METHODOLOGY

METHODOLOGY FOR ANIMAL MANURE MANAGEMENT AND BIOGAS USE FOR THERMAL ENERGY GENERATION

SDG 13

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SUMMARY

This methodology applies to the activities that involve recovery and use of methane from manure and agricultural wastes that would be decaying anaerobically, emitting methane to the atmosphere in the absence of the implemented activity. It presents an integrated methodology for Animal Waste Management System and thermal application of captured biogas with multiple applications. This methodology displaces the application of Technologies and Practices to Displace Decentralized Thermal Energy Consumption (TPDDTEC) v3.1 methodology for biogas generation and application for thermal energy project activities.

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1| Definition

1.1.1 | For this methodology, the following definitions apply:

a. **Continuous useful energy output** – Energy transferred to the contents of a cooking vessel, including the sensible heat that raises the temperature of the contents of the cooking vessel and the latent heat of evaporation of water from the cooking vessel, divided by the time of the operation of the cooking task.

b. **Double counting:** Occurs when the same emission reduction is used more than once to achieve mitigation obligations, as a result of double-issuance, double-use, or double-claiming.

c. **Technical life:** Average time for which the project technology may continue to be operated for an extended period in a safe manner and with minimal loss of performance.

d. **Technology:** refers to the single or multiple technologies and/or practices applied in the project activity that results in emission reduction.

e. **Animal manure:** collectively includes both dung and urine (i.e., the solids and the liquids) produced by livestock.

f. **Animal Waste Management System (AWMS):** refers to the system designed for proper handling, storage, and utilization of biogas generated from the operation of animal waste treatment system.

g. **Animal species:** livestock by species e.g., dairy cows, other cattle, buffalo, sheep, goats, camels, llamas, alpacas, deer, horses, rabbits, mules and asses, swine, and poultry. Populations by species can also be further subdivided by category. Category refers to classification inside a species by different relevant attributes such as sex, age or productive purpose in a relevant production system in any given country (e.g., in the case of cattle: mature males and females, replacement heifers, calves, etc.).

2| Scope, Applicability, and entry into force

2.1 | Scope

2.1.1 | The methodology applies to activities that involve recovery and use of methane from manure, agricultural wastes and other organic waste[1] that would be decaying anaerobically, emitting methane to the atmosphere in the absence of the activity.

[1] For example, co-digestion of kitchen food waste and the fresh septic tank sludge may be included. However, the methane avoidance claims are only limited to animal waste for simplification purposes.

2.1.2 | The use of biogas refers to biogas thermal applications in residential, commercial, and institutional settings (e.g., for supply to households, small farms or for use in built institutions such as schools). For example, installation of a biogas digester - where recovered biogas use displaces or avoids the consumption of fossil fuel and non-renewable biomass; biogas uses include but are not limited to biogas stoves for cooking, lighting, refrigeration, small-scale baking and drying systems, water heating, or space heating systems[2].

2.1.3 | The activity may involve progressive installation of biogas digesters - where construction of new biodigesters may occur in a gradual manner and/or adoption increases over the crediting period of a given activity.

2.2 | Applicability

2.2.1 | This methodology applies only to the fraction of the manure[3], which would decay anaerobically in the absence of the project activity established by a survey.

2.2.2 | The methodology offers two methods for baseline emission quantification from AWMS:

a. AWMS method 1 - IPCC Tier 1 approach,

b. AWMS method 2 - IPCC Tier 2 approach,

Where annual emission reduction for methane recovery component is higher than five tonnes of CO_{2eq} per biodigester the AWMS method 2 shall be applied.

The project may include both type of biodigesters – applying AWMS method 1 and AWMS method 2 in the same activity. In such cases, the project must clearly differentiate user groups (applying AWMS method 1 and AWMS method 2) and demonstrate compliance to eligibility requirements, quantification and monitoring approach for each group separately as outlined in this methodology.

2.2.3 | The methodology is applicable under the following conditions when applying AWMS method 1:

a. The category is limited to measures at individual households, small farms (e.g., installation of a domestic biogas digester) or livestock farms or institutional settings.

b. The activity shall ensure that:

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[2] The methodology does not limit the application of biogas use. The developer may apply approved Gold Standard or CDM methodology for uses (thermal or electric applications) of recovered biogas that are not covered under this methodology.

[3] Co-digestion of manure with other organic waste streams such as agricultural residue, kitchen food waste, fresh septic tank sludge etc. is permitted.

i. The digestate must be handled aerobically. In soil application of the final digestate, proper conditions and procedures (resulting in negligible methane emissions) must be ensured.

ii. The biogas captured from the biodigesters is utilized (e.g., combusted or burnt for thermal applications).

2.2.4 | The methodology is applicable under the following conditions when applying AWMS method 2 (Not applicable to AWMS method 1):

a. The livestock population in the farm is managed fully or partly under confined conditions;

b. Manure or the streams obtained after treatment are not discharged into natural water resources (e.g., river or estuaries);

c. The annual average temperature of baseline site where anaerobic manure treatment facility is located is higher than 5°C;

d. In the baseline scenario, the retention time of manure waste in the anaerobic treatment system is greater than one month, and if anaerobic lagoons are used in the baseline, their depths are at least 1 m;

e. No methane recovery and destruction by flaring or combustion for gainful use takes place in the baseline scenario.

f. The storage time of the manure after removal from the animal barns, including transportation, should not exceed 45 days before being fed into the anaerobic digester. If the project developer can demonstrate that the dry matter content of the manure when removed from the animal barns is larger than 20%, this time constraint will not apply.

g. A technical measure to ensure that the gas holding capacity of the biodigester is sufficiently large to capture the biogas during periods of non-usage. A justification to demonstrate compliance with this requirement pertaining to the biogas digester size shall be included in the PDD.

2.2.5 | The activity is implemented by a project developer and can include additional project participants listed in Appendix 2 of the PDD template. The individual households may be represented collectively by community organizations, etc., but do not individually act as project participants[4].

2.2.6 | The developer must design incentive mechanism(s)[5], which should be effective as fast as possible, for the displacing the use of inefficient baseline stoves or

[4] The developer may discuss the project specific situation with Secretariat where this clause presents limitations for developer.

[5] Incentive mechanism could be of any form which motivates user for adoption of biogas use as early as possible. For example, not limited to, frequent education campaigns, awareness raising programme, operation and maintenance services at discounted cost.

cooking practices by the project cooking devices for daily usage and describe the incentive mechanism(s) in the PDD/VPA-DD at the time of validation.

2.2.7 | To avoid double counting or double claiming, the project developer must:

a. clearly communicate its ownership rights and intention of claiming the emission reductions resulting from the project activity to the following parties by contract or clear written assertions in the transaction paperwork: all other project participants; project technology manufacturers; and retailers of the project technology; and

b. inform and notify the end users that they cannot claim emission reductions from the project, and

c. exclude from the project activity, any biodigester and cookstoves that are included in any other voluntary market or CDM or Article 6 based mechanisms project activity/PoA and strive not to displace the cooking devices of another CDM or voluntary project/PoA. See data and parameters not monitored, Avoidance of double counting or double claiming with other mitigation actions, for details on this demonstration.

2.3 | Safeguards

2.3.1 | The project shall not undermine or conflict with any national, sub-national or local regulations or guidance for animal waste management, thermal energy supply or fuel supply or use. The project shall document the national, regional and local regulatory framework for provision of animal waste management and thermal energy services of the type the project provides in the project boundary (parameter BGTA 3).

2.3.2 | If the expected or remaining technical life of project technology (parameter BGTA 5) is shorter than the crediting period, the project developer shall describe measures to ensure that end users are provided or can purchase replacement technology of comparable service and quality level at the end of the technical life, by either replacing with comparable or better technology, or retrofitting essential parts with performance guarantee.

2.4 | Entry into force

2.4.1 | The date of entry into force of this methodology is ~~dd/mm/2022~~19/10/2022.

3| Baseline Methodology

3.1 | Project Boundary

3.1.1 | The project boundary is the physical, geographical sites of:

a. The livestock[6];

b. Animal manure management systems;

c. Biogas utilization for thermal applications;

d. Digestate treatment, usage and/or disposal (where appliable).

3.1.2 | The project developer shall also include clear description of target area and fuel production and collection area in the project boundary in the PDD/VPA-DD.

a. The project boundary is the physical, geographical sites of the project technologies/practices including the fuel collection and production area, where:

i. baseline fuel is woody biomass (including charcoal), the project boundary also includes the area within which this woody biomass is grown and collected. For other fuels such as fossil fuel e.g., Coal, LPG, Kerosene, ~~it~~ the boundary can be ignored.

ii. project activity uses processed fuels, this boundary also includes the baseline and project fuel production (e.g., charcoal, plant oil) and solid waste and effluents disposal or treatment facilities associated with fuel processing.

iii. project activity introduces the use of a new biomass feedstock into the project situation, the fuel production and collection area is the area within which this new biomass is produced, collected and supplied.

b. The target area is the region(s) or town(s) where the considered baseline scenario(s) are deemed to be uniform across project area.

3.2 | Emission sources included in the project boundary

3.2.1 | Emissions can occur during biogas production, transport and consumption of the biogas, including other fuels to meet thermal energy needs.

3.2.2 | Baseline emissions from any gases marked below may be omitted for simplification.

3.2.3 | All project emissions from any of the gases marked below must be accounted for, unless demonstrably negligible or not applicable to the individual activity.

3.2.4 | Project emissions from transportation of input manure for the digesters shall be accounted if the transportation distance (including both long-distance and home delivery transport) is more than 200 km; otherwise, they can be neglected.

[6] Where co-digestion is practiced, the project developer shall also include other sources of waste treated with manure, in the project boundary. However, the methane avoidance claims are only limited to animal waste for simplification purposes.

Table 1. Emissions sources included in or excluded from the project boundary

Scenario	Source	Gas	Included	Justification/Explanation
Baseline scenario	Animal Waste Management System	CO_2	No	CO_2 emissions from the decomposition of organic waste are not included.
		CH_4	Yes	Major source of emissions
		N_2O	Yes	Direct and indirect N_2O emissions are accounted for projects applying Tier 2 approach. The baseline emission shall be estimated following the guidance from IPCC 2019, section 10.5, Tier 2 or Tier 3 approach for direct and indirect N2O emissions. This baseline emission source could be excluded for simplification and conservative.
	Delivery of thermal energy	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions, unless justified negligible
		N_2O	Yes	Can be significant for some fuels, unless justified negligible
	Production of fuel, transport of fuel	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions for some fuels, unless justified as negligible
		N_2O	No	Excluded for simplification; conservative
Project scenario	Animal waste management system	CO_2	No	CO_2 emissions from the decomposition of organic waste are not included.
		CH_4	Yes	Emissions from physical leakage, as well as emissions from the animal waste not treated in the bio-digester
		N_2O	No	Excluded as a biodigester does not produce N_2O gasses
	Delivery of thermal energy	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions
		N_2O	Yes	Can be significant for some fuels
	Production of fuel, transport of fuel	CO_2	Yes	Important source of emissions
		CH_4	Yes	Important source of emissions
		N_2O	NO	Excluded for simplification.

3.3 | Demonstration of additionality

3.3.1 | The project developer shall demonstrate additionality by conforming to additionality requirements of one of the options below,

a. Applicable GS4GG Activity Requirements

b. CDM Tool 01 - Tool for the Demonstration and Assessment of Additionality;

c. CDM Tool 19- Demonstration of additionality of microscale project activities; (not applicable to Gold Standard microscale projects)

d. CDM Tool 21 – Demonstration of additionality of small-scale project activities; (applicable to small-scale projects only)

e. An approved Gold Standard VER additionality tool

3.4 | Baseline scenario determination

3.4.1 | **Animal Waste Management System:** The baseline scenario is the situation where, in the absence of the project activity, animal manure[7] is left to decay anaerobically within the project boundary and methane is emitted to the atmosphere. The fraction of waste or raw materials that would decay anaerobically in the absence of the project activity is determined in the baseline survey (Parameter BGTA 6). The baseline survey shall be conducted with a sample group of households/small farms with a 90% confidence interval and 10% margin of error. Refer to section 4.3.3 for minimum sample size for each baseline scenario.

a. For Tier 1 approach - The survey should determine the average annualized number of animals for each waste management system type.

b. For Tier 2 approach - The survey should determine the **baseline animal manure management practices** applied. If the livestock is raised in centralized shared farms, the project proponent shall be able to show the baseline animal manure management practices at each farm, either individually or through sampling.

3.4.2 | **Thermal application:** The baseline is the fuel consumption of the thermal application used or that would have been used in the absence of the project

[7] The main factors affecting CH_4 emissions are the amount of manure produced and the portion of the manure that decomposes anaerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed. When manure is stored or treated as a liquid (e.g., in lagoons, ponds, tanks, or pits), it decomposes anaerobically and can produce a significant quantity of CH_4. The temperature and the retention time of the storage unit greatly affect the amount of methane produced. When manure is handled as a solid (e.g., in stacks or piles) or when it is deposited on pastures and rangelands, it tends to decompose under more aerobic conditions and less CH_4 is produced. (IPCC, 2019)

activity times an emission factor for the fossil fuel and non-renewable biomass displaced.

