring/combustion of the methane

$$PE_{ww,t,y} = \frac{PE_{flare,ww,y}}{GWP_{CH4}} \qquad \text{Equation (37)}$$

Where;

$PE_{ww,t,y}$	=	Project emissions of methane from wastewater discharge associated with alternative waste treatment process t in year y (tCO_2eq/year)
$Q_{ww,y}$	=	Amount of wastewater discharge generated by the project activity and treated anaerobically or released untreated from the project activity in year y (m^3/year)
$P_{COD,y}$	=	COD of the wastewater discharge generated by the project activity in year y ($tCOD/m^3$)
B_o	=	Maximum methane producing capacity ($kgCH_4/kgCOD$)
MCF_{ww}	=	Methane conversion factor (fraction)
GWP_{CH4}	=	Global Warming Potential of methane (tCO_2e / tCH_4)

$PE_{flare,ww,y}$ = Emissions from flaring associated with wastewater discharge treatment in year y (tCO_2eq/year)

$F_{CH4,flare,y}$ = Amount of methane in the wastewater discharge treatment emissions which is sent to the flare/combustor in year y (tCH_4/year)

3.1) Determination of project emissions from flaring ($PE_{flare,ww,y}$)

Project emissions from flaring ($PE_{flare,ww,y}$) can be calculate as follow;

Case 1 Methane incineration by flaring system

Methane incineration by incineration system shall be measured using the "T-VER-P-TOOL-02-04 Tool to calculate project emissions from flaring" Latest version ($PE_{flare,ww,y} = PE_{flare,y}$)

Case 2 Methane incineration in a waste incinerator

For cases where the project participant has selected option 1, use the information from section 6.3.1.2. If Option 2 to use default values was selected instead, then assume a 90 per cent destruction efficiency of the methane contained in the gas, with $PE_{flare,ww,y} = PE_{com,ww,y}$ and emissions calculated as follows:

$$PE_{COM,ww,y} = F_{CH4,flare,y} \times 0.1 \qquad \text{Equation (38)}$$

Where;

$PE_{COM,ww,y}$ = Emissions from combustion of methane generated from wastewater treatment in year y (tCO_2eq/year)

$F_{CH4,flare,y}$ = Amount of methane in the wastewater treatment gas that is sent to the flare/combustor in year y (tCO_2eq/year)

(1) Determination of Amount of methane in the wastewater treatment gas that is sent to the flare/combustor ($F_{CH4,flare,y}$)

$F_{CH4,flare,y}$ is determined using T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". These requirements are applied.

(1.1) The gaseous stream the tool shall be applied to is the wastewater treatment emissions delivery pipeline to the flare(s).

(1.2) CH_4 is the greenhouse gases for which the mass flow shall be determined.

(1.3) The flow of the gaseous stream shall be measured on continuous basis.

(1.4) The simplification offered for calculating the molecular mass of the gaseous stream is valid (the equations (3) or (17) in the tool); and

(1.5) The mass flow shall be calculated for an hourly time interval t (as per the tool) and then summed for the year y (tCH_4).

6.4 Project emissions associated with mechanical or thermal production of RDF/SB ($PE_{RDF\_SB,y}$)

Project emissions associated with mechanical or thermal production of RDF/SB can be calculated as follow;

$$PE_{RDF\_SB,y} = PE_{COM,RDF\_SB,y} + PE_{ww,RDF\_SB,y} \quad \text{Equation (39)}$$

Where

$PE_{RDF\_SB,y}$	=	Project emissions associated with RDF/SB in year y (tCO_2eq/year)
$PE_{COM,RDF\_SB,y}$	=	Project emissions from combustion of fossil waste associated with combustion of RDF/SB within the project boundary in year y (tCO_2eq/year)
$PE_{ww,RDF\_SB,y}$	=	Project emissions from electricity consumption associated with RDF/SB (production and on-site combustion) in year y (tCH_4/year)

6.4.1 Project emissions associated with RDF/SB ($PE_{COM,RDF\_SB,y}$)

$PE_{RDF\_SB,COM,y}$ will be equal to $PE_{COM,C,y}$ from the combustor c in the RDF/SB combustor. $PE_{COM,C,y}$ is calculated as follows:

$$PE_{COM,C,y} = PE_{COM,CO2,c,y} + PE_{COM,CH4,N2O,c,y} \quad \text{Equation (40)}$$

Where

$PE_{COM,C,y}$	=	Project emissions from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

$PE_{COM,CH4,N2O,c,y}$ = Project emissions of CH_4 and N_2O from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

c = Combustor used in the project activity is RDF/SB combustor

6.4.1.1 Project emissions of CO_2 from combustion within the project boundary ($PE_{COM\_CO2,c,y}$)

$PE_{COM\_CO2,c,y}$ are calculated based either on the fossil carbon content of the fresh waste or RDF/SB combusted, or on the fossil carbon content of the stack gas. There are three options for calculating the details as follows.

Option 1: Waste sorted into waste type fractions

$$PE_{COM,CO2,c,y} = EFF_{COM,c,y} \times (44/22) \times \sum_{j} Q_{j,c,y} \times FCC_{j,y} \times FFC_{j,y}$$ Equation (41)

Where:

$PE_{COM,CO2,c,y}$ = Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

$Q_{j,c,y}$ = Quantity of fresh waste type j fed into combustor c in year y (t/year)

$FCC_{j,y}$ = Fraction of total carbon content in waste type j in year y (tC/t)

$FFC_{j,y}$ = Fraction of fossil carbon in total carbon content of waste type j in year y (weight fraction)

$EFF_{COM,c,y}$ = Combustion efficiency of combustor c in year y (fraction)

44/22 = Conversion factor (tCO_2 / tC)

c = Combustor used in the project activity is RDF/SB combustor.

j = Waste type

Quantity of fresh waste type j fed into combustor c in year y ($Q_{j,c,y}$) is calculated by the equation (29).

Option 2: Based on unsorted waste

$$PE_{COM,CO2,c,y} = (44/22) \times FF_{COM,c,y} \times Q_{waste,c,y} \times FFC_{waste,c,y}$$ Equation (42)

Where;

$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{waste,c,y}$	=	Quantity of fresh waste or RDF/SB fed into combustor c in year y (t/year)
$FFC_{waste,c,y}$	=	Fraction of fossil-based carbon in waste or RDF/SB fed into combustor c in year y (tC / t)
$FF_{COM,c,y}$	=	Combustion efficiency of combustor c in year y (fraction)
44/22	=	Conversion factor (tCO_2 / tC)
c	=	Combustor used in the project activity is RDF/SB combustor.
j	=	Waste type, including RDF/SB

Option 3: Based on stack gas measurement

$$PE_{COM,CO2,c,y} = (44/22) \times SG_{c,y} \times FFC_{stack,c,y} \qquad \text{Equation (43)}$$

Where;

$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$SG_{c,y}$	=	Volume of stack gas from combustor c in year y (Nm^3/year)
$FFC_{stack,c,y}$	=	Concentration of fossil-based carbon in the stack gas of the combustor c in year y (tC/ Nm^3)
44/22	=	Conversion factor (tCO_2 / tC)
c	=	Combustor used in the project activity is RDF/SB combustor.

6.4.1.2 Project emissions of CH_4 and N_2O from combustion within the project boundary ($PE_{COM\_CH4,N2O,c,y}$)

Emissions of N_2O and CH_4 from combustion of RDF/SB are neglected because they are considered very minor. Consequently, $PE_{COM\_CH4,N2O,c,y} = 0$

6.4.2 Project emissions from the wastewater treatment associated with RDF/SB (production and on-site combustion) ($PE_{ww,RDF\_SB,y}$)

$PE_{ww,RDF\_SB,y}$ will be equaled to $PE_{ww,t,y}$ from the alternative waste treatment process t in the production of RDF/SB, There are three options for calculation as follows:

6.4.2.1 In case 1, If the wastewater discharge generated by the project activity is treated using an aerobic treatment process, such as by co-composting, then project emissions from wastewater treatment are assumed to be zero.

6.4.2.2 In case 2, If the wastewater discharge is treated in an anaerobic digester, then the associated emissions can be calculated as follows;

$$PE_{AD,y} = PF_{CH4,y} + PE_{flare,y} \quad \text{Equation (44)}$$

Where;

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year y (tCO_2eq/year)

$PF_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year y (tCO_2eq/year) (tCO2e)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (tCO_2eq/year)

1) Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. The methane emissions are calculated using the equation (25).

1.1) Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). For large scale projects only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

Option 1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the T-VER-P-TOOL 02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream" When applying the tool, the following conditions are applied:

(a) The gaseous stream to which the tool is applied is the biogas collected from the digester.

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and

(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas using the equation (3).

If missing data are encountered in the course of determining amount of biogas collected at the digester outlet ($Q_{biogas,y}$), it may be substituted by following the instruction from sector 1 of Appendix to the T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". This provision is applicable for project activities where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs).

2) Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the T-VER-P-TOOL-02-04 "Tool to calculate project emissions from flaring". The following conditions are applied;

(a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH4,default}$) in applying the tool; and

(b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

6.4.2.3 In case 3 If the project activity generates wastewater discharge that is treated anaerobically (through other than in an anaerobic digester that is part of the project activity), stored anaerobically or released without further treatment in accordance with applicable regulations, then project participants shall determine $PE_{ww,t,y}$ is calculated using the equations (35), (36) and (37).

