Ministry of Power

Ministry of Environment,

Forest and Climate Change

METHODOLOGY

BM EN01.001

Grid-connected electricity generation from renewable sources

Publication Date:

Version 1.0

Sectoral scope(s): Energy

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1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology ACM0002 (as valid from 31 May 2024).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology.

Table 1. Methodology key elements

Typical projects	Retrofit, rehabilitation, replacement or capacity addition to an existing power plant or construction and operation of a new power plant/unit that uses renewable energy sources and supplies electricity to the grid. Battery energy storage system can be integrated under certain conditions. Pumped storage projects operating in coordination with a renewable energy plant under certain conditions.
Type of GHG emissions mitigation action	Renewable energy: Displacement of electricity that would be provided to the grid by more-GHG-intensive means

2. Definitions

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

(a) **Backup generator** - a generator that is used in the event of an emergency, such as power supply outage due to either main generator failure, captive failure or tripping of generator units, to meet electricity demand of the equipment at power plants/units site during emergency;

(b) **Battery Energy Storage System (BESS)** - a rechargeable energy storage system consisting of batteries, battery chargers, controls, power conditioning systems and associated electrical equipment designed to store the electricity generated from the renewable energy plant(s);

(c) **Binary geothermal power plant** - a geothermal technology that utilizes an organic Rankine cycle (ORC) or a Kalina cycle and typically operates with temperatures varying from as low as 73°C to 180°C. In these plants, heat is recovered from the geothermal fluid using heat exchangers to vaporise an organic fluid with a low boiling point (e.g. butane or pentane in the ORC cycle and an ammonia-water mixture in the Kalina cycle) and drive a turbine. Binary geothermal plants are categorised as closed cycle technology;

(d) **Capacity addition** - a capacity addition is an investment to increase the installed power generation capacity of existing power plants through: (i) the installation of a new power plants/units besides the existing power plants/units; or (ii) the installation of new power plants/units, additional to the existing power plants/units; or (iii) construction of a new reservoir along with addition of new power plants/units in case of integrated hydro power projects. The existing power plants/units in the case of capacity addition continue to operate after the implementation of the project activity;

(e) **Dry steam geothermal power plant -** a geothermal technology that directly utilises dry steam that is piped from production wells to the plant and then to the turbine. Dry steam geothermal plants are categorised as open cycle technology;

(f) **Existing reservoir** - a reservoir is to be considered as an "existing reservoir" if it has been in operation for at least three years before the implementation of the project activity;

(g) **Flash steam geothermal power plant -** a geothermal technology that is used where water-dominated reservoirs have temperatures above 180°C. In these high-temperature reservoirs, the liquid water component boils, or "flashes", as pressure drops. Separated steam is piped to a turbine to generate electricity and the remaining hot water may be flashed again twice (double flash plant) or three times (triple flash) at progressively lower pressures and temperatures, to obtain more steam. Flash steam geothermal plants are categorised as open cycle technology;

(h) **Greenfield power plant** - a new renewable energy power plant that is constructed and operated at a site where no renewable energy power plant was operated prior to the implementation of the project activity;

(i) **Installed power generation capacity (or installed capacity or nameplate capacity)** - the installed power generation capacity of a power unit is the capacity, expressed in Watts or one of its multiples, for which the power unit has been designed to operate at nominal conditions. The installed power generation capacity of a power plant is the sum of the installed power generation capacities of its power units; In case of solar power projects, the installed capacity would refer to the sum of the DC capacity of all the solar panels installed in the project;

(j) **Integrated hydro power project** - integration of multiple hydro power plants/units with single or multiple reservoirs designed to work together;

(k) **Pumped Storage Project** - a type of hydroelectric energy storage that includes two water reservoirs at different elevations that can generate power as water moves down from one to the other reservoir, passing through a turbine. The system also requires power as it pumps water back into the upper reservoir.

(l) **Power plant/unit** - a power plant/unit is a facility that generates electric power. Several power units at one site comprise one power plant, whereas a power unit is characterized by the fact that it can operate independently from other power units at the same site. Where several identical power units (i.e. with the same capacity, age and efficiency) are installed at one site, they may be considered as one single power unit;

(m) **Rehabilitation** - is an investment to restore the existing power plants/units that was severely damaged or destroyed due to foundation failure, excessive seepage, earthquake, liquefaction, or flood. The primary objective of rehabilitation is to restore the performances of the facilities. Rehabilitation may also lead to increase in efficiency, performance or power generation capacity of the power plants/units with/without adding new power plants/units;

(n) **Replacement** - is an investment in new power plants/units that replaces one or several existing units at the existing power plant. The new power plants/units have the same or a higher power generation capacity than the plants/units that were replaced;

(o) **Reservoir** - a reservoir is a water body created in valleys to store water generally made by the construction of a dam;

(p) **Retrofit** - is an investment to repair or modify existing operating power plants/units, with the purpose to increase the efficiency, performance or power generation capacity of the plants/units, without adding new power plants/units. A retrofit restores the installed power generation capacity to or above its original level. Retrofits shall only include measures that involve capital investments and not regular maintenance or housekeeping measures.