3.5 | Baseline Emissions

A. Animal waste management system

3.5.1 | Baseline emission from AWMS is calculated ex ante, using one of the following methods, as appropriate.

a. AWMS method 1: IPCC TIER 1 approach (IPCC 2019)

3.5.2 | AWMS method 1 requires livestock population data by animal species/category, climate region or temperature and data on baseline animal manure management practice in the project boundary determined as per section 3.1 | above. Baseline emissions for each production system[8] are determined as follows:

$$BE_{AWMS,y} = N_{b,p,y} \div 365 \times GWP_{CH4} \times UF_b \times U_{p,y} \times \sum_{j,LT} (N_{LT,y} \times VS_{LT,y} \times MS\%_{Bl,j} \times EF_{LT,y}) \div 1000 \quad \textit{Eq. 1}$$

Where:

$BE_{AWMS,y}$	=	Baseline emissions in year *y* (t CO_2e)
$N_{b,p,y}$	=	Number of project technology-days included in the project database for each project scenario in year y
GWP_{CH4}	=	Global Warming Potential (GWP) of CH_4 applicable to the crediting period
UF_b		Model correction factor to account for model uncertainties (0.89)[9]
$U_{p,y}$	=	Usage rate for technologies in project scenario p in year y (fraction). For baseline emission calculation at Design Certification, the ex-ante $U_{p,y}$ shall be estimated.
LT	=	Index for all types of livestock
j	=	Index for animal waste management system
$N_{LT,y}$	=	Annual average number of animals of type *LT* in year *y* (numbers)

[8] In certain countries agricultural production systems may be transitioning from low productivity local subsistence systems to higher productivity systems aimed at fulfilling national and export markets or may simply have dual agricultural systems, with coexistence of low and high productivity systems clearly identified. Unless justified in line with the productivity class defined in IPCC 2019 refinement guidelines, the project shall use low productivity class and corresponding parameter values.

[9] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

$VS_{LT,y}$ = Volatile solids production/excretion per animal of livestock *LT* in year *y* (on a dry matter weight basis, kg-dm/animal/year)

$MS\%_{Bl,j}$ = Fraction of animal manure handled in baseline animal manure management system *j*. (%). The project developer may apply the default IPCC values or conduct surveys to assess the animal manure management practices in the baseline.

$EF_{LT,y}$ = Emission factor for direct CH_4 emissions by livestock *LT*, in manure management system j.

3.5.3 | Survey methods are used to determine the annual average animal population ($N_{LT,y}$). The annual average number of animals ($N_{LT,y}$) is determined as follows:

$$N_{LT,y} = N_{da,y} \times \left(\frac{N_{p,y}}{365}\right) \qquad \textit{Eq. 2}$$

Where:

$N_{da,y}$ = Number of days animal is alive in the farm in the year *y* (numbers)

$N_{p,y}$ = Number of animals produced annually of type *LT* for the year *y* (numbers)

3.5.4 | Volatile solids (*VS)* are the organic material in livestock manure and consist of both biodegradable and non-biodegradable fractions. The parameter $VS_{LT,y}$ shall be calculated as per the equation below:

$$VS_{LT,y} = (VS_{rate,LT} \times \frac{TAM_{LT}}{1000}) \times nd_y \qquad \text{Eq. 3}$$

Where:

$VS_{LT,y}$ = Annual volatile solid excretions for livestock *LT* entering all animal waste management systems on a dry matter weight basis (kg-dm/animal/yr)

$VS_{rate,LT}$ = VS excretion rate (kg VS / (1000 kg animal mass) / day)

TAM_{LT} = Typical animal mass for livestock LT (kg/animal).

nd_y = Number of days that the animal manure management system was operational in year *y*

b. AWMS method 2: IPCC TIER 2 approach (IPCC 2019)

3.5.5 | IPCC Tier 2[10] approach requires information about the characteristics of the manure and its the management systems in the baseline. Manure characteristics include the amount of volatile solids (VS) produced by the livestock and the maximum amount of methane that can be potentially produced from that manure (B_o). The baseline emissions are determined as follows:

$$BE_{AWMS,y} = N_{b,p,y} \div 365 \times GWP_{CH4} \times D_{CH4} \times UF_b \times U_{p,y} \times \sum_{k} \sum_{j,LT} N_{LT,y} \times B_{0,LT} \times VS_{LT,y} \times MCF_{j,k} \times MS\%_{Bl,j} \quad \text{Eq. 4}$$

Where:

$BE_{AWMS,y}$	=	Baseline emissions in year *y* (t CO_2e)
$N_{b,p,y}$	=	Number of project technology-days included in the project database for each project scenario in year y
UF_b	=	Model correction factor to account for model uncertainties (0.94)[11]
$U_{p,y}$	=	Usage rate for technologies in project scenario p in year y (fraction). For baseline emission calculation at Design Certification, the ex-ante $U_{p,y}$ shall be estimated.
GWP_{CH4}	=	Global Warming Potential (GWP) of CH_4 applicable to the crediting period.
D_{CH4}	=	CH_4 density (0.00067 t/m^3 at room temperature (20 ºC) and 1 atm pressure)
LT	=	Index for all types of livestock
j	=	Index for animal manure management system
k	=	Climate region k
$B_{0,LT}$	=	Maximum methane production potential of the volatile solid generated for animal type *LT (*m^3 CH_4/kg-dm).
$MCF_{j,k}$	=	Annual methane conversion factor (*MCF*) for the baseline animal manure management system j by climate region k. (%)
$N_{LT,y}$	=	Annual average number of animals of type *LT* in year *y* (numbers)

[10] Chapter 'Emissions from Livestock and Manure Management' under the volume '*Agriculture, Forestry and other Land use' of the 2019 IPCC Guidelines for National Greenhouse Gas* Inventories) https://www.ipcc-nggip.iges.or.jp/public/2019rf/pdf/4_Volume4/19R_V4_Ch10_Livestock.pdf

[11] Reference: FCCC/SBSTA/2003/10/Add.2, page 25.

$VS_{LT,y}$ = Volatile solids production/excretion per animal of livestock *LT* in year *y* (on a dry matter weight basis, kg-dm/animal/year)

$MS\%_{Bl,j}$ = Fraction of manure handled in baseline animal manure management system *j. (%)*

3.5.6 | *VS* are the organic material in livestock manure and consist of both biodegradable and non-biodegradable fractions. For the calculations the total VS excreted by each animal species is required.

a. Country specific VS excretion rate - The preferred method to obtain VS is to use data from nationally published sources. These values shall be compared with IPCC default values and any significant differences shall be explained.

b. IPCC default values VS excretion rate - If average daily VS excretion rates from nationally published sources are not available, country-specific *VS* excretion rates can be estimated from feed intake levels, using the equation below.

$$VS_{LT,y} = \left[GE_{LT} \times \left(1 - \frac{DE_{LT}}{100}\right) + (UE \times GE_{LT})\right] \times \left[\left(\frac{1 - ASH}{ED_{LT}}\right)\right] \times nd_y \qquad \textit{Eq. 5}$$

Where:

$VS_{LT,y}$ = Annual volatile solid excretions for livestock *LT* entering all animal waste management systems on a dry matter weight basis (kg-dm/animal/yr)

GE_{LT} = Daily average gross energy intake (MJ/animal/day).

DE_{LT} = Digestible energy of the feed (fraction).

UE = Urinary energy (fraction of GE_{LT})

ASH = Ash content of feed calculated as a fraction of the dry matter feed intake. Use country-specific values where available. The value for ash content fraction can range substantially between livestock types and should reflect national circumstances (fraction of the dry matter feed intake)

ED_{LT} = Energy density of the feed fed to livestock type *LT.* Default value is 18.45 (MJ/kg-dm). This value is relatively constant across a wide range of forage and grain-based feeds commonly consumed by livestock.

nd_y = Number of days treatment plant was operational in year *y*

c. If country specific VS values are not available IPCC default values from 2019 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10 table 10 A-1 to 10 A-9 can be used provided that the project participants assess the suitability of those data to the specific situation of the treatment site particularly with reference to feed intake levels.

3.5.7 | Project developer may adjust default IPCC values for *VS* for a site-specific average animal weight. If so, it shall be well explained and documented. The following equation shall be used:

$$VS_{LT,y} = (VS_{rate,LT} \times \frac{TAM_{LT}}{1000}) \times nd_y \qquad \textit{Eq. 6}$$

Where:

$VS_{LT,y}$	=	Annual volatile solid excretions for livestock *LT* entering all animal waste management systems on a dry matter weight basis (kg-dm/animal/yr)
$VS_{rate,LT}$	=	Default VS excretion rate.
TAM_{LT}	=	Typical animal mass for livestock LT (kg/animal)
nd_y	=	Number of days treatment plant was operational in year *y*

3.5.8 | B_o or *VS* values applicable to developed countries can be used provided the following four conditions are satisfied:

i. The genetic source of the livestock originates from an Annex I Party;

ii. The farm uses formulated feed rations (*FFR*) which are optimized for the various animal(s), stage of growth, category, weight gain/productivity and/or genetics;

iii. The use of *FFR* can be validated (through on-farm record keeping, feed supplier, etc.);

iv. The project specific animal weights are more similar to developed country IPCC default values.

3.5.9 | In the case of sequential treatment stages, the reduction of the volatile solids during a treatment stage is estimated based on referenced data for different treatment types. Emissions from the next treatment stage are then calculated following the approach outlined above, but with volatile solids adjusted for the reduction from the previous treatment stages by multiplying by (1 - RVS), where RVS is the relative reduction of volatile solids from the previous stage. The relative reduction of volatile solids (RVS) depends on the treatment technology and should be estimated in a conservative manner. Default values for different treatment technologies can be found in the table in the Annex 3: Anaerobic unit process performance~~Annex 3: Anaerobic unit process performance~~.

3.5.10 |Methane Conversion Factors (MCF) values are determined for a specific manure management system and represent the degree to which Bo is achieved. Where available country-specific MCF values that reflect the specific management systems used in particular countries or regions shall be used. Alternatively, the IPCC default values provided in table 10.17 of 2019 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 Chapter 10 can be used. The site annual average temperature is taken from official data at the nearest

meteorological station, or from data available from historical on-site observations

3.5.11 |The annual average number of animals ($N_{LT,y}$) is determined as in *Eq. 2~~Eq. 2~~* above

B. Baseline emission from thermal application

3.5.12 |The Baseline emission from thermal application in year y shall be calculated as per the methods outlined below. Note that the methods below are only applicable where each unit (e.g., cook stove, heater) have a rated capacity equal to or less than 150 kW thermal[12].

a. Thermal application method 1: Based on avoided quantity of fuel consumption

$$BE_{TA,y} = \sum_{b,p} (N_{b,p,y} \times U_{p,y} \times (f_{NRB,i,y} \times SE_{b,y,CO2} + SE_{b,y,non-CO2})) \quad \textit{Eq. 7}$$

Where:

$BE_{TA,y}$	=	Baseline emissions for total project activity in year y (tCO_2e/yr)
$\sum_{b,p}$	=	Sum over all relevant baseline b/project p pairs
$N_{b,p,y}$	=	Number of project technology-days included in the project database for each project scenario in year y. The start date is the day a plant start producing biogas. A default of 2 weeks may be use for the period from installation date and start date.
$U_{p,y}$	=	Usage rate for technologies in project scenario p in year y (fraction)
$SE_{b,y,CO2}$	=	Specific CO_2 emissions for a baseline b technology in year y (tCO_2/technology*day)
$SE_{b,y,non-CO2}$	=	Specific non-CO_2 emissions for a baseline b technology in year y (tCO_2e/technology*day)
$f_{NRB,i,y}$	=	Fraction of biomass used in year y for baseline scenario b that can be established as non-renewable biomass (fraction). The parameter $f_{NRB,b,y}$ is excluded from this *Eq. 7~~Eq. 7~~* when the observed baseline fuel is fossil fuel.

[12] Projects that include thermal generation units with rated capacity greater than 150 kW or electricity generation component shall apply other applicable GS or CDM methodologies for energy generation and applications component.

3.5.13 |Specific emission CO_2 & non-CO_2 are determined by using one of the following options below, for each[13] baseline scenario b /project scenario p pair separately.

$$SE_{b,y,Co2} = \sum_i P_{b,i,y} \times NCV_{b,i,fuel} \times EF_{b,i,CO2} \quad \textit{Eq. 8}$$

$$SE_{b,y,non-Co2} = \sum_i P_{b,i,y} \times NCV_{b,fuel} \times EF_{b,i,non-CO2} \quad \textit{Eq. 9}$$

Where:

i	=	Index for the type of baseline/fossil fuel consumed
$P_{b,i,y}$	=	Average yearly consumption of baseline fuel *i* per household before the start of the project activity or at the renewal of each crediting period, whichever is later (tonnes/household/~~day~~year)
$NCV_{b,i}$	=	Net calorific value of the fuel(s) *i* that is substituted in baseline b (TJ/tonne)
$EF_{b,i,CO2}$	=	CO_2 emission factor arising from use of fuels *i* in baseline scenario (tCO_2/TJ)
$EF_{b,i,non-CO2}$	=	Non-CO_2 emission factor arising from use of fuels in baseline scenario (tCO_{2e}/TJ)

3.5.14 |$P_{b,i,y}$ may be determined via KPT survey or using number of persons served per household multiplied by default fuel consumption (if the baseline stoves are the conventional types) per person per year (parameter BGTA 20) in baseline scenario.

b. Thermal application method 2: Based on thermal energy generated using measured quantity of biogas

3.5.15 |The baseline emissions are calculated by multiplying the useful energy delivered by the biogas technologies with the emission factor of the baseline devices with their established fuel mix, with a cap defined in this document:

$$BE_{TA,y} = EG_{p,useful,y} \times EF_b \quad \textit{Eq. 10}$$

Where:

$BE_{TA,y}$	=	Baseline emissions (tCO_{2e}) in the year y
$EG_{p,useful,y}$	=	The amount of useful energy applied in the project in year y (TJ)

[13] In the baseline situation, there might be different types of fuel, stove technologies which must be identified as different baseline scenarios. Stacking fuel could be a baseline scenario, but it would be distinguished to the single fuel baseline situation.