3.1) Determination of project emissions from flaring ($PE_{flare,ww,y}$)

Project emissions from flaring can be calculated as follow;

Case 1 Methane incineration by flaring system

Methane incineration by incineration system shall be measured using the T-VER-P-TOOL-02-04 "Tool to calculate project emissions from flaring" Latest version ($PE_{flare,ww,y}$ = $PE_{flare,y}$)

Case 2 Methane incineration in a waste incinerator

For cases where the project participant has selected option 1, use the information from section 6.4.1.2. If Option 2 to use default values was selected instead, then assume a 90 per cent destruction efficiency of the methane contained in the gas, with $PE_{flare,ww,y}$ = $PE_{com,ww,y}$ and emissions calculated as follows:

$$PE_{COM,ww,y} = F_{CH4,flare,y} \times 0.1 \quad \text{Equation (45)}$$

Where;

$PE_{COM,ww,y}$	=	Emissions from combustion of methane generated from wastewater treatment in year y (tCO_2eq/year)
$F_{CH4,flare,y}$	=	Amount of methane in the wastewater treatment gas that is delivered to the flare/combustor in year y (tCO_2eq/year)

(1) Determination of amount of methane in the wastewater treatment gas that is sent to the flare/combustor ($F_{CH4,flare,y}$)

$F_{CH4,flare,y}$ is determined using T-VER-P-TOOL-02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". These requirements are applied.

(1.1) The gaseous stream the tool shall be applied to is the wastewater treatment emissions delivery pipeline to the flare(s).

(1.2) CH_4 is the greenhouse gases for which the mass flow shall be determined.

(1.3) The flow of the gaseous stream shall be measured on continuous basis.

(1.4) The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations (3) or (17) in the tool); and

(1.5) The mass flow shall be calculated for an hourly time interval t (as per the tool) and then summed for the year y (tCH_4).

6.5 Project emissions from incineration ($PE_{INC,y}$)

$$PE_{INC,y} = PE_{COM,INC,y} + PE_{ww,INC,y} \qquad \text{Equation (46)}$$

Where;

$PE_{INC,y}$	=	Project emissions from incineration in year y (tCO_2eq/year)
$PE_{COM,INC,y}$	=	Project emissions from combustion within the project boundary of fossil waste associated with incineration in year y (tCO_2eq/year)
$PE_{ww,INC,y}$	=	Project emissions from the wastewater treatment associated with incineration in year y (tCO_2eq/year)

6.5.1 Project emissions from combustion within the project boundary of fossil waste associated with incineration ($PE_{COM,INC,y}$)

$PE_{INC,COM,y}$ will be equaled to $PE_{COM,c,y}$ from the combustor c in the incineration, $PE_{COM,c,y}$ can be calculated as follows:

$$PE_{COM,C,y} = PE_{COM,CO2,c,y} + PE_{COM,CH4,N2O,c,y} \qquad \text{Equation (47)}$$

Where

$PE_{COM,C,y}$	=	Project emissions from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$PE_{COM,CH4,N2O,c,y}$	=	Project emissions of CH_4 and N_2O from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
c	=	Combustor used in the project activity is incinerator.

6.5.1.1 Project emissions of CO_2 from combustion within the project boundary associated with combustor c ($PE_{COM\_CO2,c,y}$)

$PE_{COM\_CO2,c,y}$ are calculated based either on the fossil carbon content of the fresh waste or RDF/SB combusted, or on the fossil carbon content of the stack gas. There are three options for calculating the details as follows.

Option 1: Waste sorted into waste type fractions

$$PE_{COM,CO2,c,y} = EFF_{COM,c,y} \times (44/22) \times \sum_{j} Q_{j,c,y} \times FCC_{j,y} \times FFC_{j,y}$$ Equation (48)

Where;

$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{j,c,y}$	=	Quantity of fresh waste type j fed into combustor c the in year y (t/year)
$FCC_{j,y}$	=	Fraction of total carbon content in waste type j in year y (tC/t)
$FFC_{j,y}$	=	Fraction of fossil carbon in total carbon content of waste type j in year y (weight fraction)
$EFF_{COM,c,y}$	=	Combustion efficiency of combustor c in year y (fraction)
44/22	=	Conversion factor (tCO_2 / tC)
c	=	Combustor used in the project activity is incinerator.
j	=	Waste type

Quantity of fresh waste type j fed into combustor c in year y ($Q_{j,c,y}$) is calculated by the equation (29).

Option 2: Based on unsorted waste

$$PE_{COM,CO2,c,y} = (44/22) \times FF_{COM,c,y} \times Q_{waste,c,y} \times FFC_{waste,c,y}$$ Equation (49)

Where;

$PE_{COM,CO2,c,y}$	=	Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{waste,c,y}$	=	Quantity of fresh waste or RDF/SB fed into combustor c in year y (t/year)
$FFC_{waste,c,y}$	=	Fraction of fossil-based carbon in waste or RDF/SB fed into combustor c in year y (tC / t)
$FF_{COM,c,y}$	=	Combustion efficiency of combustor c in year y (fraction)
44/22	=	Conversion factor (tCO_2 / tC)
c	=	Combustor used in the project activity is incinerator.

j = Waste type, including RDF/SB

Option 3: Based on stack gas measurement

$$PE_{COM,CO2,c,y} = (44/22) \times SG_{c,y} \times FFC_{stack,c,y} \quad \text{Equation (50)}$$

Where;

$PE_{COM,CO2,c,y}$ = Project emissions of CO_2 from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)

$SG_{c,y}$ = Volume of stack gas from combustor c in year y (Nm^3/year)

$FFC_{stack,c,y}$ = Concentration of fossil-based carbon in the stack gas of the combustor c in year y (tC/ Nm^3)

44/22 = Conversion factor (tCO_2 / tC)

c = Combustor used in the project activity is incinerator.

6.5.1.2 Project emissions of CH_4 and N_2O from combustion within the project boundary ($PE_{COM\_CH4,N2O,c,y}$)

For the case of incineration, project participants may choose either Option 1 or Option 2 to estimate emissions of N_2O and CH_4 from combustion within the project boundary.

Option 1: Monitoring the N_2O and CH_4 content in the stack gas

$$PE_{COM\_CH4,N2O,c,y} = SG_{c,y} \times (C_{N2O,SG,c,y} \times GWP_{N2O} + C_{CH4,SG,c,y} \times GWP_{CH4}) \quad \text{Equation (51)}$$

Where;

$PE_{COM\_CH4,N2O,c,y}$ = Project emissions of CH_4 and N_2O from combustion within the project boundary of fossil carbon in combustor c in year y (tCO_2eq/year)

$SG_{c,y}$ = Volume of stack gas from combustor c in year y (Nm^3/year)

$C_{N2O,SG,c,y}$ = Concentration of nitrous oxide in the stack gas from combustor c in year y (tN_2O / Nm^3)

GWP_{N2O} = Global Warming Potential of nitrous oxide (tCO_2eq / tN_2O)

$C_{CH4,SG,c,y}$ = Concentration of methane in the stack gas from combustor c in year y (tCH_4/Nm^3)

GWP_{CH4}	=	Global Warming Potential of methane (tCO_2eq / tCH_4)
c	=	Combustor used in the project activity is incinerator.

Option 2: Using default emission factors

$$PE_{COM\_CH4,N2O,c,y} = Q_{waste,c,y} \times (EF_{N2O,t} \times GWP_{N2O} + EF_{CH4,t} \times GWP_{CH4}) \qquad \text{Equation (52)}$$

Where;

$PE_{COM\_CH4,N2O,c,y}$	=	Project emissions of CH_4 and N_2O from combustion within the project boundary associated with combustor c in year y (tCO_2eq/year)
$Q_{waste,c,y}$	=	Quantity of fresh waste or RDF/SB fed into combustor c in year y (t/year)
$EF_{N2O,t}$	=	Emission factor for N_2O associated with waste treatment process t (tN_2O / t waste)
$EF_{CH4,t}$	=	Emission factor for CH_4 associated with treatment process t (tCH_4 / t waste)
GWP_{N2O}	=	Global Warming Potential of nitrous oxide (tCO_2eq / tN_2O)
GWP_{CH4}	=	Global Warming Potential of methane (tCO_2eq / tCH_4)
c	=	Combustor used in the project activity is incinerator.
t	=	Type of alternative waste treatment processes is incineration.

6.5.2 Project emissions from the wastewater treatment associated with incineration ($PE_{ww,INC,y}$)

$PE_{ww,INC,y}$ will be equaled to $PE_{ww,t,y}$ from the alternative waste treatment process t in gasification , as follows:

6.5.2.1 In case 1, If the wastewater discharge generated by the project activity is treated using an aerobic treatment process, such as by co-composting, then project emissions from wastewater treatment are assumed to be zero.

6.5.2.2 In case 2, If the wastewater discharge is treated in an anaerobic digester, then the associated emissions can be calculated as follows;

$$PE_{AD,y} = PF_{CH4,y} + PE_{flare,y}$$ Equation (53)

Where;

$PE_{AD,y}$ = Project emissions associated with the anaerobic digester in year y (tCO_2eq/year)

$PF_{CH4,y}$ = Project emissions of methane from the anaerobic digester in year y (tCO_2eq/year)

$PE_{flare,y}$ = Project emissions from flaring of biogas in year y (tCO_2eq/year)

1) Determination of project emissions of methane from the anaerobic digester ($PE_{CH4,y}$)

Project emissions of methane from the anaerobic digester include emissions during maintenance of the digester, physical leaks through the roof and side walls, and release through safety valves due to excess pressure in the digester. The methane emissions are calculated using the equation (25).

1.1) Determination of the quantity of methane produced in the digester ($Q_{CH4,y}$)

There are two different procedures to determine the quantity of methane produced in the digester in year y ($Q_{CH4,y}$). For large scale projects only Option 1 shall be used. For small scale projects, project participants may choose between Option 1 or Option 2.

Option 1: Procedure using monitored data

$Q_{CH4,y}$ shall be measured using the T-VER-P-TOOL 02-05 "Tool to calculate the mass flow of a greenhouse gas in a gaseous stream" When applying the tool, the following conditions are applied:

(a) The gaseous stream to which the tool is applied is the biogas collected from the digester.

(b) CH_4 is the greenhouse gas i for which the mass flow should be determined; and

(c) The flow of the gaseous stream should be measured on an hourly basis or a smaller time interval; and then accumulated for the year y. Please note that units need to be converted to tons, when applying the results in this tool.