5. In addition, definition of Renewable Energy and OTEC as recognized by Central Government will be applied.

3. Scope & Applicability

3.1. Scope

6. This methodology applies to grid-connected renewable energy generation project activities that include:

(a) Construction and operation of a Greenfield power plant; or

(b) Retrofitting, rehabilitation, replacement or capacity addition of an existing power plant.

7. Further, the methodology applies to grid-connected renewable energy generation project activities which integrate Battery Energy Storage System (BESS) to a Greenfield power plant or to an existing solar photovoltaic or wind power plant.

8. Furthermore, the methodology applies to a grid-connected Greenfield pumped storage project (PSP) which is connected to a Greenfield renewable energy plant through a dedicated line and/or through the grid. A greenfield PSP connected to an existing renewable energy plant is not eligible to apply this methodology.

3.2. Applicability

9. This methodology is applicable to grid-connected renewable energy power generation project activities that:

    (a) Install a Greenfield power plant (excluding standalone grid-connected wind and solar power plants);

    (b) Involve a capacity addition to (an) existing plant(s) (excluding standalone grid-connected wind and solar power plants);

    (c) Involve a retrofit of (an) existing operating plant(s)/unit(s) (excluding standalone grid-connected wind and solar power plants);

    (d) Involve a rehabilitation of (an) existing plant(s)/unit(s) (excluding standalone grid-connected wind and solar power plants); or

    (e) Involve a replacement of (an) existing plant(s)/unit(s) (excluding standalone grid-connected wind and solar power plants); or

    (f) Install a Greenfield power plant together with a grid-connected Greenfield pumped storage power plant. The greenfield power plant may be directly connected to the PSP or connected to the PSP through the grid.

    (g) Hybrid systems

10. In case the project activity involves the integration of a BESS, the methodology is applicable to grid-connected renewable energy power generation project activities that:

    (a) Integrate BESS with a Greenfield power plant;

    (b) Integrate a BESS together with implementing a capacity addition to (an) existing solar photovoltaic[1] or wind power plant(s)/unit(s);

    (c) Integrate a BESS to (an) existing solar photovoltaic or wind power plant(s)/unit(s) without implementing any other changes to the existing plant(s);

    (d) Integrate a BESS together with implementing a retrofit of (an) existing solar photovoltaic or wind power plant(s)/unit(s);

    (e) Integrate a BESS together with a Greenfield power plant that is operating in coordination with a PSP. The BESS is located at site of the greenfield renewable power plant.

[1] In case of retrofit or capacity addition for concentrated solar power projects, stakeholders may submit a request for revision to this methodology, providing an apportioning approach to calculate the project emissions due to any fossil fuel consumption attributed to the increased electricity generation from the BESS.

Table 2. Combinations of renewable energy technologies and mode of BESS applicable for integration

Renewable Energy Technology[2] / Mode of installation of BESS	Solar photovoltaic or wind	Other renewable technologies
BESS + (a) Greenfield plant(s)	Eligible	Eligible
BESS+ capacity addition to existing plant(s)	Eligible	Not eligible
BESS with no other changes to the existing plant(s)	Eligible	Not eligible
BESS + retrofit to existing plant(s)	Eligible	Not eligible

11. The methodology is applicable under the following conditions:

(a) Hydro power plant/unit with or without reservoir, offshore wind power plant/unit, geothermal power plant/unit, wave power plant/unit or tidal power plant/unit;

(b) In the case of capacity additions, retrofits, rehabilitations or replacements (except for wind, wave or tidal power capacity addition projects) the existing plant/unit must have started commercial operation prior to the start of a minimum historical reference period of five years. The reference period is used for the calculation of baseline emissions and defined in the baseline emission section. Furthermore, no capacity expansion, retrofit, or rehabilitation of the plant/unit has been undertaken between the start of this minimum historical reference period and the implementation of the project activity;

(c) In case of Greenfield project activities applicable under paragraph 10(a) above, the project participants shall demonstrate that the BESS was an integral part of the design of the renewable energy project activity (e.g., by referring to feasibility studies or investment decision documents);

(d) The BESS should be charged with electricity generated from the associated renewable energy power plant(s). Only during exigencies[3] may the BESS be charged with electricity from the grid or a fossil fuel electricity generator. In such cases, the corresponding GHG emissions shall be accounted for as project emissions following the requirements under section 4.4.4 below. The charging using the grid or using fossil fuel electricity generator should not amount to more than 2 per cent of the electricity generated by the project renewable energy plant during a monitoring period. During the time periods (e.g., week(s), months(s)) when the BESS consumes more than 2 per cent of the electricity for charging, the project participant shall not be entitled to issuance of the Carbon Credit Certificates (CCC) for the concerned periods of the monitoring period.