EF_b = Baseline emissions factor (tCO_2e per TJ of useful energy)

3.5.16 |The baseline emissions factor is determined applying the equation below:

$$EF_b = \sum_k \left(\sum_{i,j} P_{b,i,j} \times Percentage\ of\ fuel\_i \times NCV_{b,i} \times (EF_{b,i,CO2} \times fNRB_{i,y} + EF_{b,i,non-CO2} \right)_k \div \sum_k \left(\sum_{i,j} P_{b,i,j} \times Percentage\ of\ fuel\_i \times NCV_{b,i} \times \eta_{b,i,j} \right)_k \quad \textit{Eq. 11}$$

Where:

EF_b	=	Baseline emissions factor (tCO_2e per TJ of useful energy)
$P_{b,i,j}$	=	Amount of baseline fuel *i* used in device *j* in the baseline (tonnes)
$EF_{b,i,CO2}$	=	CO_2 Emission factor of the baseline fuel *i* (tCO_2e/TJ)
$EF_{b,i,non-CO2}$	=	Non-CO_2 Emission factor of the baseline fuel *i* (tCO_2e/TJ)
$fNRB_{i,y}$	=	Non-renewability status of woody biomass fuel i during year y
$NCV_{b,i}$		The net calorific value of the baseline fuel type *i* (TJ/tonne)
$\eta_{b,i,j}$	=	Efficiency of baseline device *j* with fuel i (fraction)
$Percentage\ of\ fuel_i$	=	Percentage of fuel type i in the baseline situation (%).
k	=	Household *k* from the target population, where applicable
j	=	Baseline devices *j*
i	=	Baseline fuel *i*

3.5.17 |Useful thermal energy generated in the project activity is calculated as below:

$$EG_{p,useful,y} = \sum_d N_{b,p,y} \div 365 \times U_{p,y} \times Q_{biogas,d,y} \times NCV_{biogas} \times \eta_{p,d,y}/1000 \quad \textit{Eq. 12}$$

Where:

$EG_{p,useful,y}$	=	Quantity of useful thermal energy generated by biogas in the project in year *y* (TJ)
$Q_{biogas,d,y}$	=	The volume of biogas used in the project by device d in year y (m^3).

NCV_{biogas} = Net calorific value of the biogas (GJ/unit mass or volume, dry basis). Use default value: 0.02154 GJ/m^3 biogas (calculating from NCV of the methane: 0.0359 GJ/m^3 multiply with default methane content in biogas: 60%)

$\eta_{p,d,y}$ = Thermal efficiency of the project device (fraction)

3.6 | Project emissions

A. Project emission from AWMS system

3.6.1 | The project developer shall apply the project emission calculation as per the method 1 or 2 selected for baseline emission calculation.

a. AWMS method 1 (IPCC 2019 TIER 1 approach)

3.6.2 | The project emissions involve emissions from the biodigester, which include:

a. Physical leakage biogas

b. Emissions from the use of fossil fuels or electricity for the operation

$$PE_{AWMS,y} = PE_{PL,y} + PE_{power,y} \quad \textit{Eq. 13}$$

Where:

$PE_{AWMS,y}$ = Project emissions in year y (t CO_2e)

$PE_{PL,y}$ = Emissions due to physical leakage of biogas in year y (t CO_2e)

$PE_{power,y}$ = Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year *y* (t CO_2e)

3.6.3 | The physical leakage from biodigesters is calculated as 10% of the maximum methane producing potential of the manure fed into the management systems implemented by the project activity, as per the following equation:

Eq. 14

$$PE_{PL,y} = 0.10 \times N_{b,p,y} \div 365 \times U_{p,y} \times GWP_{CH4} \times D_{CH4} \times \sum_{k} \sum_{i,LT} B_{0,LT} \times N_{LT,y} \times VS_{LT,y} \times MS\%_{i,y}$$

Where:

$PE_{PL,y}$ = Project emissions from physical leakage in year y (t CO_2e)

GWP_{CH4} = Global Warming Potential (GWP) of CH4 applicable to the crediting period.

D_{CH4} = CH4 density (0.00067 t/m3 at room temperature (20 ºC) and 1 atm pressure)

LT = Index for all types of livestock

i	=	Index for animal manure management system
k	=	Climate region k
$B_{0,LT}$	=	Maximum methane producing potential of the volatile solid generated for animal type LT.
$MS\%_{i,y}$	=	Fraction of manure handled in project animal manure management system i

3.6.4 | Emissions from use of fossil fuels or electricity for operation of the AWMS shall be determined via UNFCCC Methodological tool "Tool 03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" and "Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"

b. AWMS method 2 (IPCC 2019 TIER 2 approach)

3.6.5 | Project activity emissions consist of:

a. Physical leakage of biogas in the manure management systems which includes production, collection and transport of biogas to the point of flaring/combustion or gainful use ($PE_{PL,y}$);

b. CO_2 emissions from use of fossil fuels or electricity for the operation of all the installed facilities ($PE_{power,y}$);

c. CO_2 emissions from incremental transportation distances;

d. Emissions from the storage of manure before being fed into the anaerobic digester ($PE_{storage,y}$).

The project developer may exclude any source of emissions that are not applicable to the project activity.

$$\boldsymbol{PE_{AWMSy} = PE_{PL,y} + PE_{power,y} + PE_{transp,y} + PE_{storage,y}} \qquad \textit{Eq. 15}$$

Where:

$PE_{AWMS,y}$	=	Project emissions in year y (t CO_2e)
$PE_{PL,y}$	=	Emissions due to physical leakage of biogas in year y (t CO_2e)
$PE_{power,y}$	=	Emissions from the use of fossil fuel or electricity for the operation of the installed facilities in the year y (t CO_2e)
$PE_{transp,y}$	=	Emissions from incremental transportation of input manure for the digesters in the year y (t CO_2e)
$PE_{storage,y}$	=	Emissions from the storage of manure (t CO_2e)

3.6.6 | Project emissions due to physical leakage of biogas from the animal manure management systems used to produce, collect and transport the biogas to the point of flaring or gainful use are estimated as:

3.6.7 | 10% of the maximum methane producing potential of the manure fed into the management systems implemented by the project activity as per the *Eq. 14*, above.

3.6.8 | Optionally, the relevant procedure in the methodological tool "TOOL 14 Project and leakage emissions from anaerobic digesters" (may be followed. In such a case, $PE_{PL,y}$ is equivalent to PECH4,y in the tool.

3.6.9 | Project emissions from electricity and fossil fuel consumption are determined by following the methodological tool "Project and leakage emissions from anaerobic digesters" (TOOL 14) , where $PE_{Power,y}$ is the sum of $PE_{EC,y}$ and $PE_{FC,y}$ in the tool.

3.6.10 |Project emissions due to incremental transport distances are calculated based on the incremental distances between:

a. The collection points of manure and the digestion site as compared to the baseline manure treatment site;

b. Treatment sites and the sites for soil application, landfilling and further treatment of the residual waste.

$$PE_{transp,y} = EF_{CO2,transport} \times [(Q_y/CT_y) \times DAF_w + (Q_{res\cdot waste,y}/CT_{res\cdot waste,y}) \times DAF_{res\cdot waste}] \quad \text{Eq. 16}$$

Where:

Q_y	=	Quantity of raw manure treated in the year y (tonnes)
CT_y	=	Average truck capacity for transportation (tonnes/truck)
DAF_w	=	Average incremental distance for raw manure transportation (km/truck)
$EF_{CO2,transport}$	=	CO_2 emission factor from fuel use due to transportation ($kgCO_2$/km, IPCC default values or local values may be used)
$Q_{res\cdot waste,y}$	=	Quantity of residual waste produced in year y (tonnes)
$CT_{res\cdot waste,y}$	=	Average truck capacity for residual waste transportation (tonnes/truck)
$DAF_{res\cdot waste}$	=	Average distance for residual waste transportation (km/truck)

3.6.11 |Project emissions on account of storage of manure before being fed into the anaerobic digester shall be accounted for if both condition (a) and condition (b) below are satisfied:

a. The storage time of the manure after removal from the animal barns, including transportation, exceeds 24 hours before being fed into the anaerobic digester;

b. The dry matter content of the manure when removed from the animal barns is less than 20%.

3.6.12 |The following method shall be used to calculate project emissions from manure storage:

$$PE_{storage} = GWP_{CH4} \times D_{CH4} \times \sum_{LT,l}\left[\frac{365}{AI_l} \times \sum_{d=1}^{AI}\left(N_{LT} \times VS_{LT,d} \times MS\%_l \times \left(1 - e^{-k(AI_l - d)}\right) \times MCF_i \times B_{0,LT}\right)\right] \quad \text{Eq. 17}$$

Where:

$PE_{storage}$	=	Project emissions on account of manure storage in year y (t CO_2e)
AI_l	=	Annual average interval between manure collection and delivery for treatment at a given storage device l (days)
$VS_{LT,d}$	=	Amount of volatile solid production by type of animal LT in a day (kg VS/head/d)
$MS\%_l$	=	Fraction of volatile solids (%) handled by storage device l
k	=	Degradation rate constant (0.069)
d	=	Days for which cumulative methane emissions are calculated; d can vary from 1 to 45 and to be run from 1 up to AI_l
MCF_l	=	Annual methane conversion factor for the project manure storage device l from Table 10.17, Chapter 10, Volume 4

B. Project emission from thermal application

a. Thermal application method 1: Based on avoided quantity of fuel consumption

3.6.13 |The Project emission from thermal application in year y shall be calculated as follows:

$$PE_y = \sum_{b,p}\left(N_{b,p,y} \times U_{p,y} \times \left(f_{NRB,i,y} \times SE_{p,y,CO2} + SE_{p,y,non-CO2}\right)\right) \quad \text{Eq. 18}$$

Where:

PE_y	=	Project emissions for total project activity in year y (tCO_2e/yr)
$\sum_{b,p}$	=	Sum over all relevant baseline b/project p pairs
$N_{b,p,y}$	=	Number of project technology-days included in the project database for each project scenario in year y

$U_{p,y}$	=	Usage rate for technologies in project scenario p in year y (fraction)
$SE_{p,y,CO2}$	=	Specific CO_2 emissions for a project p technology in year y (tCO_2/technology*day)
$SE_{p,y,non-CO2}$	=	Specific non-CO_2 emissions for a project p technology in year y (tCO_2e/technology*day)
$f_{NRB,i,y}$	=	Fraction of biomass used in year y for project scenario p that can be established as non-renewable biomass (fraction). The parameter $f_{NRB,p,y}$ is excluded from this Eq. 18~~Eq. 18~~ when the observed project additional fuel is fossil fuel.

3.6.14 |Specific emission CO_2 & non-CO_2 are determined below, for each baseline b /project p pair separately.

$$SE_{p,y,Co2} = \sum_i P_{p,i,y} \times NCV_{p,i,fuel} \times EF_{p,i,fuel,CO2} \quad \text{Eq. 19}$$

$$SE_{p,y,non-Co2} = \sum_i P_{p,i,y} \times NCV_{p,fuel} \times EF_{p,i,fuel,non-CO2} \quad \text{Eq. 20}$$

Where:

i	=	Index for the type of project/fossil fuel consumed
$P_{p,i,y}$	=	Average ~~daily~~ yearly consumption of project fuel i per household (tonnes/household/~~day~~year)
$NCV_{p,i,fuel}$	=	Net calorific value of the fuel(s) i that is used in project p (TJ/tonne)
$EF_{p,i,fuel,CO2}$	=	CO_2 emission factor arising from use of fuels i in project scenario (tCO_2/TJ)
$EF_{p,i,fuel,non-CO2}$	=	Non-CO_2 emission factor arising from use of fuels in baseline scenario (tCO_2e/TJ)

3.6.15 |$P_{p,i,y}$ shall be determined via KPT survey.

b. Thermal application method 2: Based on thermal energy generated using measured quantity of biogas

3.6.16 |In case the project developer follows Option 2 for thermal application then no project emission is considered for thermal application under the project activity.

3.7 | Leakage emissions

A. Animal waste management system

3.7.1 | AWMS method 1 The proper soil application (which not resulting in methane emissions) of the digestate shall be verified on a sampling basis following the Requirements in the "Standard for sampling and surveys for CDM project activities and programme of activities".

3.7.2 | AWMS method 2, if digestate is being stored under anaerobic conditions, it can cause CH_4 emissions due to further anaerobic digestion of the residual biodegradable organic matter. The leakage emission shall be determined by following the relevant procedure in the Methodological tool 14 "Project and leakage emissions from anaerobic digesters". If soil application of the digestate is applied, it shall be verified on a sampling basis following the Requirements in the "Standard for sampling and surveys for CDM project activities and programme of activities".