Option 2: Procedure using a default value

Under this option, the flow of the biogas is measured, and a default value is used for the fraction of methane in the biogas using the equation (3).

If missing data are encountered in the course of determining amount of biogas collected at the digester outlet ($Q_{biogas,y}$), it may be substituted by following the instruction from sector 1 of Appendix to the T-VER-P-TOOL-02-05" Tool to calculate the mass flow of a greenhouse gas in a gaseous stream". This provision is applicable for project activities where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs).

2) Determination of project emissions from flaring of biogas ($PE_{flare,y}$)

If the project activity includes flaring of biogas, then project emissions from flaring of biogas ($PE_{flare,y}$) shall be estimated using the T-VER-P-TOOL-02-04 "Tool to calculate project emissions from flaring". The following conditions are applied.

(a) For small scale projects, project participants may adopt a default value for the fraction of methane in the biogas ($f_{CH4,default}$) in applying the tool; and

(b) The tool provides default factors for the flare efficiency, which can be used for large or small scale projects as described in the tool.

6.5.2.3 In case 3, If the project activity generates wastewater discharge that is treated anaerobically (through other than in an anaerobic digester that is part of the project activity), stored anaerobically or released without further treatment in accordance with applicable regulations, then project participants shall determine $PE_{ww,t,y}$ using the equations (35), (36) and (37).

6.6 Project emissions from electricity consumption ($PE_{EC,y}$)

Project emissions from electricity consumption are calculated as follows:

$$PE_{EC,y} = PE_{EC,COMP,y} + PE_{EC,AD,y} + (PE_{EC,GAS,y} + PE_{EC,ww,GAS,y}) + (PE_{EC,RDF\_SB,y} + PE_{EC,ww,RDF\_SB,y}) + (PE_{EC,INC,y} + PE_{EC,ww,INC\_SB,y}) \quad \text{Equation (54)}$$

Where

$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (tCO_2eq/year)
$PE_{EC,COMP,y}$	=	Project emissions from electricity consumption from composting or co-composting in year y (tCO_2eq/year)

$PE_{EC,AD,y}$	=	Project emissions from electricity consumption from anaerobic digestion and biogas combustion in year y (tCO_2eq/year)
$PE_{EC,GAS,y}$	=	Project emissions from electricity consumption from gasification in year y (tCO_2eq/year)
$PE_{EC,ww,GAS,y}$	=	Project emissions from electricity consumption from the wastewater treatment associated with gasification in year y (tCO_2eq/year)
$PE_{EC,RDF\_SB,y}$	=	Project emissions from electricity consumption associated with RDF/SB in year y (tCO_2eq/year)
$PE_{EC,ww,RDF\_SB,y}$	=	Project emissions from electricity consumption from the wastewater treatment associated with RDF/SB in year y (tCO_2eq/year)
$PE_{EC,INC,y}$	=	Project emissions from electricity consumption from incineration in year y (tCO_2eq/year)
$PE_{EC,ww,INC\_SB,y}$	=	Project emissions from electricity consumption from the wastewater treatment from incineration in year y (tCO_2eq/year)

Project emissions from the use of electricity from the project implementation can be calculated from the amount of electricity consumption. Baseline emissions from electricity generation and power loss in the national grid's power generation system as follows:

$$PE_{EC,y} = EC_{PJ,y} \times EF_{Elec,y} \times (1 + TDL_y)$$ Equation (55)

Where

$PE_{EC,y}$	=	Project emissions from electricity consumption in year y (tCO_2/year)
$EC_{PJ,y}$	=	Quantity of electricity consumed in year y (MWh/year)
$EF_{Elec,y}$	=	Emission factor for electricity generation/consumption in year y (tCO_2/MWh)
TDL_y	=	Average technical transmission and distribution losses in year y

6.7 Project emissions from fossil fuel consumption ($PE_{FC,y}$)

Project emissions from fossil fuel consumption as follows:

$$PE_{FC,y} = PE_{FC,COMP,y} + PE_{FC,AD,y} + (PE_{FC,GAS,y} + PE_{FC,ww,GAS,y}) + (PE_{FC,RDF\_SB,y} + PE_{FC,ww,RDF\_SB,y}) + (PE_{FC,INC,y} + PE_{FC,ww,INC\_SB,y})$$ Equation (56)

Where

$PE_{FC,y}$ = Project emissions from fossil fuel consumption in year y (tCO_2/year)

$PE_{FC,COMP,y}$ = Project emissions from fossil fuel consumption from composting or co-composting in year y (tCO_2/year)

$PE_{FC,AD,y}$ = Project emissions from fossil fuel consumption from anaerobic digestion and biogas combustion in year y (tCO_2/year)

$PE_{FC,GAS,y}$ = Project emissions from fossil fuel consumption from gasification in year y (tCO_2/year)

$PE_{FC,ww,GAS,y}$ = Project emissions from fossil fuel consumption from the wastewater treatment associated with gasification in year y (tCO_2/year)

$PE_{FC,RDF\_SB,y}$ = Project emissions from fossil fuel consumption associated with RDF/SB in year y (tCO_2/year)

$PE_{FC,ww,RDF\_SB,y}$ = Project emissions from fossil fuel consumption from the wastewater treatment associated with RDF/SB in year y (tCO_2/year)

$PE_{FC,INC,y}$ = Project emissions from fossil fuel consumption from incineration in year y (tCO_2/year)

$PE_{FC,ww,INC\_SB,y}$ = Project emissions from fossil fuel consumption from the wastewater treatment from incineration in year y (tCO_2/year)

To calculate greenhouse gas emissions from fossil fuel use due to project implementation, use the Calculation Tool of T-VER-TOOL-02-01 "Calculating Greenhouse Gas Emissions from the Burning of Fossil Fuels from Project Emission and Leakage Emission", latest edition. There are also specific conditions:

7. Leakage Emission

Leakage emissions are associated with composting/co-composting, anaerobic digestion and the use of RDF/SB that is exported outside the project boundary. For the case that waste by-products of the alternative waste treatment process are

(a) Used for soil application, these emissions shall be neglected.

(b) Composted or co-composted, then these shall be treated as fresh waste with emissions estimated according to the procedure project emissions from composting ($PE_{COMP,y}$)

Leakage emissions are determined as follows:

$$LE_y = LE_{COMP,y} + LE_{AD,y} + LE_{RDF\_SB,y}$$ Equation (57)

Where;

LE_y	=	Leakage emissions in the year y (tCO_2eq/year)
$LE_{COMP,y}$	=	Leakage emissions from composting or co-composting in year y (tCO_2eq/year)
$LE_{AD,y}$	=	Leakage emissions from anaerobic digester in year y (tCO_2eq/year)
$LE_{RDF\_SB,y}$	=	Leakage emissions associated with RDF/SB in year y (tCO_2eq/year)

7.1 Leakage emissions from composting ($LE_{COMP,y}$)

Leakage emissions from composting ($LE_{COMP,y}$) shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS. $LE_{COMP,y}$ shall be estimated to account for methane emissions from the anaerobic decay of compost, using the T-VER-P-TOOL-02-03 “Tool to calculate Emissions from solid waste disposal sites”. latest version. The following is required when applying the tool:

(1) $LE_{COMP,y}$ corresponds to the parameter $LE_{CH4,SWDS,y}$ in the tool.

(2) $W_{j,x}$ in the tool is the amount of compost produced that is disposed of in a SWDS or subjected to anaerobic storage, where:

(2.1) j is compost and therefore the procedure in the tool to determine the amount of different waste types j disposed in the SWDS does not need to be followed ($W_{j,x} = W_x$); and

(2.2) x refers to each year since the start of the firstCrediting period, up to and including year y.

7.2 Leakage emissions from anaerobic digestion (LEAD,y)

Leakage emissions associated with anaerobic digestion of waste ($LE_{AD,y}$) depend on how the digestate is managed. They include emissions associated with storage and composting of the digestate and are determined as follows:

$$LE_{AD,y} = LE_{storage,y} + LE_{comp,y}$$ Equation (58)

Where

$LE_{AD,y}$ = Leakage emissions associated with the anaerobic digester in year y (tCO_2eq/year)

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (tCO_2eq/year)

$LE_{comp,y}$ = Leakage emissions associated with composting digestate in year y (tCO_2eq/year)

Where liquid retention or compost production from sludge occurs within the scope of the project These greenhouse gas emissions are regarded as the project emissions.

7.2.1 Determination of leakage emissions associated with storage of digestate ($LE_{storage,y}$)

This step applies in the case that the digestate is stored under the following anaerobic conditions:

(a) In an un-aerated lagoon that has a depth of more than one meter; or

(b) In a SWDS, including stockpiles that are considered a SWDS as per the definitions section.