(e) In case the project activity involves PSP, the PSP shall utilize the electricity generated from the renewable energy power plant(s) that is operating in coordination with the PSP during pumping mode.

12. In case of hydro power plants, one of the following conditions shall apply:

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[2] This may include a combination of renewable energy technologies combined with BESS.

[3] For example, upon deep discharge of the batteries.

(a) The project activity is implemented in existing single or multiple reservoirs, with no change in the volume of any of the reservoirs; or

(b) The project activity is implemented in existing single or multiple reservoirs, where the volume of the reservoir(s) is increased and the power density, calculated using equation (7), is greater than 4 W/m^2; or

(c) The project activity results in new single or multiple reservoirs and the power density, calculated using equation (7), is greater than 4 W/m^2; or

(d) The project activity is an integrated hydro power project involving multiple reservoirs, where the power density for any of the reservoirs, calculated using equation (7), is lower than or equal to 4 W/m^2, and all of the following conditions shall apply:

    (i) The power density calculated using the total installed capacity of the integrated project, as per equation (8), is greater than 4 W/m^2;

    (ii) Water flow between reservoirs is not used by any other hydropower unit which is not a part of the project activity;

    (iii) Installed capacity of the power plant(s) with power density lower than or equal to 4 W/m^2 are:

        a. Lower than or equal to 15 MW; and

        b. Less than 10 per cent of the total installed capacity of integrated hydro power project.

13. In the case of integrated hydro power projects, project participants shall:

(a) Demonstrate that water flow from upstream power plants/units spill directly to the downstream reservoir and that collectively constitute to the generation capacity of the integrated hydro power project; or

(b) Provide an analysis of the water balance covering the water fed to power units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of water balance is to demonstrate the requirement of specific combination of reservoirs constructed under ICM project activity for the optimization of power output. This demonstration has to be carried out in the specific scenario of water availability in different seasons to optimize the water flow at the inlet of power units. Therefore, this water balance will take into account seasonal flows from river, tributaries (if any), and rainfall for minimum of five years prior to the implementation of the ICM project activity.

14. In the case of PSP, the project participants shall demonstrate in the PDD that the project is not using water which would have been used to generate electricity in the baseline.

15. The methodology is not applicable to:

(a) Project activities that involve switching from fossil fuels to renewable energy sources at the site of the project activity, since in this case the baseline may be the continued use of fossil fuels at the site;

(b) Biomass fired power plants/units.

16. In the case of retrofits, rehabilitations, replacements, or capacity additions, this methodology is only applicable if the most plausible baseline scenario, as a result of the identification of baseline scenario, is "the continuation of the current situation, that is to use the power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance".

17. In addition, the applicability conditions included in the tools referred to below apply.

3.3. Methodology Approval Date

18. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of sectoral scopes

19. For validation and verification of ICM projects and programme of activities by a designated ACVA using this methodology, application of sectoral scope "*01: Energy*" is mandatory.

3.5. Applicability of approved adopted tools

20. This methodology also refers to the latest approved versions of the following adopted ICM tools:

(a) "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as BM-T-001);

(b) "BM-T-002: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

(c) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

(d) "BM-T-012: Positive lists of technologies" (hereinafter referred to as BM-T-012);

4. Methodology: Baseline Component

4.1. Project boundary

21. The spatial extent of the project boundary includes the project power plant/unit and all power plants/units connected physically to the electricity system that the ICM project power plant is connected to.

22. The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table 3.

Table 3. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/explanation
Baseline	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project activity	For dry or flash steam geothermal power plants, emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	Yes	Main emission source
		CH_4	Yes	Main emission source
		N_2O	No	Minor emission source
	For binary geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	Yes	Main emission source
		CH_4	Yes	Main emission source
		N_2O	No	Minor emission source
	For binary geothermal power plants, fugitive emissions of hydrocarbons such as n-butane and isopentane (working fluid) contained in the heat exchangers	Low GWP hydrocarbon/refrigerant	Yes	Main emission source
	CO_2 emissions from combustion of fossil fuels for electricity generation in solar thermal power plants and geothermal power plants	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	For hydro power plants, emissions of CH_4 from the reservoir	CO_2	No	Minor emission source
		CH_4	Yes	Main emission source
		N_2O	No	Minor emission source
	Charging of BESS using electricity from the grid or from fossil fuel electricity generators.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	Utilization of electricity from grid or from fossil fuel generators by PSP for pumped mode.	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	For PSP, emissions of CH_4 from the reservoir	CO_2	No	Minor emission source
		CH_4	Yes	Main emission source
		N_2O	No	Minor emission source

4.2. Identification of the baseline scenario

4.2.1. Baseline scenario for Greenfield power plant

23. If the project activity is the installation of a Greenfield power plant with or without a BESS as described under paragraph 9(a) or paragraph 10(a) or paragraph 10(e) above, the baseline scenario is electricity delivered to the grid by the project activity that would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources.