B. Thermal application

3.7.3 | For all of the preceding methods, leakage emissions, $LE_{p,y}$, shall be determined following one of two options below.

3.7.4 | Option 1 - Apply a default adjustment factor of 0.95 to the emission reductions to approximate leakage emissions for thermal application.

3.7.5 | Option 2 - The project developer must evaluate the following potential sources of leakage and provide an evidence-based description and preliminary quantification of each potential source and its relevance for the project:

a. The displaced baseline technologies are reused outside the project boundary in place of lower emitting technology or with a higher intensity than would have occurred in the absence of the project.

b. Members of the population who do not participate in the project, and previously used lower emitting energy sources, instead use the non-renewable biomass or fossil fuels saved under the project activity.

c. The project significantly reduces the NRB fraction within an area where other GHG mitigation project activities account for NRB fraction in their baseline scenario.

d. The project population compensates for loss of the space heating effect of inefficient technology by adopting some other form of space heating or by retaining some use of inefficient technology.

e. By virtue of promotion and marketing of a new technology, the project stimulates substitution with this technology by households who commonly used a technology with relatively lower emissions.

3.7.6 | For each source for which the leakage assessment expects an increase in fuel consumption by non-project households/users attributable to the project activity, then calculations must be undertaken to account for the leakage from

this source. Leakage is either calculated as a quantitative emissions volume (tCO_2e) or as a percentage of total emission reductions. The project documentation shall include a projection of leakage emissions based on available data and information. The monitoring plan must include monitoring parameters to be registered during the leakage investigation every two years to populate the leakage calculation.

3.7.7 | The project developer must conduct a leakage investigation every two years using relevant methods. Surveys to determine parameters for the leakage calculation may be combined with project monitoring surveys, as is applicable.

3.8 | Emission reductions

3.8.1 | The emission reductions for each of the component (AWMS and thermal energy) are calculated separately as follows:

$$ER_y = BE_y - PE_y - LE_y \qquad \textit{Eq. 21}$$

Where:

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

3.8.2 | The total emission reduction from project activity will be the sum of emission reductions from each component i.e., AWMS and Thermal energy.

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

3.9.1 | When the project developers apply for crediting period renewal, the baseline fuel consumption must be reassessed, in addition to other relevant methodological parameters as per the latest version of the methodology available at the time submission of renewal of crediting period and GS4GG crediting period renewal requirements.

3.10 |General requirements for data and information sources

3.11 |Data and parameters not monitored

Data/parameter ID	BGTA 1
Data / Parameter:	Avoidance of double counting or double claiming among project participants
Data unit:	NA
Description:	Evidence of avoidance of double counting or double claiming with other parties directly involved with the project or programme.

Source of data:	Written assertions with the project developer of the ownership rights and intention of selling the emission reductions resulting from the project activity directed at or signed with all the applicable parties of the following: - all other project participants; - project technology producers; and - retailers of the project technology or the renewable fuel.
Any comment:	Any written assertions not available at validation shall be included as a FAR and be provided and verified at the time of first verification.

Data/parameter ID	**BGTA 2**
Data / Parameter:	Avoidance of double counting or double claiming with other mitigation actions
Data unit:	NA
Description:	Review and analysis of mitigation actions in other voluntary market or UNFCCC/compliance mechanisms
Source of data:	Using publicly available information from Gold Standard and other voluntary standards, at a minimum Verra and any recognized national or regional standards in the project location, and UNFCCC CDM project & PoA database: - identify and list any mitigation actions of similar technology, ~~i.e.~~i.e., that provide the same kind of output and use the same kind of equipment or conversion process, operating in overlapping spatial boundaries. If one or more are identified: - describe the practices that will be implemented to ensure that the programme or project activity quantifies emission reductions only from technology it has implemented, - describe the practices to avoid that the programme or project activity implementation displaces technology of other mitigation actions, and - design a method to discount emission reductions in case the programme or project activity is found to displace or operate alongside another mitigation action.
Any comment:	Undertake at the time of project design review and VPA inclusion review. VVB shall validate the information reported by the project and report findings and opinion specifically on this point in the validation or verification report.

Data/parameter ID	BGTA 3
Data / Parameter:	Regulatory framework for provision of animal waste management and thermal energy services
Data unit:	NA
Description:	Evidence that the project does not undermine or conflict with any national, sub-national or local regulations or guidance for thermal energy supply/devices or fuel supply or use
Source of data:	List and provide a summary of any national, sub-national and local regulations or guidance for provision of thermal energy services/devices of the type the project provides in the project boundary, including any tariff requirements. Describe how the project complies with the regulatory framework.
Any comment:	Undertake at the start of each crediting period.

Data/parameter ID	BGTA 4
Data / Parameter:	Project technology description
Data unit:	NA
Description:	The detailed description of the project technology (including both biodigester and biogas stove) shall include as a minimum: - manufacturer name (if applicable), - product name (if applicable), - technology type, - capacity characteristics (e.g., volume of digester[14]), - continuous useful energy output demonstration, - rated thermal efficiency of biogas stove - Any performance certifications from national standards body or certification body recognised by national standards body also shall be provided.
Source of data:	Any of the following sources shall be used: - Manufacturer specifications - Certifications by national standards body or an appropriate certification party recognised by national standards body - Commercial guarantee - Technical reports from the installer

[14] A technical measure to ensure that the gas holding capacity of the biodigester is sufficiently large to capture the biogas during periods of non-usage. A justification to demonstrate compliance with this requirement pertaining to the biogas digester size shall be included in the PDD.

	Professional opinion or expert opinion is not accepted as a source for this parameter.
Any comment:	For any information not available at the time of validation, validating VVB shall include a FAR. Project developer shall provide this information to verifying VVB before completion of 1st verification report. No issuance shall be requested for project technologies for which the project technology details are not verified by the verifying VVB prior to completion of verification report.

Data/parameter ID	**BGTA 5**
Data / Parameter:	Expected technical life of project technology
Data unit:	Operating hours (e.g., "5,500 hours") or time period (e.g., "ten years")
Description:	The expected technical life of an individual project technology shall be defined in the PDD.
Source of data:	Fixed and recorded at the time of registration or distribution Any of the following sources shall be used: - Manufacturer specifications - Certification by national standards body or an appropriate certification party recognised by national standards body - Commercial guarantee or Guarantee from the installer - Field studies from similar project/technology. Professional opinion or expert opinion is not accepted as a source for this parameter.
Any comment:	If the expected or remaining technical life of project technology is shorter than the crediting period, describe measures to ensure that end users are provided or can purchase replacement technology of comparable service and quality level at the end of the technical life, by either - replacing with comparable or better technology, or - retrofitting essential parts with performance guarantee. The project shall ensure that the units are replaced or retrofitted at the end of their technical life within a valid crediting period to continue claiming emission reductions. However, a new project or programme cannot be registered for replacement/retrofitted project devices.

Data/parameter ID	**BGTA 6**
Data / Parameter:	Baseline scenario survey results

Data unit:	NA
Description:	Report of the results of the baseline scenario survey
Source of data:	The report presents the results of the Baseline Scenario Survey, described in section 4.3 |Baseline scenario survey, relevant for the baseline scenario definition.
Any comment:	Undertake at the start of the first crediting period.

Data/parameter ID	**BGTA 7**
Data / Parameter:	GWP_{CH4}
Data unit:	tCO_{2e} per tCH_4
Description:	Global Warming Potential (GWP) of methane applicable to the crediting period
Source of data:	IPCC
Any comment:	25 using IPCC AR4 report and 28 using IPCC AR5 report. It shall be updated according to any future COP/MOP decisions.

a. Parameters related to AWMS

Data/parameter ID	**BGTA 8**
Data / Parameter:	$MS\%_{Bl,j}$
Data unit:	%
Description:	Fraction of manure handled in baseline animal manure management system j
Source of data:	$MS\%_{Bl,j}$ values shall be determined in following preference order: a. Country-specific $MS\%_{Bl,j}$ values – Where available country-specific $MS\%_{Bl,j}$ values that reflect the specific management systems used in particular countries or regions shall be used (AWMS method 2). b. Default values from table 10.A.6, 10.A.7, 10.A.8 and 10.A.9 of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 IPCC Guidelines for National Greenhouse Gas Inventories (AWMS method 1).
Any comment:	Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 9**
Data / Parameter:	EF_{LT}
Data unit:	$kgCH_4$ per animal per year for livestock type LT

Description:	Animal manure methane emission factor by average temperature
Source of data:	Default values from table 10.14 of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 IPCC Guidelines for National Greenhouse Gas Inventories, (kg CH_4 / kg VS).
Any comment:	Applicable for AWMS method 1

Data/parameter ID	**BGTA 10**
Data / Parameter:	$VS_{rate,LT}$
Data unit:	kg VS / (1000 kg animal mass) / day
Description:	Default Volatile solids production/excretion rate per animal of livestock LT in year y.
Source of data:	Method – 1 – IPCC Default Values Method – 2 – Country specific values or IPCC default, if country specific default not available, apply IPCC default Default values from table 10.13A of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 IPCC Guidelines for National Greenhouse Gas Inventories (kg VS / (1000 kg animal mass) / day) The calculation is a simple linear adjustment, so in the case of an animal that is 500 kg of weight, the VS emission rate will be half of the rate presented per 1000 kg live weight.
Any comment:	Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 11**
Data / Parameter:	$B_{0,LT}$
Data unit:	m^3 CH_4/kg-dm
Description:	Maximum methane production potential of the volatile solid generated for animal type LT
Source of data:	The maximum methane-producing capacity of the manure (B_o) varies by species and diet and shall be determined in following preference order: a. Country-specific Bo values - The preferred method to obtain Bo measurement values is to use data from country-specific published sources, measured with a standardised method (Bo shall be based on total as-excreted VS). These values shall be compared to IPCC

	default values and any significant differences shall be explained. b. IPCC default Bo θ values - If country specific Bo values are not available, default values from tables 10.16 of 2019 IPCC Guidelines for National Greenhouse Gas Inventories volume 4 Chapter 10 can be used, provided that the project participants assess the suitability of those data to the specific situation of the treatment site; (m^3 CH_4/kg-dm).
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 12**
Data / Parameter:	$MCF_{j,k}$
Data unit:	%
Description:	Annual methane conversion factor (MCF) for the baseline animal manure management system by climate region *k*
Source of data:	Methane Conversion Factors (MCF) values are determined for a specific manure management system and represent the degree to which Bo is achieved. MCF values shall be determined in following preference order: a. Country-specific MCF values - Where available country-specific MCF values that reflect the specific management systems used in particular countries or regions shall be used. b. IPCC default MCF values - Alternatively, the IPCC default values provided in table 10.17 of *2019 IPCC Guidelines* for National Greenhouse Gas Inventories Volume 4 Chapter 10 can be used. The site annual average temperature is taken from official data at the nearest meteorological station, or from data available from historical on-site observations
Any comment:	Applicable for AWMS method 2

b. Parameters related to Thermal application

Data/parameter ID	**BGTA 13**
Data / Parameter:	$EF_{b,i,CO2}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor arising from use of fuels in baseline scenario
Source of data:	**Wood**: Methodology default, 112 tCO_2/TJ **Charcoal**: Methodology default, 112 tCO_2/TJ (combustion only)

	Methodology default, 165.22 tCO_2/TJ (includes charcoal production emissions) Methodology cap, 197.15 tCO_2/TJ (includes charcoal production emissions) **Other fuels**: IPCC defaults When emissions from fuel production, transport, and similar are included to determine a project-specific emission factor, then the following shall apply as well: - The project boundary must include these processes - Avoidance of double counting considerations (see two parameter tables) must cover all steps in the project boundary - The determination of the specific emissions from these sources is fully documented and evidenced in the PDD These provisions may be applied to include the actual GHG emissions happening upstream in charcoal production in the charcoal emission factor; however, emission factors higher than the methodology cap are not permitted.
Any comment:	Charcoal should apply the emission factor for charcoal fuel. This parameter is used to calculate $SE_{b,y,CO2}$ Applicable for Thermal application method 1 and Thermal application method 2

Data/parameter ID	**BGTA 14**
Data / Parameter:	$EF_{b,i,non-CO2}$
Data unit:	tCO_2/TJ
Description:	Non-CO_2 emission factor arising from use of fuels in baseline scenario
Source of data:	**Wood**: Methodology default: - 9.46 tCO_2e/TJ (AR5 GWP) or - 8.692 tCO_2e/TJ (AR4 GWP) **Charcoal**: Methodology defaults: - 5.865 tCO_2e/TJ (AR5 GWP) (combustion only) - 44.83 tCO_2e/TJ (AR5 GWP) (includes charcoal production emissions), - Methodology cap: 92.29 tCO2e/TJ (AR5 GWP) (includes charcoal production emissions) - or - 5.298 tCO_2e/TJ (AR4 GWP) (combustion only) - 40.26 tCO_2e/TJ (AR4 GWP) (includes charcoal production emissions)