Storage of digestate under anaerobic conditions can cause CH_4 emissions due to further anaerobic digestion of the residual biodegradable organic matter. The procedure for determining $LE_{storage,y}$ is distinguished for liquid digestate and solid digestate and are determined as follows:

7.2.1.1 Determining $LE_{storage,y}$ for liquid digestate

Where digestate is liquid, as per the definitions section, or where a liquid fraction of mechanically separated digestate is stored, then choose between Options 1 or 2 below to determine $LE_{storage,y}$

Option 1: Procedure using monitored data

$$LE_{storage,y} = Q_{stored,y} \times P_{COD,y} \times B_O \times MCF_p \times GWP_{CH4} \quad \text{Equation (59)}$$

Where;

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (tCO_2eq/year)

$Q_{stored,y}$ = Amount of liquid digestate stored anaerobically in year y (m^3/year)

$P_{COD,y}$ = Average chemical oxygen demand (COD) of the liquid digestate in year y ($tCOD / m^3$)

B_O = Maximum methane producing capacity of the COD applied (tCH_4 / tCOD)

MCF_p = Methane conversion factor (fraction)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2 / tCH_4)

Option 2: Procedure using a default value

$$LE_{storage,y} = F_{ww,CH4,default} \times Q_{CH4} \times GWP_{CH4}$$ Equation (60)

Where;

$LE_{storage,y}$ = Leakage emissions associated with storage of digestate in year y (tCO_2eq/year)

$F_{ww,CH4,default}$ = Default factor representing the remaining methane production capacity of liquid digestate (fraction)

Q_{CH4} = Quantity of methane produced in the digester in year y (tCH_4/year)

GWP_{CH4} = Global warming potential of CH_4 (tCO_2 / tCH_4)

7.2.1.2 Determining $LE_{storage,y}$ for solid digestate

Where solid digestate is disposed in a SWDS or a stockpile that can be considered a SWDS, as per the definition section, then project participants may choose between Option 1 or Option 2 to determine $LE_{storage,y}$

Option 1: Procedure using monitored data

In this case, $LE_{storage,y}$ corresponds to the parameter $LE_{CH4,SWDS,y}$ is determined using the T-VER-P-TOOL-02-03 “Tool to calculate emissions from solid waste disposal sites”. latest version and j represents the digestate that is disposed at a SWDS.

Option 2: Procedure using default values

$LE_{storage,y}$ is determined as follows:

$$LE_{storage,y} = F_{SD,CH4,default} \times Q_{CH4} \times GWP_{CH4}$$ Equation (61)

Where;

$LE_{storage,y}$	=	Leakage emissions associated with storage of digestate in year y. ($tCO_2eq/year$)
$F_{SD,CH4,default}$	=	Default factor for the methane generation capacity of solid digestate (fraction)
Q_{CH4}	=	Quantity of methane produced in the anaerobic digester in year y ($tCH_4/year$)
GWP_{CH4}	=	Global warming potential of CH_4 (tCO_2 / tCH_4)

7.2.2 Determination of leakage emissions associate with composting digestate ($LE_{COMP,y}$)

$LE_{COMP,y}$ shall be accounted for if compost is subjected to anaerobic storage or disposed of in a SWDS. $LE_{COMP,y}$ shall be estimated to account for methane emissions from the anaerobic decay of compost, using the T-VER-P-TOOL-02-03 "Tool to calculate emissions from solid waste disposal sites". latest version. The following is required when applying the tool:

(1) $LE_{COMP,y}$ corresponds to the parameter $LE_{CH4,SWDS,y}$ in the tool.

(2) $W_{j,x}$ in the tool is the amount of compost produced that is disposed of in a SWDS or subjected to anaerobic storage, where:

(2.1) j is compost and therefore the procedure in the tool to determine the amount of different waste types j disposed in the SWDS does not need to be followed ($W_{j,x} = W_x$); and

(2.2) x refers to each year since the start of the firstCrediting period, up to and including year y.

7.3 Leakage emissions associated with RDF/SB ($LE_{RDF\_SB,y}$)

$$LE_{RDF\_SB,y} = LE_{ENDUSE\_RDF\_SB,y} + LE_{SWDS,WBP\_RDF\_SB,y} \quad \text{Equation (62)}$$

Where;

$LE_{RDF\_SB,y}$	=	Leakage emissions associated with RDF/SB in year y ($tCO_2eq/year$)
$LE_{SWDS,WBP\_RDF\_SB,y}$	=	Leakage emissions associated with disposing of waste by-products associated with RDF/SB production in a SWDS in year y ($tCO_2eq/year$)

$LE_{ENDUSE\_RDF\_SB,y}$ = Leakage emissions associated with the end-use of RDF/SB exported outside the project boundary in year y (tCO_2eq/year)

7.3.1 Leakage emissions from disposal of waste by-products from RDF/SB production in a SWDS ($LE_{SWDS,WBP\_RDF\_SB,y}$)

$LE_{SWDS,WBP\_RDF\_SB,y}$ is determined using the "T-VER-P-TOOL-02-03 Tool to calculate Emissions from solid waste disposal sites". latest version. The following is required when applying the tool:

(a) x begins with the start of the project activity and extends to the end of year y (e.g. emissions are calculated using Application B in the tool and waste disposed from the start of the firstCrediting period shall be considered).

(b) $W_{j,x}$ in the tool is the amount of organic waste contained in the waste by-products from the production of RDF/SB in year y (e.g. it does not include waste by-products that are composted instead of being disposed to a SWDS in the project activity or waste by-products from the combustion of RDF/SB).

7.3.2 Leakage emissions associated with end use of RDF/SB exported outside the project boundary ($LE_{ENDUSE,\ RDF\_SB,y}$)

The potential leakage emissions associated with the use of the RDF/SB that is exported outside the project boundary are that it may be combusted or decompose anaerobically. Emissions are therefore calculated allowing for the situation that RDF/SB exported in year y may have three different end uses u, as follows:

End use 1: documented evidence is provided that the RDF/SB exported off-site is used as raw material in fertilizer, ceramic manufacture or as a fuel that is combusted in a project activity. In this case, no leakage emissions are estimated;

End use 2: documented evidence is provided that the RDF/SB exported off-site is combusted or used as a raw material in furniture: In this case, the RDF/SB is considered to be combusted and $LE_{ENDUSE,RDF\_SB,y}$ shall be calculated, according to procedure below;

End use 3: no documented evidence is provided that the off-site end use of RDF/SB is either combustion, furniture manufacture, fertilizer or ceramic production. In this case, the RDF/SB may decay anaerobically or be combusted. Therefore, it is conservatively assumed that the RDF/SB decays anaerobically according to the procedure below.

7.3.2.1 Leakage emissions from combusted off-site end use of RDF/SB ($LE_{ENDUSE,RDF\_SB,y}$) (End use 2)

$$LE_{ENDUSE\_RDF\_SB,y} = Q_{RDF\_SB,COM,y} \times NCV_{RDF\_SB,y} \times EF_{CO2\_RDF\_SB,y} \quad \text{Equation (63)}$$

Where;

$LE_{ENDUSE\_RDF\_SB,y}$	=	Leakage emissions of CO_2 from off-site combustion of RDF/SB in year y (tCO_2eq/year)
$Q_{RDF\_SB,COM,y}$	=	Quantity of RDF/SB exported off-site with potential to be combusted in year y (t/year)
$EF_{CO2\_RDF\_SB,y}$	=	CO_2 emissions factor for RDF/SB in year y (tCO_2 / GJ)
$NCV_{RDF\_SB,y}$	=	NetCalorific value of RDF/SB in year y (GJ/t)

7.3.2.2 Leakage emissions from off-site anaerobic decomposition of RDF/SB (End use *3*)

$$W_{RDF\_SB,j,x,adj} = \frac{Q_{expert,RDF\_SB,y}}{Q_{RDF\_SB,y}} \times W_{RDF\_SB,j,x} \quad \text{Equation (64)}$$

Where;

$W_{RDF\_SB,j,x,adj}$	=	Amount of solid waste type j prevented from disposal in the SWDS using the waste to produce RDF/SB in the year x, adjusted by the proportion of RDF/SB that is disposed of in a SWDS (t/year)
$W_{RDF\_SB,j,x}$	=	Amount of solid waste type j prevented from disposal in the SWDS using the waste to produce RDF/SB in the year x (t/year)
$Q_{expert,RDF\_SB,y}$	=	Amount of RDF/SB exported offsite with potential to decay anaerobically in year y (t/year)
$Q_{RDF\_SB,y}$	=	Amount of RDF/SB produced by the project activity in year y (t/year)

8. Emission Reduction

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

$$ER_y = BE_y - PE_y - LE_y \qquad \text{Equation (65)}$$

Where;

ER_y	=	Emissions reductions in year y (tCO_2eq/year)
BE_y	=	Baseline emissions in year y (tCO_2eq/year)
PE_y	=	Project emissions in the year y (tCO_2eq/year)
LE_y	=	Leakage emissions in year y (tCO_2eq/year)

There are guidelines for using the equation as follows.

1) If the sum of PE_y and LE_y is smaller than 1 per cent of BE_y in the first full operation year of a crediting period, the project participants may choose to assume a fixed percentage of 1 per cent for the sum of PE_y and LE_y for the remaining years of the crediting period.

2) In the case that overall negative emission reductions arise in a year, CERs are not issued to project participants for the year concerned and in subsequent years, until emission reductions from subsequent years have compensated the quantity of negative emission reductions from the year concerned. (For example: if negative emission reductions of 30 tCO_2e occur in the year y and positive emission reductions of 100 tCO_2e occur in the year y+1, 0 CERs are issued for year y and only 70 CERs are issued for the year y+1.

9. Monitoring Plan

9.1 Monitoring methodology

1) The project developer explain and specify the steps for monitoring the project activity data (Activity data) or verify all measurement results in the project proposal document. including the type of measuring instruments used Person responsible for monitoring results and verifying information Calibration of measuring instruments (if any) and procedures for warranty and quality control Where methods have different options, such as using default values or on-site measurements The project developer must specify which option to use. In addition, the installation, maintenance and calibration of measuring instruments should be carried out in

accordance with the instructions of the equipment manufacturer and in accordance with national standards. or international standards such as IEC, ISO

2) All data collected as part of the greenhouse gas reduction monitoring. The data should be stored in electronic file format and the retention period is in accordance with the guidelines set by the Administrative Organization or the organization's quality system, but the period of time is not less than that specified by the TGO. Must follow the follow-up methods specified in the follow-up parameters specified in Table 9.2.

9.2 Data and parameters monitored

9.2.1 Data and parameters monitored from municipal solid waste management to replace landfills

Parameter	$COD_{available,m}$
Data unit	tCOD
Description	Quantity of chemical oxygen demand available for degradation in the anaerobic lagoon or sludge pit in month m
Source of data	Project developer's measurement report
Measurement procedures	Analyzed according to the latest Standard Method. The results are reported as a monthly average.