4.2.2. Baseline scenario for capacity addition to an existing renewable energy power plant or integration of a BESS to an existing solar photovoltaic or wind power plant/unit

24. If the project activity is a capacity addition with or without a BESS as described under paragraph 9(b) or paragraph 10(b) above or is an integration of a BESS to (an) existing solar photovoltaic or wind power plant(s)/unit(s) without implementing any other changes to the existing plant(s) as described under paragraph 10(c) above, the baseline scenario is the existing facility that would continue to supply electricity to the grid at historical levels, until the time at which the generation facility would likely be replaced or retrofitted ($DATE_{BaselineRetrofit}$), and electricity delivered to the grid by the added capacity would have otherwise been generated by the operation of grid-connected power plants and by the addition of new generation sources. From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and no emission reductions are assumed to occur.

4.2.3. Baseline scenario for retrofit or rehabilitation or replacement of an existing power plant

25. If the project activity is retrofit or rehabilitation or replacement of an existing plant as described under paragraph 9(c) or paragraph 9(d) or paragraph 9(e) above, the following step-wise procedure to identify the baseline scenario shall be applied.

4.2.4. Baseline scenario for retrofit of an existing solar photovoltaic or wind power plant/unit with the integration of BESS

26. If the project activity is retrofit to an existing solar photovoltaic or wind power plant/unit as described under paragraph 10(d) above, the project activity provides the possibility of supplying additional electricity to the grid using the same existing power generation capacity. This allows for a higher power plant load factor over the year, enabling more electricity supply to the grid from project activity renewable power plant as compared to the situation prior to the installation of the BESS. This potentially displaces an equivalent amount of electricity generation in the grid, which may comprise many fossil fuel plants. The baseline scenario shall be determined following the same procedure as in the case of a retrofit or rehabilitation or replacement of an existing power plant, described above.

4.2.5. Baseline scenario for pumped storage projects operating in coordination with the renewable energy plants

27. If the project activity is as described under paragraph 9(f) above, the project participant shall demonstrate that the baseline scenario is neither the installation of the project Greenfield renewable power plant without PSP nor the installation of the PSP without the Greenfield renewable power plant. If the project participant failed to demonstrate the

baseline scenario is not Greenfield renewable energy plant without PSP or the PSP without the Greenfield renewable power plant, the methodology is not applicable.

4.3. Additionality

4.3.1. Simplified procedure to demonstrate additionality

28. For the simplified procedure to demonstrate additionality the non-obligated entities shall refer to the methodological tool BM-T-012 to identify if the activity is listed under the positive list. If not, the following procedures shall be followed.

4.3.2. Demonstrate additionality based on the BM-T-001.

4.3.2.1. Step 1: Identify realistic and credible alternative baseline scenarios for power generation

29. Apply Step 1 of BM-T-001. The options considered should include:

(a) P1: The project activity not implemented as a ICM project;

(b) P2: The continuation of the current situation, that is to use all power generation equipment that was already in use prior to the implementation of the project activity and undertaking business as usual maintenance. The additional power generated under the project would be generated in existing and new grid-connected power plants in the electricity system; and

(c) P3: All other plausible and credible alternatives to the project activity that provide an increase in the power generated at the site, which are technically feasible to implement. This includes, inter alia, different levels of replacement, retrofit and/or rehabilitation at the power plants/units. Only alternatives available to project participants should be taken into account.

4.3.2.2. Step 2: Barrier analysis

30. Apply Step 2 of BM-T-001.

4.3.2.3. Step 3: Investment analysis

31. If this option is used, apply one of the following:

(a) Apply an investment comparison analysis, as per Step 3 of BM-T-001, if more than one alternative is remaining after Step 2 and if the remaining alternatives include scenarios P1 and P3;

(b) Apply a benchmark analysis, as per BM-T-001, if more than one alternative is remaining after Step 2 and if the remaining alternatives include scenarios P1 and P2.