	- Methodology cap: 82.90 tCO_2e/TJ (AR4 GWP) (includes charcoal production emissions) **Other fuels**: Any of the following, in order of preference: - IPCC defaults - project-specific field tests prior to first verification by a qualified entity that is certified or accredited by National Standards body - project-relevant measurement reports by qualified entities - national defaults - credible published literature for the project area If either project-specific or project-relevant results are used, these must be cross-checked with IPCC defaults and differences shall be justified using evidence. When emissions from fuel production, transport, and similar are included to determine a project-specific emission factor, then the following shall apply as well: - The project boundary must include these processes - Avoidance of double counting considerations (see two parameter tables) must cover all steps in the project boundary - The determination of the specific emissions from these sources is fully documented and evidenced in the PDD These provisions may be applied to include the actual GHG emissions happening upstream in charcoal production in the charcoal emission factor; however, emission factors higher than the methodology cap are not permitted.
Any comment:	This parameter is used to calculate $SE_{b,y,non-CO2}$ If the emission factor is expressed in tonnes of CH_4 or N_2O, it shall be converted to tCO_2e using the applicable GWP and this shall be documented in the PDD. Applicable for Thermal application method 1 and Thermal application method 2

Data/parameter ID	BGTA 15
Data / Parameter:	$EF_{p,i,CO2}$
Data unit:	tCO_2/TJ
Description:	CO_2 emission factor arising from use of fuels in project scenario
Source of data:	**Wood**: Methodology default, 112 tCO_2/TJ

	Charcoal: Methodology default, 112 tCO_2/TJ (combustion only) Methodology default, 165.22 tCO_2/TJ (includes charcoal production emissions) Methodology cap, 197.15 tCO_2/TJ (includes charcoal production emissions) **Other fuels**: - IPCC defaults When emissions from fuel production, transport, and similar are included to determine a project-specific emission factor, then the following shall apply as well: - The project boundary must include these processes - Avoidance of double counting considerations (see two parameter tables) must cover all steps in the project boundary - The determination of the specific emissions from these sources shall be fully documented and evidenced in the PDD These provisions may be applied to include the actual GHG emissions happening upstream in charcoal production in the charcoal emission factor; however, emission factors higher than the methodology cap are not permitted. If emissions of this nature are included in the baseline emission factor, then they shall also be included in the project emission factor.
Any comment:	This parameter is used to calculate $SE_{p,y,CO2}$ This has same value as $EF_{b,i,fuel,CO2}$ in projects which reduce use of the same fuel. Applicable for Thermal application method 1

Data/parameter ID	BGTA 16
Data / Parameter:	$EF_{p,i,non-CO2}$
Data unit:	tCO_2/TJ
Description:	Non-CO_2 emission factor arising from use of fuels in project scenario
Source of data:	Wood: Methodology default: - 9.46 tCO_2e/TJ (AR5 GWP) or - 8.692 tCO_2e/TJ (AR4 GWP) Charcoal: Methodology defaults: - 5.865 tCO_2e/TJ (AR5 GWP) (combustion only) - 44.83 tCO_2e/TJ (AR5 GWP) (includes charcoal production emissions),

	- Methodology cap: 92.29 tCO_2e/TJ (AR5 GWP) (includes charcoal production emissions) - or - 5.298 tCO_2e/TJ (AR4 GWP) (combustion only) - 40.26 tCO_2e/TJ (AR4 GWP) (includes charcoal production emissions) - Methodology cap: 82.90 tCO_2e/TJ (AR4 GWP) (includes charcoal production emissions) Other fuels: Any of the following, in order of preference: - IPCC defaults, - project-specific field tests prior to first verification by a qualified entity that is certified or accredited by National Standard body - project-relevant measurement reports by qualified entities, - national defaults - credible published literature for the project area, If either project-specific or project-relevant results are used, these must be cross-checked with IPCC defaults and differences shall be justified using evidence. When emissions from fuel production, transport, and similar are included to determine a project-specific emission factor, then the following shall apply as well: - The project boundary must include these processes - Avoidance of double counting considerations (see two parameter tables) must cover all steps in the project boundary - The determination of the specific emissions from these sources is fully documented and evidenced in the PDD - The determination of the specific emissions from these sources shall be fully documented and evidenced in the PDD. These provisions may be applied to include the actual GHG emissions happening upstream in charcoal production in the charcoal emission factor; however, emission factors higher than the methodology cap are not permitted. If emissions of this nature are included in the baseline emission factor, then they shall also be included in the project emission factor.
Any comment:	This parameter is used to calculate $SE_{p,y,non-CO2}$ Applicable for Thermal application method 1

Data/parameter ID	**BGTA 17**
Data / Parameter:	$NCV_{b,i}$

Data unit:	TJ/ton
Description:	Net calorific value of the fuels used in the baseline
Source of data:	Wood: Methodology default, 0.0156 TJ/ton Charcoal: Methodology default, 0.0295 TJ/ton Other fuels: - IPCC defaults - project-specific testing by a qualified entity that is certified or accredited - project-relevant measurement reports by a qualified entity If either project-specific or project-relevant results are used, these must be cross-checked with IPCC defaults and differences shall be justified using evidence.
Any comment:	The methodology default emission factor must be applied when the methodology default NCV is applied. This parameter is used to calculate $SE_{b,y,CO2}$ and $SE_{b,y,non-CO2}$ Applicable for Thermal application method 1 and Thermal application method 2

Data/parameter ID	**BGTA 18**
Data / Parameter:	$NCV_{p,i}$
Data unit:	TJ/ton
Description:	Net calorific value of the fuels used in the project
Source of data:	Wood: Methodology default, 0.0156 TJ/ton Charcoal: Methodology default, 0.0295 TJ/ton Other fuels: - IPCC defaults - project-specific testing by a qualified entity that is certified or accredited - project-relevant measurement reports by a qualified entity If either project-specific or project-relevant results are used, these must be cross-checked with IPCC defaults and differences shall be justified using evidence.
Any comment:	The methodology default emission factor must be applied when the methodology default NCV is applied. This parameter is used to calculate $SE_{p,y,CO2}$ and $SE_{p,y,non-CO2}$ Applicable for Thermal application method 1

Data/parameter ID	**BGTA 19**

Data / Parameter:	NCV_{biogas}
Data unit:	GJ/m^3
Description:	Net calorific value of the biogas (GJ/unit mass or volume, dry basis)
Source of data:	Use default value: 0.0215 GJ/m^3 biogas (assuming NCV of the methane: 0.0359 GJ/m^3, default methane content in biogas: 60%)
Any comment:	Applicable for Thermal application method 2

Data/parameter ID	**BGTA 20**
Data / Parameter:	$P_{b,i,y}$
Data unit:	tonnes/household/year
Description:	Average yearly consumption of baseline fuel i per household before the start of the project activity or at the renewal of each crediting period, whichever is later
Source of data:	KPT or default value For conventional baseline stove Default factor of 0.5 tonnes of fuel wood/capita/year and 0.13 tonnes of charcoal/capita/year may be used. The default per capita fuel consumption values shall be multiplied with average number of persons served per household. Provide evidence that this is coherent with the information on target population characteristics, baseline technology use & fuel consumption using evidence from at least one of the following sources: - baseline survey, - Credible published literature for project region, - Studies by academia, NGOs or multilateral institutions, or - Official government publications or statistics Source applied must not be more than 3 years old; further, cross-check with older sources may be used provided they give conservative results (for example, an older source shows that in the past, there was a higher per-capita fuel consumption).
Any comment:	At the start of crediting period (fixed for one crediting period) If the values resulting from the baseline KPTs are higher than the following **threshold value** (on equivalent terms), then the results shall be further substantiated by independent third-party studies that are specific to the project region, including but not limited to government publications, peer-reviewed literature, third party assessments (for example – WISDOM, FAO, UN and similar organizations) and/or official data or statistics about

	cooking technologies and fuel use. In any case, the value applied shall not be higher than the **cap value** (on equivalent terms). **Threshold value**: 0.75 tonnes/person*year of fuelwood and 0.195 tonnes/person*year of charcoal **Cap value**: 0.95 tonnes/person*year of fuelwood and 0.25 tonnes/person*year of charcoal Applicable for Thermal application method 1 and Thermal application method 2

Data/parameter ID	**BGTA 21**
Data / Parameter:	$Percentage\ of\ fuel\_i$
Data unit:	%
Description:	Percentage of fuel type i in the baseline situation.
Source of data:	Provide evidence that this is coherent with the information on target population characteristics, baseline technology use & fuel consumption using evidence from at least one of the following sources: - baseline survey, - Credible published literature for project region, - Studies by academia, NGOs or multilateral institutions, or - Official government publications or statistics Source applied must not be more than 3 years old; further, cross-check with older sources may be used provided they give conservative results
Any comment:	Applicable for Thermal application method 2

Parameter ID	**BGTA 22**
Data/Parameter:	$\eta_{b,i,j}$
Data unit:	Fraction
Description:	Efficiency of baseline device j with fuel i (fraction)
Source of data:	The efficiency of baseline stove(s) shall be established following any of the below options: a. **Default values:** The following default values may be applied for this parameter and for cases when it is not possible to conduct efficiency tests. – Three-stone fire or a conventional system for woody biomass lacking improved combustion air supply mechanism and flue gas ventilation system, that is without either a grate or a chimney: default efficiency 10%.

	– Other conventional systems using woody biomass: default efficiency 20% – Improved cookstoves: manufacturer specification, or if not available, default efficiency 30% – Fossil fuel combusting system: manufacturer specification, if available. b. **Sample testing:** The baseline stove efficiency may be established based on water boiling test (WBT) conducted on randomly selected sample stoves following. The WBT shall be carried out in accordance with national standards (if available) or international standards or guidelines (e.g., the WBT Protocol[15,16] or ISO 19867-1 listed by Clean Cooking Alliance and available at: https://cleancookingalliance.org/research-evidence-learning/standards-testing/protocols/) At minimum, a sample test on three stoves with three tests conducted for each baseline stove type by a recognised certification body. c. **Published third party reference:** The baseline stove(s) efficiency may be applied from; – Credible published literature, or – Studies by academia, NGOs or multilateral institutions, – Official government publications or statistics, Source applied must not be more than 3 years old and shall be relevant to the project region and baseline technology.
Any comment:	Applicable for Thermal application method 2

Data/parameter ID	**BGTA 23**
Data / Parameter:	$\eta_{p,d,y}$
Data unit:	%
Description:	Thermal efficiency of the project device
Source of data:	Literature, manufacturer data
Any comment:	Applicable for Thermal application method 2

[15] The project developer may conduct only the first two phases of the stove tests: cold-start high-power phase and hot-start high-power phase (not including the simmer phase) for calculation of the high-power thermal efficiency.

[16] The guidance provided in the WBT protocol may be followed for calibration of testing equipment.

4| Monitoring methodology

4.1 | Monitoring data and information requirements

4.1.1 | Following data shall be monitored and recorded during project crediting period:

4.1.2 | **Total sales or dissemination record:** The project developer must maintain an accurate and complete sales record. In projects with non-commercial distribution or dissemination practice, maintain an accurate and complete "dissemination record" or "installation record." In the case the project involves sale of a renewable fuel, the record tracks quantities of the fuel sold. The record must be maintained continuously and backed up electronically.

The required data for each project unit is:

1. Date of installation
2. Geographic area of sale
3. Model/type of project technology sold
4. Quantity of project technologies sold
5. Name and telephone number (if available), and address and/or GPS coordinates:
    a. Required for all bulk purchasers, i.e., retailers and industrial users;
    b. Required for all end users, e.g., households
6. Mode of use: domestic, institutional commercial, other.

4.1.3 | **Project Database:** The project database lists all the project technology units (biodigesters) that have been installed, sold or distributed by the project and have not surpassed their technical life. It is derived from the total installation, sales record (or dissemination record in case of non-commercial distribution) and must be maintained continuously.

4.1.4 | Within the database, project technologies units are labelled, at a minimum, with their corresponding project scenario p and their date of sale/dissemination.

4.1.5 | **Project Surveys:** The project surveys include the usage survey ($U_{p,y}$) (**BGTA 25**), and the baseline and project performance field tests (BFT and PFT if the Thermal application method 1: Based on avoided quantity of fuel consumption~~Thermal application method 1: Based on avoided quantity of fuel consumption~~ is selected). The general requirements for these are described here.

- The project surveys have the same sample sizing and data collection guidelines as the baseline scenario survey. Refer to section 4.3 |.
- The project surveys are only conducted with end users representative of the project scenario and currently using the project technology (except

for the case of a renewal of the crediting period which requires a re-assessment of the baseline fuel consumption).

- The project surveys can be conducted with usage survey participants that are currently using the project technology.

4.1.6 | **Usage Survey ($U_{p,y}$):** The objective of the usage survey is to provide a single usage parameter from the total distribution for project technologies in the Project Database. The selected samples should take into account possible stratification of the population according to the biogas digester types . Monitoring of usage of the biogas systems shall be following the requirement in BGTA 25.

4.1.7 | The usage survey must be conducted with the whole population so that the age group monitoring is not required .

4.1.8 | **Field Tests:** The baseline and project performance field tests (BFT and PFT) measure real, observed technology performance in the field. When Option 1 (based on avoided quantity of fuel consumption) is applied, a field test is carried out both for baseline[17] and project scenarios, either by testing a paired sample (baseline and project performance measured for same subjects) or by testing an independent sample (different subjects for baseline and project scenarios).

4.1.9 | The approach taken to conduct the performance tests must be such that:

- it is transparent and can easily be replicated,
- it is evidently conservative,
- the sample is randomly selected so as to not introduce a material bias, other sampling approaches as per "Standard for sampling and surveys for CDM project activities and programme of activities" may be followed.
- and the impact of daily and seasonal variations on the expected average fuel consumption savings is accounted for.