Parameter	$COD_{AD,m}$
Data unit	tCOD / m^3
Description	Chemical oxygen demand in the wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m
Source of data	Project developer's measurement report
Measurement procedures	Measure the COD according to national or international standards. If COD is measured more than once per month, the average value of the measurements should be used

Parameter	$COD_{out,x}$ and $COD_{in,x}$
Data unit	tCOD
Description	COD of the effluent in the period x COD directed to the anaerobic lagoons or sludge pits in the period x (tCOD)

Source of data	**For existing plants:** If there is no effluent: $COD_{out,x}$ = 0; If there is effluent: data are determined as follows; 1) One year of historical data should be used, or 2) If one year data is not available then x represents a measurementCampaign of at least 10 days to the COD inflow ($COD_{in,x}$) and COD outflow ($COD_{out,x}$) from the lagoon or sludge pit. **For greenfield projects:** Use the design COD inflow for COD in and the design effluentCOD flow for COD outCorresponding to the design features of the lagoon system identified in the procedure for the selection of the baseline scenario
Measurement procedures	For the measurementCampaign of at least 10 days: The measurements should be undertaken during a period that is representative for the typical operation conditions of the plant and ambientConditions of the site (temperature)

Parameter	$COD_{BL,m}$
Data unit	$tCOD/m^3$
Description	Quantity of chemical oxygen demand that would be treated in anaerobic lagoons or sludge pits in the absence of the project activity in month m
Source of data	Project developer's measurement report
Measurement procedures	The analysis was carried out in accordance with the latest Standard Method continuously throughout the measurement period by reporting detailed data on a monthly basis.

Parameter	$F_{PJ,AD,m}$
Data unit	m^3
Description	Quantity of wastewater or sludge that is treated in the anaerobic digester or under clearly aerobic conditions in the project activity in month m
Source of data	Project developer's measurement report
Measurement procedures	-
Monitoring frequency	Parameter monitored continuously but aggregated monthly and annually for calculations
QA / QC procedures	-
Any comment	-

Parameter	$T_{2,m}$
Data unit	K
Description	Average temperature at the project site in month m
Source of data	Measurement in the project site, or national or regional weather statistics
Measurement procedures	In case that project participants decide to measure temperature in the project site: The temperature sensor must be housed in a ventilated radiation shield to protect the sensor from thermal radiation
Monitoring frequency	Continuously, aggregated in monthly average values
QA / QC procedures	In case that project participants decide to measure temperature in the project site: Uncertainty of the measurements provided by temperature sensor supplier should be discounted from the readings
Any comment	-

Parameter	$EFF_{COM,c,y}$
Data unit	fraction
Description	Combustion efficiency of combustor c in year y
Source of data	The source of data shall be the following, in order of preference: 1. Project specific data; 2. Country specific data; or 3. IPCC default values
Measurement procedures	-
Monitoring frequency	Annually
QA / QC procedures	-
Any comment	As per guidance from the Board, IPCC default values shall be used only when country or project specific data are not available or difficult to obtain

Parameter	$Q_{waste,c,y}$
Data unit	T
Description	Quantity of fresh waste or RDF/SB fed into combustor c in year y
Source of data	Project developer's measurement report
Measurement procedures	Measured with calibrated scales or load cells
Monitoring frequency	Continuously, aggregated at least annually

QA / QC procedures:	-
Any comment:	Parameter required for procedure to calculate project emissions from combustion within the project boundary

Parameter	$SG_{c,y}$
Data unit	m^3/yr
Description	Volume of stack gas from combustor c in year y
Source of data	Project developer's measurement report
Measurement procedures	1) The stack gas flow rate is directly measured. 2) calculated from other variables where direct monitoring is not feasible. 3) Where there are multiple stacks of the same type, then it is sufficient to monitor one stack of each type. 4) For the case that biogas is combusted, then the stack gas volume flow rate may be estimated by summing the inlet biogas and air flow rates and adjusting for stack temperature. 5) Direct measurement of the air inlet flow rate shall be made using a flow meter
Monitoring frequency	Continuous or periodic (at least quarterly)
QA / QC procedures	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment	-

Parameter	$C_{N2O,SG,c,y}$
Data unit	tN_2O/Nm^3
Description	Concentration of N_2O in stack gas from combustor c in year y
Source of data	Project developer's measurement report
Measurement procedures	-
Monitoring frequency	At least every three months
QA / QC procedures	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected.
Any comment	More frequent sampling is encouraged

Parameter	$C_{CH4,SG,c,y}$

Data unit	tCH_4 / Nm^3
Description	Concentration of CH_4 in stack gas from combustor c in year y
Source of data	Project developer's measurement report
Measurement procedures	-
Monitoring frequency	At least every three months
QA / QC procedures	Maintenance and calibration of equipment will be carried out according to internationally recognised procedures. Where laboratory work is outsourced, one which follows rigorous standards shall be selected
Any comment	More frequent sampling is encouraged

Parameter	$p_{n,j,y}$
Data unit	Weight fraction
Description	Fraction of waste type j in the sample n collected during the year y
Source of data	Project developer's measurement report
Measurement procedures	-
Monitoring frequency	A minimum of three samples shall be undertaken every three months with the mean value valid for year y
QA / QC procedures	-
Any comment	-

Parameter	$Q_{RDF\_SB,COM,y}$
Data unit	tonne/year
Description	Quantity of RDF/SB exported off-site with potential to be combusted in year y
Source of data	Project developer's measurement report
Measurement procedures	Sale invoices of the RDF/SB should be kept at the project site. They shall contain customer contact details, physical location of delivery, type, amount (in tons) and purpose of RDF/SB (use as fuel or as material in furniture, etc.). A list of customers and delivered SD amount shall be kept at the project site
Monitoring frequency	Weekly
QA / QC procedures	-
Any comment	-

Parameter	$Q_{RDF\_SB,COM,y}$
Data unit	Tonne/year
Description	Quantity of RDF/SB exported off-site with potential to be combusted in year y
Source of data	Project developer's measurement report
Measurement procedures	Sale invoices of the RDF/SB should be kept at the project site. They shall contain customer contact details, physical location of delivery, type, amount (in tons) and purpose of RDF/SB (use as fuel or as material in furniture, etc.). A list of customers and delivered SD amount shall be kept at the project site
Monitoring frequency	Weekly
QA / QC procedures	-
Any comment	-

Parameter	$Q_{RDF,SB,y}$
Data unit	Tonne/year
Description	Quantity of RDF/SB produced in year y
Source of data	Project developer's measurement report
Measurement procedures	Weighbridge
Monitoring frequency	Annually
QA / QC procedures	Weighbridge will be subject to periodic calibration (in accordance with stipulation of the weighbridge supplier)
Any comment	-

Parameter:	$Q_{ww,y}$
Data unit:	m^3/year
Description:	Amount of wastewater discharge generated by the project activity and treated anaerobically or released untreated from the project activity in year y
Source of data:	Project developer's measurement report
Measurement procedures:	Measured value by flow meter
Monitoring frequency:	Monthly, aggregated annually
QA / QC procedures:	The monitoring instruments will be subject to regular maintenance and testing to ensure accuracy

Any comment:	If the wastewater is treated aerobically, emissions are assumed to be zero, and hence this parameter does notNeed to be monitored

Parameter	$P_{COD,y}$
Data unit	tCOD / m^3
Description	COD of the wastewater discharge generated by the project activity in year y
Source of data	Project developer's measurement report
Measurement procedures	Measured value by purity meter or COD meter
Monitoring frequency	Monthly and averaged annually
QA / QC procedures	The monitoring instruments will be subject to regular maintenance and testing to ensure accuracy
Any comment	If the wastewater discharge is treated aerobically, emissions are assumed to be zero, and hence this parameter does not need to be monitored

Parameter	$EF_{CO2,RDF\_SB,y}$
Data unit	tCO_2 / GJ
Description	Weighted average CO_2 emission factor for RDF/SB in year y
Source of data	$EF_{CO2,RDF\_SB,y}$ is zero for biomass residues, otherwise determine from one of the following sources: <table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>(a) Measurements by the project participants</td><td>This is the preferred data source</td></tr><tr><td>(b) IPCC default values at the upper/lower limit 20 of the uncertainty at a 95 per centConfidence interval as provided in table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If (a) is not available</td></tr></table>
Measurement procedures	For (a): Measurements shall be undertaken in line with national or international fuel standards

Monitoring frequency	For (a): the CO_2 emission factor shall be obtained for each shipment of RDF/SB exported from the project site for which there is documented evidence that it will be combusted, from which weighted average annual values shall be calculated. For (b): any future revision of the IPCC Guidelines shall be taken into account.
QA / QC procedures	-
Any comment	This parameter is required for the procedure to calculate leakage emissions for the combustion of RDF/SB outside the project boundary

Parameter	$NCV_{RDF\_SB,y}$
Data unit	GJ/mass or volume units
Description	Weighted average netCalorific value of RDF/SB in year y
Source of data	Project developer's measurement report
Measurement procedures	Measurement is not required for RDF/SB produced wholly from biomass residues, otherwise measurements shall be undertaken in line with national or international fuel standards
Monitoring frequency	The NCV shall be obtained for each shipment of RDF/SB exported from the project site for which there is documented evidence that it will be combusted, from which weighted average annual values shall be calculated
QA / QC procedures	-
Any comment	This parameter is required for the procedure to calculate leakage emissions for the combustion of RDF/SB outside the project boundary

Parameter	GWP_{CH4}
Data unit	tCO_2e/tCH_4
Description	The global warming potential of methane
Source of data	It uses data from the IPCC Assessment Report produced by the Intergovernmental Commission on Climate Change. (Intergovernmental Panel on Climate Change or IPCC announced by TGO.
Measurement procedures	**For the preparation of project proposal documents** – Use the latest GWP_{CH4} value as announced by TGO. **For monitoring the results of reducing emissions** – Use the value of GWP_{CH4} as announced by TGO. for estimating the amount of greenhouse gases according to the crediting period that has been certified for the amount of greenhouse gases.
Monitoring frequency	
QA / QC procedures	