4.4. Project emissions

32. For most renewable energy power generation project activities, PE_y = 0. However, some project activities may involve project emissions that can be significant. These emissions shall be accounted for as project emissions by using the following equation:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y} + PE_{BESS,y} + PE_{PSP,y} \qquad \text{Equation (1)}$$

Where:

PE_y	=	Project emissions in year y (t CO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year y (t CO_2/yr)
$PE_{GP,y}$	=	Project emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO_2e/yr)
$PE_{HP,y}$	=	Project emissions from water reservoirs of hydro power plants amd pumped storage plants in year y (t CO_2e/yr)
$PE_{BESS,y}$	=	Project emissions from charging of a BESS using electricity from the grid or from fossil fuel electricity generators (t CO_2e/yr)
$PE_{PSP,y}$	=	Project emissions from utilizing electricity from the grid for pumping operation of PSP in excess to the production of the renewable power plant operating in coordination with the PSP (t CO_2e/yr)

4.4.1. Emissions from fossil fuel combustion (*$PE_{FF,y}$*)

33. For geothermal or solar thermal projects which also use fossil fuels for electricity generation, CO_2 emissions from the combustion of fossil fuels shall be accounted for as project emissions ($PE_{FF,y}$).

34. For all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator can be neglected.

35. $PE_{FF,y}$ shall be calculated as per BM-T-002.

4.4.2. Emissions from the operation of dry steam, flash steam[4] and binary[5] geothermal power plants due to non-condensable gases and/or working fluid (*$PE_{GP,y}$*)

36. For dry or flash steam geothermal project activities, project participants shall account for emissions of CO_2 and CH_4 due to release of non-condensable gases from produced

[4] In open cycle geothermal technologies, the underground geothermal fluid would come in touch with the atmosphere during the heat exchange process. In such process, non-condensable and other gases within the geothermal fluid are partially released to the atmosphere.

[5] In binary geothermal technologies, the underground fluid is re-injected back to the heat source without any exposure to the atmosphere. In this case, non-condensable and other gases within the geothermal fluid are kept within the outgoing geothermal fluid and sent back into the heat source. However, there may be some physical leakage from closed cycle pipes and wells.

steam.[6] Non-condensable gases in geothermal reservoirs usually consisting mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarbons, predominantly CH_4. In dry or flash steam geothermal power projects, non-condensable gases flow with the steam into the power plant. A small proportion of the CO_2 is converted to carbonate/bicarbonate in the cooling water circuit. In addition, parts of the non-condensable gases are re-injected into the geothermal reservoir. However, as a conservative approach, this methodology assumes that all non-condensable gases entering the power plant in dry or flash steam geothermal technologies are discharged to atmosphere via the cooling tower. Fugitive CO_2 and CH_4 emissions due to well testing and well bleeding are not considered, as they are negligible.

37. $PE_{GP,y}$ is calculated as follows:

$$PE_{GP,y} = PE_{dry\ or\ flash\ steam,\ y} + PE_{binary,y} \quad \text{Equation (2)}$$

Where:

$PE_{GP,y}$	=	Project emissions from the operation of dry steam, flash steam and/or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{dry\ or\ flash\ steam,\ y}$	=	Project emissions from the operation of dry steam or flash steam geothermal power plants due to release of non-condensable gases in year *y* (t CO_2e/yr)
$PE_{binary,y}$	=	Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases and working fluid in year *y* (t CO_2e/yr)

(a) Project emissions from dry or flash steam geothermal power plants:

$$PE_{dry\ or\ flash\ steam,\ y} = \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \times M_{steam,y} \quad \text{Equation (3)}$$

Where:

$w_{steam,CO2,y}$	=	Average mass fraction of CO_2 in the produced steam in year *y* (t CO_2/t steam)
$w_{steam,CH4,y}$	=	Average mass fraction of CH_4 in the produced steam in year *y* (t CH_4/t steam)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)
$M_{steam,y}$	=	Quantity of steam produced in year *y* (t steam/yr)

(b) Project emissions from binary geothermal power plants:

$$PE_{binary,y} = PE_{steam,y} + PE_{working\ fluid,y} \quad \text{Equation (4)}$$

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[6] In the case of retrofit, rehabilitation or replacement projects at geothermal plants, this methodology does not account for baseline emissions from release of non-condensable gases from produced steam or fossil fuel combustion. Project participants are welcome to propose revisions to this methodology to account for these baseline emissions.

Where:

$PE_{steam,y}$	=	Project emissions from the operation of binary geothermal power plants due to physical leakage of non-condensable gases in year *y* (t CO_2e/yr). In case the difference between steam inflow and outflow to the power plant is less than 1%, then the project participants are not required to account these project emissions
$PE_{working\ fluid,\ y}$	=	Project emissions from the operation of binary geothermal power plants due to physical leakage of working fluid contained in heat exchangers in year *y* (t CO2e/yr)

$$PE_{steam,y} = \left(M_{Inflow,y} - M_{outflow,y}\right) \times \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \quad \text{Equation (5)}$$

Where:

$\mathrm{M}_{inflow,y}$	=	Quantity of steam entering the geothermal plant in year *y* (t steam/yr)
$M_{outlow,y}$	=	Quantity of steam leaving the geothermal plant in year *y* (t steam/yr)
$\mathrm{w}_{steam,CO2,y}$	=	Average mass fraction of CO_2 in the produced steam in year *y* (t CO_2/t steam)
$w_{steam,CH4,y}$	=	Average mass fraction of CH_4 in the produced steam in year *y* (t CH_4/t steam)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO2e/t CH_4)

$$PE_{working\ fluid,y} = M_{working\ fluid,y} \times GWP_{working\ fluid} \quad \text{Equation (6)}$$

Where:

$M_{working\ fluid,y}$	=	Quantity of working fluid leaked/reinjected in year *y* (t working fluid/yr)
$GWP_{working\ fluid}$	=	Global Warming Potential for the working fluid used in the binary geothermal power plant

4.4.3. Emissions from water reservoirs of hydro power plants and pumped storage projects (*$PE_{HP,y}$*)

38. The power density (*PD*) of the project activity is calculated as follows:

$$PD = \frac{Cap_{PJ} - Cap_{BL}}{A_{PJ} - A_{BL}} \quad \text{Equation (7)}$$

Where:

PD	=	Power density of the project activity (W/m^2)
Cap_{PJ}	=	Installed capacity of the hydro power plant or PSP after the implementation of the project activity (W)
Cap_{BL}	=	Installed capacity of the hydro power plant or PSP before the implementation of the project activity (W). For new hydro power plants or PSP, this value is zero

A_{PJ}	=	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full (m^2)
A_{BL}	=	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero

39. For hydro power project or PSP activities that result in new single or multiple reservoirs and hydro power project or PSP activities that result in the increase of single or multiple existing reservoirs, project participants shall account for CH_4 and CO_2 emissions from the reservoirs, estimated as follows:

(a) For integrated hydro power project or PSP, PD of the entire project is calculated as follows:

$$PD = \frac{\sum Cap_{PJ,i}}{\sum A_{PJ,j}}$$ Equation (8)

Where:

i	=	Individual power plants included in integrated hydro power project/ PSP
j	=	Individual reservoirs included in integrated hydro power project/ PSP

(b) If the power density of the project activity using equation (7) or in case of integrated hydro power project using equation (8) is greater than 4 W/m^2 and less than or equal to 10 W/m^2:

$$PE_{HP,y} = \frac{EF_{Res} \times TEG_y}{1000}$$ Equation (9)

Where:

$PE_{HP,y}$	=	Project emissions from water reservoirs (t CO2e/yr)
EF_{Res}	=	Default emission factor for emissions from reservoirs of hydro power plants/ PSP (kg CO2e/MWh)
TEG_y	=	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh)

(c) If the power density of the project activity is greater than 10 W/m^2:

$$PE_{HP,y} = 0$$ Equation (10)

4.4.4. Emissions from charging of a BESS using electricity from the grid or from fossil fuel electricity generators ($PE_{BESS,y}$)

40. Under normal conditions, BESS should be charged with the electricity generated by the associated renewable power plant. In a few instances, the BESS may be charged using grid electricity or electricity from fossil fuel generators ($EC_{BESS,y}$).

41. In cases where BESS is charged using grid electricity, the corresponding project emissions ($PE_{BESS,y}$) shall be calculated according to the procedure described in BM-T-003.

42. In cases where BESS is charged using electricity from fossil fuel generators, the corresponding project emissions ($PE_{BESS,y}$) shall be calculated according to the procedure described in BM-T-002.

43. In line with the requirement under paragraph 11(d) above, the charging using the grid or using fossil fuel electricity generator should not amount to more than 2 per cent of the electricity generated by the project renewable energy plant during a monitoring period. During the periods where the BESS consumes more than 2 per cent of the electricity for charging, the project participant shall not be entitled to issuance of the CCC for the concerned period. Furthermore, the project participant(s) should compensate in full, any negative emissions reductions which may arise from power consumption from the grid by the BESS, including for monitoring periods for which no emission reductions can be claimed.

4.4.5. Emissions from utilizing grid electricity by pumped hydro plants ($PE_{PSP,y}$)

44. Under normal conditions, PSP should utilize the electricity generated by the associated renewable power plant. Exceptionally, the PSP may utilize grid electricity in excess to the electricity supplied by the renewable power plant ($EC_{PSP,y}$).

45. In cases where PSP utilizes grid electricity in excess to the production of the renewable power plant, the corresponding project emissions ($PE_{PSP,y}$) shall be calculated according to the procedure described in BM-T-003.

46. In line with the requirement under paragraph 11(e) above, utilization of electricity from grid in excess of the electricity generated by the project renewable energy plant shall only be used during exigencies[7] and shall not amount to more than 2 per cent of the electricity in excess of the electricity generated by the project renewable energy plant during a monitoring period.

47. During the monitoring periods where the PSP consumes more than 2 per cent of the electricity in excess of the electricity generated by the project renewable energy plant, the project participant shall not be entitled to issuance of the CCC for the concerned monitoring period.