4.1.10 |The project developer must design the field test to ensure monitoring is representative of technology and fuel use practices. It must be made explicit to the households/institutions that they must behave and consume fuel normally, using the technologies they normally use.

- For example, participants must be asked to cook typical meals during the study period, include primary and secondary stoves and fuels, exclude large parties or infrequent cooking events, and match cooking tasks in the BFT and the PFT. Participants should never be influenced to use a specific stove or fuel during the study, nor deviate from typical stove and fuel practices.

[17] The default value for baseline scenario could be applied following the guidance for parameter BGTA 20~~BGTA 20~~

4.1.11 |The detailed instructions and requirements for BFT and PFT are found in Annex 2, Kitchen Performance Test.

4.1.12 |**Baseline Fuel Consumption:** The BFT are completed once ex-ante before the first verification, and at crediting period renewal. The project developer must determine Pb,y, Quantity of fuel that is consumed in baseline scenario b during year y in units of kg/household-day.

4.1.13 |The baseline fuel consumption is determined using project specific Baseline Performance Field Tests (BFT).

4.1.14 |The following requirements apply for selecting the end user locations of the Baseline Performance Field Tests:

- The BFT must reflect the average household size within the project area.
- The BFT must take place in those households where biogas devices have not yet been disseminated and where baseline technology is still in use in the project area.
- Where all households in the project area already use exclusively improved devices, the BFT is performed in households in the vicinity of the project target area that exhibit the similar socio-economic circumstances (including number of people, animal ownership and other) as the households that have already received the improved devices in the project target area and are operating devices that are similar to the baseline technology in the project activity.

4.1.15 |**Project Fuel Consumption:** The PFT is completed every other year, or more frequently, and the first PFT must be completed before the first verification of the project. The project developer must determine Pp,y, Quantity of fuel that is consumed in project scenario p during year y in units of kg/household-day.

4.1.16 |The project fuel consumption is determined using a project specific Project Performance Field Test (PFT).

4.1.17 |The following requirements apply for selecting the end user locations of the Project Performance Field Tests:

- PFT are conducted with end users representative of the project scenario target population and currently using the project technology.
- The PFT is not just a test of the operation of the project technology. It is a study of the fuel consumption of the cooking practices of project technology end users during the crediting period. The PFT must evaluate whether the project technology provides the same services at the same/similar frequency as the baseline technology.
- As well, where the baseline technology or other non-project technologies operate as backups or complementary units in parallel with project technologies ("stove stacking"), the project fuel consumption implications must be accounted for in the PFT.
- PFTs are required in the project situation even in cases where a 'zero emission' project technology is introduced, so as to capture the

potential use of the baseline technology as backup or auxiliary units; the potential introduction of an emitting backup or auxiliary project technology introduced in parallel with the project technology; or the use of a suitable non-renewable fuel in the project technology at times when the supply of a renewable fuel is disrupted or for preheating (e.g. plant oil stoves).

4.2 | Data and parameters monitored

Data/parameter ID	BGTA 24
Data / Parameter:	Avoidance of double counting or double claiming among project technology end users
Data unit:	NA
Description:	Evidence of avoidance of double counting or double claiming with project technology end users
Source of data:	Evidence of informing / notification of end users, such as: - leaflets distributed with the warranty card of the product alerting end-users to the waiving of their carbon rights in exchange for discount pricing of the improved technology below its true cost, - carbon title waiver forms signed by end users, etc.
Measurement procedures (if any):	-
Monitoring frequency:	Monitored whenever project technology is sold or otherwise disseminated
QA/QC procedures:	Cross check using general internet search and search of public records of Gold Standard and other voluntary market and UNFCCC mechanisms
Any comment:	-

Data/parameter ID	BGTA 25
Data / Parameter:	$U_{p,y}$
Data unit:	Percentage
Description:	Average usage rate in project scenario p during year y
Source of data:	Users survey/on-going rental/lease payments or a recurring maintenance fee/Measurement campaigns
Measurement procedures (if any):	Monitoring of operationality of the biogas systems, including the operationality of both the biogas digester and biogas cookstove, shall be conducted using one of the following methods:

<table>
<tr><td></td><td>(a)Census of users or survey of the users at randomly selected sample sites;
(b)Based on on-going rental/lease payments or a recurring maintenance fee by users;
(c)Measurement campaigns using biogas flow meters.
For all cases where sampling is applied, the "Standard for sampling and surveys for CDM project activities and programme of activities" shall be used for determining the sample size to achieve 90/10 ~~(for annual monitoring) or 95/10 (for biennial monitoring) confidence/precision levels~~.
The project can claim up to 90% in cases where the operationality is determined based on user reported questionnaire survey i.e., using option (a) above to account for uncertainties. Maximum up to 100% usage rate can be claimed using option (b) and (c).
For the case of measurement campaigns using biogas flow meters, it may be undertaken at randomly selected sample sites. The selected samples should take into account possible stratification of the population according to the capacity, biogas digester types and region where the digesters are installed (e.g., 6 cubic metre or 8 cubic metre capacity, fixed dome or floating dome type, regions where seasons influence average ambient temperature). The stratification of the population could be exempted in cases the project demonstrates that the approach applied for measuring the used biogas, results in conservative values for biogas used.
The continuous use monitoring campaign shall be conducted for a minimum of 100 households for at least 30 days.
The operational rate of each system is determined by dividing the number of days in operation by the length of the campaign. An operational day is a day in which biogas is consumed</td></tr>
<tr><td>Monitoring frequency:</td><td>Annual Or more frequently<table><tr><th>Method</th><th>Frequency</th></tr><tr><td>Census of users or survey of the users at randomly selected sample sites</td><td>Annual</td></tr><tr><td>Based on on-going rental/lease payments or a recurring maintenance fee by users;</td><td>Continuous measurement</td></tr><tr><td>Measurement campaigns using biogas flow meters</td><td>Annual</td></tr></table></td></tr>
<tr><td>QA/QC procedures:</td><td>Compliance with the general requirements for sampling (Section 4.4 |) and general requirements for QA/QC (Section 4.5 |)</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

a. Parameters related to AWMS

Data/parameter ID	BGTA 26
Data / Parameter:	$N_{LT,y}$
Data unit:	Number
Description:	Annual average number of animals of type *LT* in year *y*
Source of data:	-
Measurement procedures (if any):	AWMS Method – 1 Monitoring surveys AWMS Method - 2 Monitoring plan for the number of livestock population shall be included in the PDD. Photographic evidence with timestamps and GIS coordinates could also be used to determine average number of animals. The consistency between the value and indirect information (monthly records of sales, records of food purchases, or other national statistic, etc.) should be assessed.
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 1

Data/parameter ID	BGTA 27
Data / Parameter:	TAM_{LT}
Data unit:	kg/animal
Description:	Typical animal mass for livestock LT at the project site
Source of data:	Default value depending on the productivity system. The relevant IPCC default TAM values as provided in Table 10A.5 as well as in the Annexes of Chapter 10 of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 IPCC Guidelines for National Greenhouse Gas Inventories shall be selected accordingly. When IPCC values of VS are adjusted for site specific animal weight as per para 3.5.4 | or 3.5.7 | and Eq. 3~~Eq. 3~~ or Eq. 6~~Eq. 6~~ sampling procedures can be used to estimate this variable as per the Section 4.4 |General requirements for sampling
Measurement procedures (if any):	-

Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 28**
Data / Parameter:	nd_y
Data unit:	Days
Description:	Number of days the treatment plant was operational in year *y*
Source of data:	-
Measurement procedures (if any):	Monitoring surveys
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 29**
Data / Parameter:	$N_{da,y}$
Data unit:	-
Description:	Number of days animal is alive in the farm in the year y
Source of data:	Monitoring survey
Measurement procedures (if any):	The PDD shall describe the monitoring system for monitoring the number of days animal is alive in the farm during the monitoring period. The monitoring result must be confirmed or justified with the local practice in animal raising.
Monitoring frequency:	Annual, based on monitoring survey
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 30**
Data / Parameter:	$N_{p,y}$

Data unit:	[-]
Description:	Annual average number of animals of type LT in year y
Source of data:	Survey
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	The PDD should describe the system on monitoring the number of livestock population. This can be estimated in various ways, depending on - nature of the animal population. In the case of static animal populations (e.g., dairy cows, breeding swine, layers), estimating the number of given livestock species may be as animal inventory data. However, a growing population (e.g., meat animals, such as broilers, turkeys, beef cattle, and market swine) - most animals in these growing populations are alive for only part of a complete year and thus requires more evaluation. Applicable for AWMS method 1 and AWMS method 2

Data/parameter ID	**BGTA 31**
Data / Parameter:	$MS\%_{i,y}$
Data unit:	%
Description:	Fraction of manure handled in project animal manure management system i
Source of data:	Survey
Measurement procedures (if any):	Method 1- Default value from IPCC Method 2 - If animal manure is treated in different treatment systems manure weight delivered to each system shall be directly measured or alternatively manure volume can be measured together with the density determined from representative sample (90/10 precision). The quantity of animal manure from different farms and different animal types shall be recorded separately for cross-check. Recording of the baseline animal manure management system where the animal manure would have been treated anaerobically is also required

Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Applicable for calculating project emission with AWMS method 1, AWMS method 2

Data/parameter ID	**BGTA 32**
Data / Parameter:	AI_l
Data unit:	days
Description:	Annual average interval between manure collection and delivery for treatment at a given storage device l
Source of data:	Survey
Measurement procedures (if any):	-
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	Applicable for calculating project emission with AWMS method 2

Data/parameter ID	**BGTA 33**
Data / Parameter:	GE_{LT}
Data unit:	MJ/animal/day
Description:	Daily average gross energy intake
Source of data:	-
Measurement procedures (if any):	Only when country-specific excretion rates are to be estimated from feed intake levels via the enhanced characterisation method (Tier 2) described in section 10.2 in *2019 IPCC Guidelines for National Greenhouse Gas Inventories Volume 4 chapter 10*
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 34**
Data / Parameter:	DE_{LT}

Data unit:	fraction
Description:	Digestible energy of the feed
Source of data:	-
Measurement procedures (if any):	If IPCC Tier 2 is used for VS determination. IPCC 2019 Table 10.2, Chapter 10, Volume 4.
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 35**
Data / Parameter:	UE
Data unit:	Fraction of GE
Description:	Urinary energy, expressed as fraction of *GE*
Source of data:	-
Measurement procedures (if any):	If IPCC Tier 2 is used for VS determination. Typically, 0.04GE can be considered urinary energy excretion by most ruminants (reduce to 0.02 for ruminants fed with 85% or more grain in the diet or for swine). Use country-specific values where available
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 36**
Data / Parameter:	ASH
Data unit:	Fraction of the dry matter feed intake
Description:	Ash content of feed calculated as a fraction of the dry matter feed intake
Source of data:	-
Measurement procedures (if any):	If IPCC Tier 2 is used for VS determination. Use country-specific values where available
Monitoring frequency:	-

QA/QC procedures:	-
Any comment:	Suggested values from IPCC 2019 are: 6% for sows: (Dämmgen et al. 2011) and 17.9% for pasture-fed sheep, beef cattle and dairy cattle Applicable for AWMS method 2

Data/parameter ID	**BGTA 37**
Data / Parameter:	ED_{LT}
Data unit:	MJ/kg-dm
Description:	Energy density of the feed in MJ/kg fed to livestock type LT
Source of data:	-
Measurement procedures (if any):	If IPCC Tier 2 is used for VS determination. IPCC notes the energy density of feed, ED, is typically 18.45 MJ/kg-dm, which is relatively constant across a wide variety of grain-based feeds. The project proponent will record the composition of the feed to enable the DOE to verify the energy density of the feed
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

b. Parameters related to Thermal application

Data/parameter ID	**BGTA 38**
Data / Parameter:	$N_{b,p,y}$
Data unit:	days
Description:	Number of project technology-days included in the project database for each project scenario in year y
Source of data:	Calculated from the Project database (see section 4.1.3 |Project database) as the sum of the number of installed project technology units times the calendar days during the year y that they were used at the end user locations.
Measurement procedures (if any):	-
Monitoring frequency:	Calculated annually
QA/QC procedures:	Cross check the results of the usage survey with the contents of the project database to confirm whether the project technology

	units surveyed are present at end user locations as expected, or not. If there is discrepancy, this must be explained or corrected.
Any comment:	Applicable for Baseline Emission and Project Emission calculation

Data/parameter ID	**BGTA 39**
Data / Parameter:	$LE_{p,y}$
Data unit:	tCO_2e per year
Description:	Leakage in project scenario p during year y
Source of data:	Sources established by following section 3.7 |Leakage emissions
Measurement procedures (if any):	-
Monitoring frequency:	Every two years, or default discount value of 0.95 applied to emission reductions
QA/QC procedures:	Compliance with the general requirements for sampling (Section 4.4 |) and general requirements for QA/QC (Section 4.5 |)
Any comment:	Monitoring parameters required for calculating leakage emissions shall be included in the monitoring plan in the PDD as required to monitor and quantify the sources of leakage determined by following section 3.7 |Leakage emissions.