Any comment	

Parameter	GWP_{N2O}
Data unit	tCO_2e / tN_2O
Description	The global warming potential of Nitrous oxide
Source of data	It uses data from the IPCC Assessment Report produced by the Intergovernmental Commission on Climate Change. (Intergovernmental Panel on Climate Change or IPCC announced by TGO.
Measurement procedures	**<u>For the preparation of project proposal documents</u>** – Use the latest GWP_{N2O} value as announced by TGO. **<u>For monitoring the results of reducing emissions</u>** – Use the value of GWP_{N2O} as announced by TGO. for estimating the amount of greenhouse gases according to the crediting period that has been certified for the amount of greenhouse gases.
Monitoring frequency	-
QA / QC procedures	-
Any comment	-

9.2.2 Data and parameters monitored from emission from electricity consumption

Parameter	$EC_{PJ,i,y}$
Data unit	MWh/year
Description	Amount of electricity consumption in the source of electricity j in years y
Source of data	Project developer's measurement report
Measurement procedures	Measured by kWh Meter and continuously measured throughout the follow-up period. (Amount of electricity deducted from electricity generation for own use before being supplied to the transmission line)
Monitoring frequency	Continuous monitoring and at least monthly recording

Parameter	TDL
Data unit	-
Description	Average technical transmission and distribution losses for providing electricity to source j in year y

Source of data	Option 1 Measurement Report In the case of information on the amount of electricity released from the producer and the amount of electricity received by the consumer Option 2 uses a Default Value of 0.03 (3%).
Measurement procedures	1) If using Option 1, the project developer will have to monitor the value every year throughout the monitoring of greenhouse gas emissions reductions. 2) If using Option 2, the project developer must use this value throughout the monitoring of greenhouse gas emissions reductions.
Monitoring frequency	Defined once in the first year of the credit period.
QA / QC procedures	If the measurement results differ from previous measurements or other sources that are significantly related make additional measurements.
Any comment	-

Parameter	$EF_{Elec,y}$
Data unit	tCO_2/MWh
Description	Emission factor for electricity generation/consumption in year y
Source of data	Report on greenhouse gas emissions (Emission Factor) from electricity generation/consumption for projects and activities of greenhouse gas reduction published by TGO.
Measurement procedures	**For the preparation of project proposal documents** Use the latest $EF_{Elec,y}$ announced by TGO **For monitoring the results of reducing greenhouse gas emissions** Use the $EF_{Elec,y}$ values announced by TGO according to the year of the carbon creditCertification period. However, in the case that the year of the Carbon CreditCertification period does not have $EF_{Elec,y}$ values announced by TGO, use the latest $EF_{Elec,y}$ values announced by TGO in that year instead.

9.2.3 Data and parameters monitored from emission from composting

Parameter	Q_y
Data unit	t / year
Description	Quantity of waste composted in year y (wet basis)
Measurement procedures	Use a weighbridge or any other applicable and calibrated weighing device, e.g. belt-scales
Monitoring frequency	Continuously
QA / QC procedures	Weighbridge or any other applicable weighing device is subject to periodic calibration (in accordance with stipulation of the weighing device supplier) in case option 1 in the step “Determination of the quantity of waste composted”

Any comment	In case the data from weighbridge or any other applicable and calibrated weighing device available on site are missing for up to 30 consecutive days within six consecutive months, one of the following options to estimate quantity of waste composted can be applied: a) Option 2 from the step "Determination of the quantity of waste composted"; b) The highest value of the parameter for the same calendar period of the previous years These options are applicable for project activities or PoAs, where end users of the subsystems or measures are households/communities/small and medium enterprises (SMEs)

Parameter	$CT_{t,y}$
Data unit	t
Description	Carrying capacity of each truck delivering waste to the composting installation in year y
Measurement procedures	The maximum carrying capacity as stated on the truck's nameplate is registered by personnel at the entrance gate of the composting installation
Monitoring frequency	Register maximum carrying capacity of every truck delivery for the year y.
QA / QC procedures	-
Any comment	Applicable to Option 2 in the step "Determination of the quantity of waste composted"

Parameter	Q_c
Data unit	t
Description	Quantity of waste composted in composting cycle c (wet basis)
Measurement procedures	Weighed using weighbridge or any other applicable and calibrated weighing device, e.g. belt-scales
Monitoring frequency	Measure the weight of waste for every truck delivery and aggregate for the same composting cycle for which $ECC_{CH4,c}$ or $ECC_{N2O,c}$ is being
QA / QC procedures:	Weighbridge or any other applicable weighing device is subject to periodic calibration (in accordance with stipulation of the weighing device supplier).
Any comment	This is the specific amount of waste treated for the composting cycle c that emission measurements are made for ($ECC_{CH4,c}$ or $ECC_{N2O,c}$) Applicable to Option 1 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Parameter	$ECC_{CH4,c}$ and $ECC_{N2O,c}$
Data unit	tCH_4 and tN_2O
Description	Methane and nitrous oxide emissions from the composting installation during the composting cycle c
Measurement procedures	Measurement procedures are specified for closed composting installations and non-closed composting installations: Closed composting installation. Choose between the following two options to measure emissions from a closed-composting system for composting cycle c: • **Option 1:** Measure methane and/or nitrous oxide concentrations, gas velocity, temperature and pressure in the exhaust pipe using appropriate analytical equipment (e.g. FID, IR, FTIR). Gas flow can be calculated from gas velocity and exhaust pipe diameter and has to be corrected for pressure and temperature. Methane and nitrous oxide emissions are obtained by integrating the product of gas flow and methane and nitrous oxide concentrations in the gas over the entire duration of the measurement (one composting cycle) • **Option 2:** Use the “Tool to determine the mass flow of a greenhouse gas in a gaseous stream”. When applying the tool, the following guidance is given: o The gaseous stream the tool shall be applied to is the exhaust gas from the closed composting installation. o CH_4 and/or N_2O are the greenhouse gases for which the mass flow should be determined; o Measure the gas flow hourly or at shorter intervals. o The simplification offered for calculating the molecular mass of the gaseous stream is valid (equations 3 or 17 in the tool) **Non-closed composting installation (windrows)** Measure emissions using a flux box. In a flux box measurement, the concentration increase of CH_4 and/or N_2O in the box is measured over time and the emission flux from the surface covered by the box is calculated (kilogram CH_4 or N_2O per square meter per hour). From the measurements made during the cycle, an overall emission flux value can be determined. Emissions during the composting cycle can then be calculated over the time of the composting cycle and the total surface area of the windrow (kg per windrow per hour). The measurements shall be conducted as follows: • Identify at least two measurement Cross sections (across the width), which are spaced equally along the length of the windrow; In each cross-section, identify five measurement locations equally apart; two on each side of the windrow, and one on the top.

	Measurement frequency: • Perform at least five measurement events in each measurement site of the windrow during a composting cycle (resulting in at least 50 individual measurements). Measurement events must be at regular time intervals during the composting cycle. Identify and repeat invalid measurements • Make measurements at each measurement site over at least a continuous one-minute period, with consecutive concentration readings stored at a frequency of at least one per second; • Identify if concentration increase is constant in time. If it is constant, then the measurement is valid. If the rate of increase is notConstant, then this indicates a build-up of pressure in the flux box and the measurement is invalid and must be repeated. Identify the overall flux rate for the composting cycle • Identify the 80% confidence interval for all measurement made during a composting cycle (this is at least 50 measurements); • Identify an overall flux rate as the upper value in the 80% confidence interval Note: When measuring emissions using a flux box, the use of SF6 is strictly banned
Monitoring frequency	Measure at least one composting cycle per climatic season, and at least two cycles in one climatic season. This means there are at least three measurements of $ECC_{CH4,cc}$/$ECC_{N2O,cc}$ in each year in the case of two seasons
QA / QC procedures	**Closed composting installation:** Apply T-VER-P-TOOL 02-05 "Tool to determine the mass flow of a greenhouse gas in a gaseous stream" latest version. **Flux box measurement:** Flux box equipment accuracies (as specified by the supplier of the flux box equipment) shall be 1 ppm or better for CH_4 and 100 ppb or better for N_2O
Any comment	Applicable to Option 1 in the step "Determination of methane and nitrous oxide emissions from the composting process"

Parameter	$COD_{RO,y}$ and $COD_{wastewater,y}$
Data unit	tCOD / m³
Description	Average COD of the run-off wastewater from the co-composting installation valid for year y Average COD of the wastewater co-composted valid for year y

Measurement procedures:	• Measure the COD according to national or international standards in wastewater samples leaving the system from unfiltered run-off wastewater. • The location for taking the sample depends on the collection system: ▪ If there is a dedicated drainage system for collecting only the run-off wastewater from the composting installation, then the sample should be taken from this system; ▪ If there is no dedicated drainage system, then the sample should be taken from run-off wastewater exiting the installation and before entering a drainage system thatCollects run-off from other sites as well as the composting installation (if applicable)
Monitoring frequency	Monthly
QA / QC procedures	Document which national or international standard is applied for COD measurement in the monitoring report. Monitoring instruments shall be subject to regular maintenance and testing to ensure accuracy.
Any comment	An example of an international standard is ISO 6060:1989 “Water quality -- Determination of the chemical oxygen demand”. Applicable to Option 1 of the step “Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Parameter	$Q_{RO,y}$
Data unit	m^3 / year
Description	Volume of run-off wastewater from the co-composting installation in year y
Measurement procedures	Measurement procedures are distinguished based on whether the composting installation is roofed and whether it has a dedicated drainage system (meaning a system that only collects run-off wastewater from the composting installation and not from other areas or sites as well). • If run-off wastewater is collected in a dedicated drainage system, then measure the accumulative volume flow over time using a flow meter. If the site is unroofed, then also measure the rainfall precipitation on the surface of the composting installation. In the situation that the flow meter fails at an unroofed site (such as during a severe storm event), then for the period of time that the flow meter failed, substitute this missing data from the flow meter with the volume of precipitation on the surface of the composting installation. This is estimated as the amount of rainfall multiplied by the surface area of the site;