48. Furthermore, the project participant(s) should compensate in full any negative emissions reductions which may arise from power consumption from the grid by the PSP, including for monitoring periods for which no emission reductions can be claimed. These will be adjusted from subsequent issuances.

4.5. Baseline emissions

49. Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The methodology assumes that all project electricity generation above baseline levels would have been generated by

[7] For example, when the electricity from the renewable energy plant is not available for the internal consumption of the pumped storage plant.

existing grid-connected power plants and/or the addition of new grid-connected power plants. The baseline emissions are to be calculated as follows:

$$BE_y = EG_{PJ,y} \times EF_{grid,\mathrm{CM},y} \qquad \text{Equation (11)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and supplied to the grid as a result of the implementation of the ICM project activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	=	Grid Emission Factor (for net effective injection into grid) for grid connected power generation in year *y,* as published by the CEA[8]

4.5.1. Calculation of quantity of net electricity generation

50. The calculation of $EG_{PJ,y}$ is different for Greenfield plants, capacity additions, retrofits, rehabilitations, and replacements. These cases are described as follows:

4.5.1.1. Greenfield power plants

51. If the project activity is the installation of a Greenfield power plant with or without the BESS or PSPs operating in coordination with a Greenfield power plant, as described under paragraph 9(a) or paragraph 10(a) above $EG_{PJ,y}$ shall be calculated as follows :

$$EG_{PJ,y} = EG_{facility,y} \qquad \text{Equation (12)}$$

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and supplied to the grid as a result of the implementation of the ICM project activity in year *y* (MWh/yr).
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plant/unit to the grid in year *y* (MWh/yr)

4.5.1.2. Capacity addition to offshore wind, wave or tidal plants/units

52. In the case of capacity additions referred to in paragraphs 5(b) and 6(b), different approaches apply according to renewable energy technologies. In the case of offshore wind, wave or tidal power plants/units, it is assumed that the addition of new capacity does not significantly affect the electricity generated by existing plants/units.[9] In this case, the electricity supplied to the grid by the added power plants/units shall be directly metered and used to determine $EG_{PJ,y}$.

$$EG_{PJ,y} = EG_{PJ\_Add,y} \qquad \text{Equation (13)}$$

[8] https://cea.nic.in/?lang=en

[9] In this case of capacity additions to wind power plants/units, some shadow effects can occur, but are not accounted under this methodology.

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and supplied to the grid as a result of the implementation of the ICM project activity in year *y* (MWh/yr)
$EG_{PJ\_Add,y}$	=	Quantity of net electricity generation supplied to the grid in year *y* by the project plant/unit that has been added under the project activity (MWh/yr)

4.5.1.3. Capacity addition to hydro or geothermal power plants/units

53. In the case of hydro or geothermal power plants/units, the addition of new power plants/units under paragraph 5(b) may significantly affect the electricity generated by the existing plants/units. For example, a new hydro turbine installed at an existing dam may affect the power generation by the existing turbines. Therefore, the approach as in section 5.5.1.4 below for retrofit or rehabilitation or replacement projects shall be used. . $EG_{facility,y}$ corresponds to the net electricity generation supplied to a grid by the existing plants/units and the added plants/units together constituting "project plants/units". A separate metering of electricity supplied to a grid by the added plants/units is not necessary under this option.

4.5.1.4. Retrofit or rehabilitation or replacement of an existing renewable energy power plant

54. If the project activity is the retrofit or rehabilitation or replacement of an existing grid-connected renewable energy power plant as described under paragraphs 9(c), 9(d) 9(e) above, or retrofit of an existing power plant/unit with the BESS as described under paragraph 10(d) above, the methodology uses historical electricity generation data to determine the electricity generation by the existing plant in the baseline scenario, assuming that the historical situation observed prior to the implementation of the project activity would continue.

55. The power generation from renewable energy generation project activities can vary significantly from year to year, due to natural variations in the availability of the renewable source (e.g. varying rainfall, wind speed or solar radiation). The use of few historical years to establish the baseline electricity generation can therefore involve a significant uncertainty. The methodology addresses this uncertainty by adjusting the historical electricity generation by its standard deviation. This ensures that the baseline electricity generation is established in a conservative manner and that the calculated emission reductions are attributable to the project activity. Without this adjustment, the calculated emission reductions could mainly depend on the natural variability observed during the historical period rather than the effects of the project activity.[10]

56. $EG_{PJ,y}$ is calculated as follows:

$$EG_{PJ,y} = EG_{facility,y} - (EG_{historical} + \sigma_{historical}); until\ DATE_{BaselineRetrofit} \qquad \text{Equation (14)}$$

[10] As an alternative approach for hydropower plants, the baseline electricity generation could be established as a function of the water availability. In this case, the baseline electricity generation would be established ex post based on the water availability monitored during the crediting period. Project participants are encouraged to consider such approaches and submit the related request for a revision to this methodology.