Data/parameter ID	**BGTA 40**
Data / Parameter:	$Q_{biogas,d,y}$
Data unit:	m^3
Description:	The volume of biogas used in the project by device d in year y
Source of data:	Direct measurement or conservative default
Measurement procedures (if any):	In the specific case of biogas project activities using biogas flow meters to monitor accumulated biogas supplied to thermal energy equipment: - Measurement campaigns shall be undertaken at randomly selected sample sites in each year of the crediting period. - The "Standard for sampling and surveys for CDM project activities and programme of activities" shall be used for determining the sample size to achieve 90/10 confidence/precision levels. - The selected samples shall take into account possible stratification of the population according to the capacity, types and region where the digesters are installed

	(e.g.e.g., 6 cubic metre or 8 cubic metre capacity, fixed dome or floating dome type, regions where seasons influence average ambient temperature). The stratification of the population could be exempted in cases the project demonstrates that the approach applied for measuring the used biogas, results in conservative values for biogas used. - For each measurement campaign at each site, continuous measurement shall be carried out for at least 30 days. - To account for seasonal variation in biogas generation from biogas digesters, it may be measured over a year during several disjointed periods (e.g.e.g., one week per quarter), but still covering at least 30 days for a year. These figures are then turned into an annual figure for a biogas digester. However, if disjoint periods are not practical or too expensive, then a single period may be chosen, from which an annualised figure is derived taking into account seasonality. If adjustment for seasonality is not possible, then a conservative approach shall be taken where a single period is chosen corresponding to the least amount of biogas generation, which is then scaled. Compare useful energy content from result of measured biogas (project energy use) to the reference value of 0.0045 GJ per capita per day. If the project energy use is more than the reference value, then the project energy use shall be further substantiated by independent third-party studies about cooking technologies and fuel/energy use that are specific to the project region, including but not limited to government publications, peer-reviewed literature, third party assessments (for example – UN and similar organizations) and/or official data or statistics. If the results cannot be further substantiated, then apply the reference value as a cap on the fuel consumption (on equivalent terms) as applied in baseline emission calculation.
Monitoring frequency:	Annual or more frequent
QA/QC procedures:	-
Any comment:	Applicable for Thermal application method 2

Data/parameter ID	BGTA 41
Data / Parameter:	$fNRB_{,i,y}$

Data unit:	percentage
Description:	Fractional non-renewability status of woody biomass fuel during year *y*, in case the baseline fuel is biomass or charcoal
Source of data:	-
Measurement procedures (if any):	Determined by following the CDM TOOL30, Calculation of the fraction of non-renewable biomass
Monitoring frequency:	One of two options, with the option defined and fixed at project design certification stage: 1. Determined ex-ante and fixed for a given crediting period (if it is fixed ex-ante, then include $fNRB_{,b,y}$ in the "data and parameters fixed ex ante" section of the PDD), or 2. Updated biennially or at each monitoring and verification
QA/QC procedures:	Requirements of the CDM TOOL30
Any comment:	Project developers applying for a renewal of the crediting period must reassess the NRB based on most recent information available. Applicable for Thermal application method 1 and method 2

c. Parameters related to other project emission

Data/parameter ID	**BGTA 42**
Data / Parameter:	$P_{p,i,y}$
Data unit:	tonnes/household/year
Description:	Quantity of fuel that is consumed in project scenario p during year y
Source of data:	Project performance field tests - see section 4.1 |
Measurement procedures (if any):	-
Monitoring frequency:	Updated every two years, or more frequently The KPT values are valid for two years and may be applied for before or after period.
QA/QC procedures:	Compliance with the general requirements for sampling (Section 4.4 |), general requirements for QA/QC (Section 4.5 |) and Annex 2: COMPLEMENTARY GUIDELINES FOR KITCHEN PERFORMANCE TESTING~~Annex 2: COMPLEMENTARY GUIDELINES FOR KITCHEN PERFORMANCE TESTING~~.
Any comment:	Applicable for Thermal application method 1

Data/parameter ID	**BGTA 43**

Data / Parameter:	Q_y
Data unit:	tonnes
Description:	Quantity of raw manure treated in the year y
Source of data:	On-site data sheets recorded
Measurement procedures (if any):	On-site data sheets recorded monthly using weigh bridge. Weighbridge will be subject to periodic calibration (in accordance with stipulation of the weighbridge supplier)
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 44**
Data / Parameter:	CT_y
Data unit:	tonnes/truck
Description:	Average truck capacity for transportation
Source of data:	On site measurement
Measurement procedures (if any):	-
Monitoring frequency:	Monthly
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	**BGTA 45**
Data / Parameter:	DAF_w
Data unit:	km/truck
Description:	Average incremental distance for raw manure transportation
Source of data:	On site measurement
Measurement procedures (if any):	Assumption to be approved by VVB
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	BGTA 46
Data / Parameter:	$EF_{CO2,transport}$
Data unit:	$kgCO_2/km$
Description:	CO_2 emission factor from fuel use due to transportation
Source of data:	IPCC default values or local values may be used
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	BGTA 47
Data / Parameter:	$Q_{res\cdot waste,y}$
Data unit:	tonnes
Description:	Quantity of residual waste produced in year *y*
Source of data:	On-site data sheets recorded
Measurement procedures (if any):	On-site data sheets recorded monthly using weigh bridge. Weighbridge will be subject to periodic calibration (in accordance with stipulation of the weighbridge supplier)
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	BGTA 48
Data / Parameter:	$CT_{res\cdot waste,y}$
Data unit:	tonnes/truck
Description:	Average truck capacity for residual waste transportation
Source of data:	On site measurement
Measurement procedures (if any):	-
Monitoring frequency:	-

QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

Data/parameter ID	BGTA 49
Data / Parameter:	$DAF_{res\cdot waste}$
Data unit:	km/truck
Description:	Average distance for residual waste transportation
Source of data:	On site measurement
Measurement procedures (if any):	Assumption to be approved by VVB
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable for AWMS method 2

4.3 | Baseline scenario survey

4.3.1 | The baseline scenario survey provides critical information on target population characteristics, baseline technology use, fuel consumption, leakage, and sustainable development indicators.

4.3.2 | **Representativeness:** The baseline survey requires in person interviews with a robust sample of end users without project technologies that are representative of end users targeted in the project activity.

4.3.3 | **Sample Sizing:** The baseline survey should be carried out for each baseline scenario using representative and random sampling, following these guidelines for minimum sample size:

Group size	Minimum sample size
<300	30 or population size, whichever is smaller
300 to 1000	10% of group size
> 1000	100

4.3.4 | **Data Collected:** The data collected is specific to the characteristics of each baseline scenario and should be tailored accordingly. Information on the following needs to be gathered:

1. User follow up	i. Address or location ii. Mobile telephone number and/or landline telephone number (when possible)
2. End user characteristics	i. Number of people served by baseline technology

	ii. Typical baseline technology usage patterns and tasks (commercial, institutional, domestic, etc.)
3. Baseline technology and fuels	i. Types of baseline technologies used and estimated frequency ii. Types of fuels used and estimated quantities iii. Seasonal variations in baseline technology and fuel use iv. Sources of fuels; purchased, collected, etc.
4. AWMS	i. Type of animals ii. Average number of ~~animal~~animals for each system type iii. The amount of waste or raw materials that would decay anaerobically in the baseline situation iv. Fraction of manure handled in baseline animal manure management system v. If the livestock is raised in shared centralized farms, the project proponent shall be able to show the baseline animal manure management practices at each farm, either individually or through sampling

4.4 | General requirements for sampling

4.4.1 | When sampling is applied to determine mean (average) parameter values or proportion (yes/no) parameter values for both ex-ante and monitored data and parameters, the following guidelines shall always be applied. Furthermore, specific requirements apply for the sampling related to some parameters, and these are described below or in the parameter tables.

4.4.2 | A statistically valid sample can be used to determine parameter values, as per the relevant requirements for sampling in the latest version of the CDM Standard for sampling and surveys for CDM project activities and programme of activities. 90% confidence interval and a 10% margin of error requirement shall be achieved for the sampled parameters unless mentioned otherwise in the methodology. In any case, a minimum sample size of 30, or the whole group size if this is lower than 30, must always be applied.

4.4.3 | Cross-VPA sampling is not allowed across groups larger than 10 VPAs, and cross-VPA sampling is not allowed for large scale PoAs. The requirements described here apply both when sampling is applied to a single VPA and to permissible cross-VPA sampling.

4.4.4 | For guidance, project developers may refer to the latest version of the CDM Standard for sampling and surveys for CDM project activities and programme of activities for the type of sampling approach (simple random, cluster, stratified etc.) applicable to their project context.

4.4.5 | Requirements for cases where pairs of baseline and project parameters are derived through sampling:

For determination of the parameters of fuel consumption, there are two valid options for the statistical analysis. In all cases, sample sizes must be derived following the general requirements for sampling and be greater than 30. The two options are:

a. 90/30 rule. When the sample sizes are large enough to satisfy the "90/30 rule," ~~i.e.~~ i.e., the endpoints of the 90% confidence interval lie within +/- 30% of the estimated mean GHG emission or fuel consumption, overall emission reductions can be calculated on the basis of the estimated MEAN annual emission reduction per unit or MEAN fuel annual savings per unit. When the sample sizes are such that the "90/30 rule" is not complied with, the emission or fuel saving result is not the mean (or average) test result, but a lower value equivalent to the LOWER BOUND of the one-sided 90% confidence interval.

b. 90/10 rule. When the sample sizes are large enough to satisfy the "90/10 rule," ~~i.e.~~ i.e., the endpoints of the 90% confidence interval lie within +/- 10% of the estimated mean thermal energy output, overall emission reductions can be calculated on the basis of the estimated MEAN annual emission reduction per unit or MEAN fuel annual savings per unit. When the sample sizes are such that the "90/10 rule" is not complied with, the emission or fuel saving result is not the mean (or average) test result, but a lower value equivalent to the LOWER BOUND of the one-sided 90% confidence interval.

4.4.6 | Applying the rules to estimate baseline and project average emissions or average fuel use separately is not permitted. The only exception is for cases involving a single set of data; see the following section.

4.4.7 | Requirements for cases where only the project parameter is derived through sampling

When data from a single project field test sampling determines project fuel consumption, there are two valid options for the statistical analysis. In all cases, the sample size must be derived following the general requirements for sampling and must be greater than 30. The two options are:

a. 90/10 rule. When the sample size is large enough to satisfy the "90/10 rule," ~~i.e.~~ i.e., the endpoints of the 90% confidence interval lie within +/- 10% of the estimated mean (GHG emission or fuel consumption or thermal energy output), overall emission reductions can be calculated on the basis of the estimated MEAN fuel consumption per unit.

b. 90% confidence rule. When the sample sizes are such that the "90/10 rule" is not complied with, the fuel consumption result is not the mean (or average) test result, but a higher value equivalent to the UPPER BOUND of the one-sided 90% confidence interval.

4.5 | General Requirements for Quality Assurance and Quality Control

4.5.1 | The project developer is responsible for accurate and transparent record keeping, monitoring and evaluation. All supporting documentation and records

for the project must be easily accessible for spot checking and cross referencing by a third-party auditor.

4.5.2 | Contact information in the total sales record must allow a project auditor to easily contact and visit end users.

4.5.3 | An auditor must be able to cross reference pertinent project documentation, including archives such as production records (e.g., materials purchases, internal logs), financial accounts, sales records or national statistic or local ~~expertsexperts~~experts' judgements, etc.

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METHODOLOGY

ANNEX ~~1~~1 : IPCC 2019 DEFAULTS VALUES

TABLE 10.2 (UPDATED)
REPRESENTATIVE FEED DIGESTIBILITY FOR VARIOUS LIVESTOCK CATEGORIES

Main categories	Class	Digestibility (DE as percent)
Swine[1]	Mature Swine – confinement	70 - 80
	Growing Swine - confinement	80 - 90
	Swine – free range	50 - 70
Cattle and other ruminants	Feedlot animals fed with > 85% concentrate or high-grain diet;	72 - 85
	Pasture / mixed-diet fed animals;	55 - 80
	Animals fed – low quality forage	45 - 55
Poultry[1]	Broiler Chickens –confinement	85 - 93
	Layer Hens – confinement	70 - 80
	Poultry – free range	55 - 90[1]
	Turkeys – confinement	85 - 93
	Geese – confinement	80 - 90

[1] The range in digestibility of feed consumed by free-range swine and poultry is extremely variable due to the selective nature of these diets. Often it is likely that the amount of manure produced in these classes will be limited by the amount of feed available for consumption as opposed to its degree of digestibility. In instances where feed is not limiting and high quality feed sources are readily accessible for consumption, digestibility may approach values that are similar to those measured under confinement conditions.