	• If there is no dedicated drainage system and a roof covering the composting installation then $Q_{RO,y}$ is the annual volume of wastewater applied ($Q_{wastewater,y}$) subtracted by the amount absorbed by the compost. The amount of wastewater absorbed is assumed to be the weight of the compost ($Q_{comp,y}$) multiplied by a default factor of 0.15 t/m^3 ; • If there is no dedicated drainage system and no roof covering the composting installation, then the annual volume of rainfall precipitation on the surface of the composting installation must be added to the amount of wastewater applied in excess of the amount absorbed by the compost, as calculated in the bullet points above.
Monitoring frequency	Continuously
QA / QC procedures	Flow meters shall undergo maintenance and calibration in accordance with manufacturer specifications. Rainfall shall be measured using an on-site rain gauge. The gauge shall be calibrated according to manufacturer specifications
Any comment	Applicable to the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Parameter	$Q_{wastewater,y}$
Data unit	m^3 / yr
Description	Amount of wastewater co-composted in year y
Measurement procedures	Flow meter
Monitoring frequency	Monthly aggregated annually
QA / QC procedures	Flow meters shall undergo maintenance and calibration in accordance with manufacturer specifications.
Any comment	Applicable to Option 2 in the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)" and shall be used to estimate $Q_{RO,y}$ for the situation there is no dedicated drainage system

Parameter	$COD_{wastewater,y}$
Data unit	tCOD / m^3
Description	Average COD of wastewater co-composted valid for year y
Measurement procedures	Measure the COD according to national or international standards in liquid samples that are taken in a representative way from unfiltered wastewater. $COD_{wastewater,y}$ is the average of the COD measurements of the 12 samples taken in year y
Monitoring frequency	Monthly

QA / QC procedures	The monitoring instruments shall be subject to regular maintenance and testing to ensure accuracy
Any comment	Applicable to Option 2 in the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

9.2.3 Data and parameters monitored from emission from anaerobic digesters

Parameter	$Q_{biogas,y}$
Data unit	Nm^3 biogas/year
Description	Amount of biogas collected at the digester outlet in year y
Measurement procedures:	The volumetric flow measurement should always refer to the actual pressure and temperature. Instruments with recordable electronic signal (analogical or digital) are required
Monitoring frequency:	Continuously measurement by the flow meter. Data to be aggregated monthly and yearly
QA / QC procedures:	-
Any comment:	-

Parameter	$P_{COD,y}$
Data unit	tCOD / m^3
Description	Average chemical oxygen demand (COD) of the liquid digestate in year y
Measurement	Manual collection of samples and laboratory analysis
Monitoring frequency	Monthly and averaged annually
QA / QC procedures	Samples should be collected based on the "2005 Standard Methods for the Examination of Water and Wastewater, 21 st. American Public Health Association, Water Environment Federation and American Water Works Association" or any other equivalentNational or international standard
Any comment	-

Parameter	$Q_{stored,y}$
Data unit	m^3/year
Description	Amount of liquid digestate stored anaerobically in year y
Measurement	Using flow meters
Monitoring frequency	Continuously and aggregated annually
QA / QC procedures	-

Any comment	Applicable to Option 1 in the section "Determining $LE_{storage,y}$ for liquid digestate"

9.3 Data and parameters not monitored

9.3.1 Data and parameters not monitored from emission from municipal solid waste management to replace landfills

Parameter	$RATE_{COMPLIANCE}$
Data unit	Fraction
Description	Rate of compliance with a regulatory requirement to implement the alternative waste treatment t implemented in the project activity.
Source of data	Official studies, reports, and certification from municipal authorities.
Any comment	Calculated based on the number of instances of compliance identified at the time of the investment decision and updated once for every subsequent crediting period

Parameter	$FFC_{j,y}$
Data unit	%
Description	Fraction of fossil carbon in total carbon content of waste type j
Source of data	Table 2.4, chapter 2, volume 5 of IPCC 2006 guidelines
Value to be applied	For MSW the following values for the different waste types j may be applied:

Table 1: Default values for $FFC_{j,y}$

Waste type j	Values
Paper/cardboard	5
Textiles	50
Food waste	-
Wood	-
Garden and Park waste	0
Nappies	10
Rubber and Leather	20
Plastics	100
Metal*	NA
Glass*	NA
Other, inert waste	100

	1) Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is notCommon. 2) If a waste type is notComparable to a type listed in Table 4, or can notClearly be described as a combination of types in this table above, or if the project participants wish to measure FFC_j, then project participants shall measure $FFC_{j,y}$ using the following standards, or similar national or international standards:: 2.1) ASTM D6866: “Standard Test Methods for Determining the Biobased Content of Solid, Liquid, and Gaseous Samples Using Radiocarbon Analysis”; 2.2) ASTM D7459: “Standard Practice for Collection of Integrated Samples for the Speciation of Biomass (Biogenic) and Fossil Carbon Dioxide Emitted from Stationary Emissions Sources” 3) The frequency of measurement shall be as a minimum four times in year y with the mean value valid for year y
Any comment:	-

Parameter	$FCC_{j,y}$
Data unit	%
Description	Fraction of total carbon content in waste type j
Source of data	Table 2.4, chapter 2, volume 5 of IPCC 2006 guidelines
Value to be applied	For MSW the following values for the different waste types j may be applied:

Table 2: Default values for $FCC_{j,y}$

Waste type j	Values
Paper/cardboard	50
Textiles	50
Food waste	50
Wood	54
Garden and Park waste	55
Nappies	90
Rubber and Leather	67
Plastics	85
Metal*	NA
Glass*	NA
Other, inert waste	5

* Metal and glass contain some carbon of fossil origin. Combustion of significant amounts of glass or metal is not common

Any comment:	-

Parameter	B_O
Data unit	$tCH_4/tCOD$
Description	Maximum methane producing capacity, expressing the maximum amount of CH_4 thatCan be produced from a given quantity of chemical oxygen demand ($kgCH_4/kgCOD_{removal}$)
Source of data	Section 6.2.3.2, chapter 6, volume 5 of IPCC 2006 guidelines
Value to be applied	0.25
Any comment	-

Parameter	MCF_{ww}
Data unit	Fraction
Description:	The Methane Correction Factor (MCF) shall be determined based on the following table: (see table below)
Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5, CHAPTER 6, table 6.3)
Measurement procedures	-
Any comment	

Type of wastewater treatment and discharge pathway or system	**MCF value**
Discharge of wastewater to sea, river or lake	0.1
Land application	0.1
Aerobic treatment, well managed	0.0
Aerobic treatment, poorly managed or overloaded	0.3
Anaerobic digester for sludge without methane recovery	0.8
Anaerobic reactor without methane recovery	0.8
Anaerobic shallow lagoon (depth less than 2 metres)	0.2
Anaerobic deep lagoon (depth more than 2 metres)	0.8
Septic system	0.5

Parameter	$EF_{CH4,t}$
Data unit	tCH_4 / t waste (wet basis)
Description	Emission factor for CH_4 associated with waste treatment process t

<table>
<tr><td>Source of data</td><td>Table 5.3, chapter 5, volume 5 of IPCC 2006 guidelines</td></tr>
<tr><td>Measurement procedures</td><td>If country-specific data is available, then this shall be applied and the method used to derive the value as well as the data sources need to be documented in the CDM-PDD. If country-specific data are not available, then apply the default values listed in Table 6. For continuous incineration of industrial waste, apply the CH_4 emission factors provided in Volume 2, Chapter 2, Stationary Combustion of IPCC 2006 Guidelines.

Table 6 CH4 emission factors for combustion

<table>
<tr><th>Waste type</th><th colspan="2">Type of incineration/technology</th><th>CH_4 emission factors (tCH_4 / t waste) wet basis</th></tr>
<tr><td rowspan="6">MSW</td><td rowspan="2">Continuous incineration</td><td>stoker</td><td>$1.21 \times 0.2 \times 10^{-6}$</td></tr>
<tr><td>Fluidised bed</td><td>~0</td></tr>
<tr><td rowspan="2">Semi-continuous incineration</td><td>stoker</td><td>$1.21 \times 6 \times 10^{-6}$</td></tr>
<tr><td>Fluidised bed</td><td>$1.21 \times 188 \times 10^{-6}$</td></tr>
<tr><td rowspan="2">Batch type incineration</td><td>stoker</td><td>$1.21 \times 60 \times 10^{-6}$</td></tr>
<tr><td>Fluidised bed</td><td>$1.21 \times 237 \times 10^{-6}$</td></tr>
<tr><td colspan="3">Sludge (semi-continuous or batch type incineration)</td><td>$1.21 \times 9{,}700 \times 10^{-6}$</td></tr>
<tr><td colspan="3">Waste oil (semi-continuous or batch type incineration)</td><td>$1.21 \times 560 \times 10^{-6}$</td></tr>
</table>

A conservativeness factor of 1.21 has been applied to account for the uncertainty of the IPCC default values</td></tr>
<tr><td>Any comment</td><td>Applicable to Option 2 of procedure to estimate $PE_{COM, c, y}$</td></tr>
</table>

Parameter	$EF_{N2O,t}$
Data unit	tN_2O / t waste (wet basis)
Description	Emission factor for N_2O associated with treatment process t
Source of data	Table 5.6, chapter 5, volume 5 of IPCC 2006 guidelines
Measurement procedures	If country-specific data is available, then this shall be applied, and the method used to derive the value as well as the data sources need to be documented in the PDD. If country-specific data are not available, then apply the default values listed in Table 4

<table>
<tr><td></td><td>Table 4 N_2O emission factors for combustion

<table>
<tr><th>Type of waste</th><th>Technology / Management practice</th><th>Emission factor (tN_2O / t waste) wet basis</th></tr>
<tr><td>MSW</td><td>Continuous and semi-continuous incinerators</td><td>$1.21 \times 50 \times 10^{-3}$</td></tr>
<tr><td>MSW</td><td>Batch-type incinerators</td><td>$1.21 \times 60 \times 10^{-3}$</td></tr>
<tr><td>Industrial waste</td><td>All types of incineration</td><td>$1.21 \times 100 \times 10^{-3}$</td></tr>
<tr><td>Sludge (except sewage sludge)</td><td>All types of incineration</td><td>$1.21 \times 450 \times 10^{-3}$</td></tr>
<tr><td>Sewage sludge</td><td>Incineration</td><td>$1.21 \times 900 \times 10^{-3}$</td></tr>
</table>

A conservativeness factor of 1.21 has been applied to account for the uncertainty of the IPCC default values</td></tr>
<tr><td>Any comment</td><td>Applicable to Option 2, of procedure to estimate $PE_{COM,c,y}$</td></tr>
</table>

Parameter	x
Data unit	Time
Description	Representative historical reference period
Source of data	**For existing plants:** x should represent one year of historical data; If one-year data is not available. x represents a measurement campaign of at least 10 days. **For Greenfield project:** This parameter is not relevant
Measurement procedures	-
Any comment	-

Parameter	p
Data unit	-
Description	Discount factor to account for the uncertainty of the use of historical data to determine $COD_{BL,y}$
Source of data	**For existing plants:** 1. If one year of historical data is available, p =1; 2. If a measurementCampaign of at least 10 days is available, p =0.89. **For greenfield projects:** p = 1

Measurement procedures	The value of 0.89 for the case where there is no one year historical data is to account for the uncertainty range (of 30 per cent to 50 per cent) associated with this approach as compared to one-year historical data
Any comment	-

Parameter	D
Data unit	m
Description	Average depth of the lagoons or sludge pits
Source of data	**For existing plants:** Conduct measurements. **For greenfield project:** Apply the value from design
Measurement procedures	Determine the average depths of the whole lagoon/sludge pit under normal operating conditions
Any comment	-

Parameter	E
Data unit	cal/mol
Description	Activation energy constant
Source of data	Page 23 of ACM0022: Large-scale consolidated methodology Alternative waste treatment processes Version 03.0
Value to be applied	15,175

Parameter	R
Data unit	cal /K-mol
Description	Ideal gas constant
Source of data	Page 23 of ACM0022: Large-scale consolidated methodology Alternative waste treatment processes Version 03.0
Value to be applied	1.986

9.3.2 Data and parameters not monitored from emission from composting

Parameter	$B_{0,ww}$
Data unit	tCH_4 / tCOD
Description	Default methane producing capacity of the wastewater
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value to be applied	0.25
Any comment	Applicable to the step "Determination of project emissions from run-off wastewater ($PE_{RO,y}$)"

Parameter	$EF_{CH4,default}$
Data unit	tCH_4 / t
Description	Default emission factor of methane per tonne of waste composted (wet basis)
Source of data	The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high quality sources was analyzed and a value conservatively selected from the higher end of the range in results.
Value to be applied	0.002
Any comment	Applicable to Option 2 in the step “Determination of methane and nitrous oxide emissions from the composting process

Parameter	$EF_{N2O,default}$
Data unit	tN_2O / t
Description	Default emission factor of nitrous oxide per tonne of waste composted (wet basis)
Source of data	The emission factor was selected based on studying published results of emission measurements from composting facilities, literature reviews on the subject and published emission factors. Data from recent, high quality sources was analyzed and a value conservatively selected from the higher end of the range in results.
Value to be applied	0.0002
Any comment	Applicable to Option 2 in the step “Determination of methane and nitrous oxide emissions from the composting process

Parameter	$MCF_{ww,treatment}$
Data unit	-
Description	Methane correction factor from wastewater treatment
Value to be applied	The Methane Correction Factor (MCF) shall be determined based on the following table:

	<table><tr><th>Type of wastewater treatment</th><th>MCF</th></tr><tr><td>Discharge of wastewater to sea, river or lake</td><td>0.1</td></tr><tr><td>Land application</td><td>0.1</td></tr><tr><td>Aerobic treatment, well managed</td><td>0.0</td></tr><tr><td>Aerobic treatment, poorly managed or overloaded</td><td>0.3</td></tr><tr><td>Anaerobic digester for sludge without methane recovery</td><td>0.8</td></tr><tr><td>Anaerobic reactor without methane recovery</td><td>0.8</td></tr><tr><td>Anaerobic shallow lagoon (depth less than 2 metres)</td><td>0.2</td></tr><tr><td>Anaerobic deep lagoon (depth more than 2 metres)</td><td>0.8</td></tr><tr><td>Septic system</td><td>0.5</td></tr></table>
Source of data	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Volume 5, CHAPTER 6, table 6.3)
Any comment	Applicable to the step "Determination of project emissions from run-off wastewater ($PE_{RO,y}$)"

Parameter	φ
Data unit	-
Description	Default model correction factor to account for model uncertainties of methane emissions from run-off wastewater
Source of data	default value from Draft Decisions On Methodological Issues Relating To Articles 5, 7 And 8 Of The Kyoto Protocol (Agenda Item 4 (B)) (FCCC/SBSTA/2003/10/Add.2, page 25)
Value to be applied	1.12
Any comment	An assigned uncertainty band of 40% was assumed when selecting this default value from the source referenced above. Applicable to the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

Parameter	$DF_{COD,RO}$
Data unit	-
Description	Default factor for the ratio of the amount of COD in run-off wastewater and wastewater co-composted
Source of data	Measurements from project developers
Value to be applied	0.02
Any comment	Applicable to Option 2 of the step "Determination of emissions from run-off wastewater ($PE_{RO,y}$)"

9.3.3 Data and parameters not monitored from emission from anaerobic digesters

Parameter	$f_{CH4,default}$
Data unit	m^3 CH_4 / m^3 biogas biogas corrected to reference conditions Reference conditions are defined as 0 °C (273.15 K, 32ºF) and 1 atm (101.325 kN/m^2, 101.325 kPa, 14.69 psia, 29.92 in Hg, 760 torr).
Description	Default value for the fraction of methane in the biogas
Source of data	The default value was derived based on reported values from registered projects and research papers (Davidsson, 2007)
Value to be applied	0.6
Any comment	Use this value for Option 2 of the step “Determination of the quantity of methane produced in the digester”

Parameter	p_{CH4}
Data unit	tCH_4 / m^3 CH_4
Description	Density of methane atNormal conditions
Source of data	Thermophysical properties of fluids. II. Methane, Ethane, Propane, Isobutane and Normal Butane’ by B.A. Younglove, J.F. Ely. <https://www.nist.gov/sites/default/files/documents/srd/jpcrd331.pdf>
Value to be applied	0.00067
Any comment	Corrected to reference conditions

Parameter	$EF_{CH4,default}$
Data unit	tCH_4 leaked / tCH_4 produced
Description	Default emission factor for the fraction of CH_4 produced that leaks from the anaerobic digester
Source of data	IPCC (2006), Flesch et al. (2011) and Kurup (2003)
Value to be applied	Use the default value corresponding to the type of digester used in the project activity. The digester type shall be identified by manufacturer information. If this is not possible, then the factor 0.1 shall be applied (upper range of the IPCC values). ● 0.028: Digesters with steel or lined concrete or fiberglass digesters and a gas holding system (egg shaped digesters) and monolithic construction; ● 0.05: UASB type digesters, floating gas holders with no external water seal;

	• 0.10: Digesters with unlined concrete/ferrocement/brick masonry arched type gas holding section; monolithic fixed dome digesters, covered anaerobic lagoon
Any comment:	Applicable to the step "Determination of project emissions of methane from the anaerobic digester"

Parameter	B_o
Data unit	tCH_4 / tCOD
Description	Maximum CH_4 producing capacity of the COD applied
Source of data	2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value to be applied	0.25
Any comment	-

Parameter	$F_{ww,CH4,default}$
Data unit	Fraction
Description	Default factor representing the remaining CH_4 production capacity of liquid digestate
Source of data	Reference papers (see references below) and current industry
Value to be applied	• 0.10: Covered anaerobic lagoons; • 0.15: UASB type digesters / Anaerobic filter bed digesters / Anaerobic fluidized bed digesters; • 0.20: Conventional digesters; • 0.05: Two stage digesters
Any comment	-

Parameter	MCF
Data unit	Dimensionless
Description	Methane conversion factor
Source of data	Table 6.3, Chapter 6, Volume 5, 2006 IPCC Guidelines for National Greenhouse Gas Inventories
Value to be applied	• 0.8 for a depth of liquid digestate storage $\geq$ 2 m; • 0.2 for a depth of liquid digestate storage < 2 m and $\geq$ 1 m; • 0 for a depth of liquid digestate storage < 1 m
Any comment	-

10. Reference

Clean Development Mechanism (CDM)

AMS-III.H.: Methane recovery in wastewater treatment Version 19.0

TOOL 03 : Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion version 03.0

TOOL 04 : Emissions from solid waste disposal sites version 08.0

TOOL 05 : Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation version 03.0

TOOL 06 : Project emissions from flaring version 04.0

TOOL 08 : Tool to determine the mass flow of a greenhouse gas in a gaseous stream version 03.0

TOOL 13 : Project and leakage emissions from composting version 02.0

TOOL 14 : Project and leakage emissions from anaerobic digesters version 02.0

Document information T-VER-P-METH-09-01

Version	Amendment	Entry into force	Description
01	-	1 March 2023	- Change document code from TVER-METH-09-01 Version 01. - Add the definition of project starting date. - Change the sign and the meaning for parameter of $EF_{grid,y}$ and revise the data sources.
01	-	30 November 2022	Initial adoption