TABLE 10.13A (NEW)
DEFAULT VALUES FOR VOLATILE SOLID EXCRETION RATE (KG VS (1000 KG ANIMAL MASS)-1 DAY-1)

Category of animal	Region																		
	North America	Western Europe	Eastern Europe	Oceania[7]	Latin America			Africa[6]			Middle East[6]			Asia			India sub-continent		
					Mean	High PS[1]	Low PS[1]	Mean	High PS	Low PS	Mean	High PS	Low PS	Mean	High PS	Low PS	Mean	High PS	Low PS
Dairy cattle[4]	9.3	7.5	6.7	6.0	7.9	9.0	7.1	18.2	21.7	15.2	10.7	8.4	11.8	9.0	8.1	9.2	14.1	9.1	16.1
Other cattle[4]	7.6	5.7	7.6	8.7	8.5	8.1	8.6	12.0	10.2	12.7	14.1	10.5	16.8	9.8	6.8	10.8	12.2	13.5	12.0
Buffalo[4]	NA	7.7	6.2	NA	11.2	NE		12.9	NE		9.8	NE		13.5	NE			NE	
Swine[3]	3.3	4.5	4.0	4.0	5.0	3.3	8.3	7.2	4.3	8.7	4.3	3.9	7.2	5.8	4.3	7.1	7.7	5.5	8.7
Finishing	3.9	5.3	4.9	5.6	6.4	4.3	10.0	8.2	5.3	9.4	4.9	4.4	7.8	6.8	5.1	8.1	8.6	6.5	9.5
Breeding	1.8	2.4	2.0	2.1	2.7	1.7	4.8	4.4	2.4	6.0	2.5	2.3	4.6	3.4	2.3	4.3	4.6	3.0	5.5
Poultry[3]	14.5	12.3	12.6	15.4	13.5	13.3	15.7	12.6	12.3	13.0	14.2	14.1	16.5	11.2	10.6	14.3	14.9	14.3	15.7
Hens ±1 yr	9.4	8.6	9.4	8.6	10.1	9.3	14.7	10.2	8.0	11.6	9.0	8.4	15.8	9.3	8.5	12.8	13.2	11.6	14.6
Pullets	5.9	5.3	5.9	6.2	7.6	5.7	18.5	12.0	5.8	16.5	6.8	5.6	18.5	7.5	5.4	17.7	13.2	6.8	18.9
Broilers	16.8	16.1	16.0	18.3	15.6	15.5	17.8	15.9	16.0	15.4	17.7	17.7	17.9	15.7	15.6	17.1	17.7	17.6	18.2
Turkeys[8]	10.3																		
Ducks[8]	7.4																		
Sheep[3]	8.2				8.3														
Goats[5]	9				10.4														
Horses[8]	5.65				7.2														
Mules/ Asses[8]	7.2																		
Camels[8]	11.5																		

TABLE 10.14 (UPDATED)
METHANE EMISSION FACTORS BY ANIMAL CATEGORY, MANURE MANAGEMENT SYSTEM AND CLIMATE ZONE (G CH_4 KG VS^{-1}) [7]

Livestock species	Productivity Class	Manure Storage System[4]	Cool				Temperate		Warm			
			Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Dairy Cattle	High Productivity	Uncovered anaerobic lagoon	96.5	107.7	80.4	78.8	117.4	122.2	122.2	128.6	128.6	128.6
		Liquid/Slurry, Pit storage > 1 month [5]	33.8	41.8	22.5	22.5	59.5	65.9	94.9	122.2	117.4	119.0
		Solid storage	3.2				6.4		8.0			
		Dry lot	1.6				2.4		3.2			
		Daily spread	0.2				0.8		1.6			
		Anaerobic Digestion - Biogas[8]	3.2				3.7		3.7			
		Burned for fuel	16.1									
	Low Productivity	Uncovered anaerobic lagoon	52.3	58.4	43.6	42.7	63.6	66.2	66.2	69.7	69.7	69.7
		Liquid/Slurry, Pit storage > 1 month [5]	18.3	22.6	12.2	12.2	32.2	35.7	51.4	66.2	63.6	64.5
		Solid storage	1.7				3.5		4.4			
		Dry lot	0.9				1.3		1.7			
		Daily spread	0.1				0.4		0.9			
		Anaerobic Digestion - Biogas[8]	9.2				9.5		9.5			
		Burned for fuel	8.7									

TABLE 10.14 (UPDATED) (CONTINUED)
METHANE EMISSION FACTORS BY ANIMAL CATEGORY, MANURE MANAGEMENT SYSTEM AND CLIMATE ZONE (G CH_4 KG VS^{-1}) [7]

Livestock species	Productivity Class	Manure Storage System[4]	Cool				Temperate		Warm			
			Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Non Dairy Cattle	High Productivity	Uncovered anaerobic lagoon	72.4	80.8	60.3	59.1	88.0	91.7	91.7	96.5	96.5	96.5
		Liquid/Slurry, Pit storage > 1 month [5]	25.3	31.4	16.9	16.9	44.6	49.4	71.2	91.7	88.0	89.2
		Solid storage	2.4				4.8		6.0			
		Dry lot	1.2				1.8		2.4			
		Daily spread	0.1				0.6		1.2			
		Anaerobic Digestion - Biogas[8]	2.4				2.7		2.8			
		Burned for fuel	12.1									
	Low Productivity	Uncovered anaerobic lagoon	52.3	58.4	43.6	42.7	63.6	66.2	66.2	69.7	69.7	69.7
		Liquid/Slurry, Pit storage > 1 month[5]	18.3	22.6	12.2	12.2	32.2	35.7	51.4	66.2	63.6	64.5
		Solid storage	1.7				3.5		4.4			
		Dry lot	0.9				1.3		1.7			
		Daily spread	0.1				0.4		0.9			
		Anaerobic Digestion - Biogas[8]	9.2				9.5		9.5			
		Burned for fuel	8.7									

TABLE 10.14 (UPDATED) (CONTINUED)
METHANE EMISSION FACTORS BY ANIMAL CATEGORY, MANURE MANAGEMENT SYSTEM AND CLIMATE ZONE (G CH_4 KG VS^{-1}) [7]

Livestock species	Productivity Class	Manure Storage System[4]	Cool				Temperate		Warm			
			Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Growing and Breeding Swine	High Productivity	Uncovered anaerobic lagoon	180.9	202.0	150.8	147.7	220.1	229.1	229.1	241.2	241.2	241.2
		Liquid/Slurry, and Pit storage below animal confinements > 1 month [5]	63.3	78.4	42.2	42.2	111.6	123.6	177.9	229.1	220.1	223.1
		Liquid/Slurry, and Pit storage below animal confinements < 1 month[5]	18.1	24.1	12.1	12.1	39.2	45.2	75.4	114.6	108.5	126.6
		Solid storage	6.0				12.1		15.1			
		Dry lot	3.0				4.5		6.0			
		Daily spread	0.3				1.5		3.0			
		Anaerobic Digestion - Biogas[8]	6.0				6.8		7.0			
		Burned for fuel	30.2									
	Low Productivity	Uncovered anaerobic lagoon	116.6	130.2	97.2	95.2	141.8	147.7	147.7	155.4	155.4	155.4
		Liquid/Slurry, and Pit storage below animal confinements > 1 month [5]	40.8	50.5	27.2	27.2	71.9	79.7	114.6	147.7	141.8	143.8
		Liquid/Slurry, and Pit storage below animal confinements < 1 month[5]	11.7	15.5	7.8	7.8	25.3	29.1	48.6	73.8	69.9	81.6
		Solid storage	3.9				7.8		9.7			
		Dry lot	1.9				2.9		3.9			
		Daily spread	0.2				1.0		1.9			
		Anaerobic Digestion - Biogas[8]	20.6				21.1		21.2			
		Burned for fuel	19.4									

TABLE 10.14 (UPDATED) (CONTINUED)
METHANE EMISSION FACTORS BY ANIMAL CATEGORY, MANURE MANAGEMENT SYSTEM AND CLIMATE ZONE (G CH_4 KG VS^{-1}) [7]

Livestock species	Productivity Class	Manure Storage System[4]	Cool				Temperate		Warm			
			Cool Temp. Moist	Cool Temp. Dry	Boreal Moist	Boreal Dry	Warm Temp. Moist	Warm Temp. Dry	Tropical Montane	Tropical Wet	Tropical Moist	Tropical Dry
Poultry	High productivity	Uncovered anaerobic lagoon	156.8	175.1	130.7	128.0	190.7	198.6	198.6	209.0	209.0	209.0
		Liquid/Slurry, and Pit storage below animal confinements > 1 month [5]	54.9	67.9	36.6	36.6	96.7	107.1	154.2	198.6	190.7	193.4
		Solid storage	5.2				10.5		13.1			
		Dry lot	2.6				3.9		5.2			
		Anaerobic Digestion - Biogas[6]	5.2				10.5		13.1			
		Burned for fuel	2.6									
	Low productivity	All Systems	2.4									
Sheep	High productivity	Solid storage	2.5				5.1		6.4			
		Dry lot	1.3				1.9		2.5			
	Low productivity	Solid storage	1.7				3.5		4.4			
		Dry lot	0.9				1.3		1.7			
Goats	High productivity	Solid storage	2.4				4.8		6.0			
		Dry lot	1.2				1.8		2.4			
	Low productivity	Solid storage	1.7				3.5		4.4			
		Dry lot	0.9				1.3		1.7			

TABLE 10.14 (UPDATED) (CONTINUED)
METHANE EMISSION FACTORS BY ANIMAL CATEGORY, MANURE MANAGEMENT SYSTEM AND CLIMATE ZONE (G CH_4 KG VS^{-1}) [7]

Livestock species	Productivity Class	Manure Storage System[4]	Cool	Temperate	Warm
Camels	High productivity	Solid storage	3.5	7.0	8.7
		Dry lot	1.7	2.6	0.0
	Low productivity	Solid storage	2.8	5.6	7.0
		Dry lot	1.4	2.1	2.8
Horses	High productivity	Solid storage	4.0	8.0	10.1
		Dry lot	2.0	3.0	4.0
	Low productivity	Solid storage	3.5	7.0	8.7
		Dry lot	1.7	2.6	3.5
Mules/ Asses	High productivity	Solid storage	4.4	8.8	11.1
		Dry lot	2.2	3.3	4.4
	Low productivity	Solid storage	3.5	7.0	8.7
		Dry lot	1.7	2.6	3.5
All Animals	High and Low Productivity	Pasture Range and Paddock	0.6		

All values are calculated based on MCFs and B_0s reported in Tables 10.17 and 10.16, respectively, using the equation MCF*B_0*0.67.

[1] For the application of Tier 1, for all regions other than North America, Europe and Oceania the Tier 1 default values are the low productivity EFs. Pasture range and paddock emission factors are based on observation in updated version of Cai et al. (2017) database (see Annex 10B.6). No differences were observe for animal type, region or productivity class and are therefore reported as a constant for all animal and productivity categories.

[2] Temp. is an abbreviation for temperate

[3] Composting is the biological oxidation of organic material

[4] Definitions of manure management systems can be found in Table 10.18

[5] Emissions for liquid systems are calculated from manure management systems with a 6 month retention time.

[6] Buffalo emission factors are equivalent to low productivity non dairy animals.

[7] Uncertainty is ±30% consisten with the *2006 IPCC Guidelines*

[8] Anaerobic digestion for high productivity used emission estimates from high quality gas-tight digesters and average MCFs for storage whereas, low quality used high digester leakage rates and average MCFs for storage leakage rates. Countries should consider the type and quality of digesters used in their individual countries in evaluating what emission factors they choose to employ as opposed to the level of productivity for anaerobic digesters only.

TABLE 10.16 (UPDATED)
DEFAULT VALUES FOR MAXIMUM METHANE PRODUCING CAPACITY (B_0) (M^3 CH_4 KG^{-1} VS)

Category of animal [2]	Region					
	North America	Western Europe	Eastern Europe	Oceania	Other Regions[1]	
					High productivity systems	Low productivity systems
Dairy cattle	0.24				0.24	0.13
Non dairy cattle	0.19	0.18	0.17	0.17	0.18	0.13
Buffalo	0.10				0.10	0.10
Swine	0.48	0.45	0.45	0.45	0.45	0.29
Chicken-Layer	0.39				0.39	0.24
Chicken-Broilers	0.36				0.36	0.24
Sheep	0.19				0.19	0.13
Goats	0.18				0.18	0.13
Horses	0.30				0.30	0.26
Mules/ Asses	0.33				0.33	0.26
Camels	0.26				0.26	0.21
All Animals PRP	0.19					

Sources: All values are consistent with IPCC 2006 values from Annex 10A.2 with the exception of PRP, taken from the analysis described in Annex 10B.6.

[1] For other regions, low productivity is considered the default value for Tier 1 if not using the Tier 1a.

[2] Only presenting values for manure, compilers are recommended to consult scientific literature or develop country-specific B_0 values for the different codigestates that may be used in anaerobic digesters.

Uncertainty values are ±15 percent

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ANNEX 2: COMPLEMENTARY GUIDELINES FOR KITCHEN PERFORMANCE TESTING

Refer to the methodology REDUCED EMISSIONS FROM COOKING AND HEATING: TPDDTEC, version 4.0.

ANNEX 3: ANAEROBIC UNIT PROCESS PERFORMANCE

Anaerobic unit process performance

Anaerobic Treatment	HRT	COD	TS	VS	TN	P	K
	days	Per cent Reduction					
Pull plug pits	4-30	—	0-30	0-30	0-20	0-20	0-15
Underfloor pit storage	30-180	—	30-40	20-30	5-20	5-15	5-15
Open top tank	30-180	—	—	—	25-30	10-20	10-20
Open pond	30-180	—	—	—	70-80	50-65	40-50
Heated digester effluent prior to storage	12-20	35-70	25-50	40-70	0	0	0
Covered first cell of two cell lagoon	30-90	70-90	75-95	80-90	25-35	50-80	30-50
One-cell lagoon	>365	70-90	75-95	75-85	60-80	50-70	30-50
Two-cell lagoon	210+	90-95	80-95	90-98	50-80	85-90	30-50
HRT=hydraulic retention time; COD=chemical oxygen demand; TS=total solids; VS=volatile solids; TN=total nitrogen; P=phosphorus; K=potassium; — =data not available.							

~~*Source:*~~*Source :* Moser and Martin, 1999

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