and

$$EG_{PJ,y} = 0; on/after\ DATE_{BaselineRetrofit} \quad \text{Equation (15)}$$

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and supplied to the grid as a result of the implementation of the ICM project activity in year *y* (MWh/yr)
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the project plants/units to the grid in year *y* (MWh/yr)
$EG_{historical}$	=	Annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$\sigma_{historical}$	=	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy power plants/units that was operated at the project site prior to the implementation of the project activity (MWh/yr)
$DATE_{BaselineRetrofit}$	=	Point in time when the existing equipment would need to be replaced in the absence of the project activity (date). This only applies to retrofit or replacement projects

57. In case $EG_{facility,y} < (EG_{historical} + \sigma_{historical})$ in a year *y* then:

$$EG_{PJ,y} = 0 \quad \text{Equation (16)}$$

58. To determine $EG_{historical}$, project participants may choose between two historical periods as shown in the following paragraph. This allows some flexibility of application in that the use of the longer time period may result in a lower standard deviation and the use of the shorter period may allow a better reflection of the (technical) circumstances observed during the more recent years.

59. Project participants may choose among the following two-time spans of historical data to determine $EG_{historical}$:

(a) The last five calendar years prior to the implementation of the project activity; or

(b) The time period from the calendar year following $DATE_{hist}$, up to the last calendar year prior to the implementation of the project, as long as this time span includes at least five calendar years, where $DATE_{hist}$ is latest point in time between:

(i) The commissioning of the plant/unit;

(ii) If applicable: the last capacity addition to the plant/unit; or

(iii) If applicable: the last retrofit or rehabilitation of the plant/unit.

60. In case of rehabilitation where the power plant/unit did not operate for the last five calendar years before the rehabilitation starts, $EG_{historical}$ is equal to zero.

4.5.2. Calculation of $DATE_{BaselineRetrofit}$

61. In order to estimate the point in time when the existing equipment would need to be replaced/retrofitted in the absence of the project activity ($DATE_{BaselineRetrofit}$), project participants may take into account the typical average technical lifetime of the equipment, which shall be determined and documented

62. The point in time when the existing equipment would need to be replaced/retrofitted in the absence of the project activity should be chosen in a conservative manner that is, if a range is identified, the earliest date should be chosen.

4.6. Leakage

63. No other leakage emissions are considered. The emissions potentially arising due to activities such as power plant construction and upstream emissions from fossil fuel use (e.g., extraction, processing, transport etc.) are neglected.

4.7. Emission reductions

64. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y$$ Equation (17)

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e/yr)
BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
PE_y	=	Project emissions in year *y* (t CO_2e/yr)

4.7.1. Estimation of emission reductions prior to validation

65. Project participants shall prepare as part of the ICM-PDD an estimate of likely emission reductions from the proposed project activity during the crediting period.

66. Where the grid emission factor ($EF_{CM,grid,y}$) is determined ex-post during monitoring, non-obligated entities may use the annual grid emission factor, corresponding to the time period of the data being used for calculating emission reductions, as published by the Central Electricity Authority (CEA) under 'CO2 Baseline Database' under Annual Reports[11]. The choice between ex-ante and ex-post vintage for calculation of the build margin and the operating margin should be specified in the PDD and cannot be changed during the crediting period.

4.8. Data and parameters not monitored

67. In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

[11] https://cea.nic.in/?lang=en

Data / Parameter table 1.

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of methane
Source of data:	IPCC Sixth Assessment Report (AR6)
Value to be applied:	Value: 29.8 t CO_2e/t CH_4
Any comment:	The GWP value will be updated in line with the latest available IPCC Assessment Reports.

Data / Parameter table 2.

Data / Parameter:	$EG_{historical}$
Data unit:	MWh/yr
Description:	Annual average historical net electricity generation delivered to the grid by the existing renewable energy power plant that was operated at the project site prior to the implementation of the project activity
Source of data:	Project activity site
Value to be applied:	Electricity meters
Any comment:	–

Data / Parameter table 3.

Data / Parameter:	$\sigma_{historical}$
Data unit:	MWh/yr
Description:	Standard deviation of the annual average historical net electricity generation delivered to the grid by the existing renewable energy power plant that was operated at the project site prior to the implementation of the project activity
Source of data:	Calculated from data used to establish $EG_{historical}$
Value to be applied:	Parameter to be calculated as the standard deviation of the annual generation data used to calculate $EG_{historical}$ for retrofit, or rehabilitation or replacement project activities
Any comment:	–

Data / Parameter table 4.

Data / Parameter:	$DATE_{BaselineRetrofit}$
Data unit:	date
Description:	Point in time when the existing equipment would need to be replaced in the absence of the project activity
Source of data:	Project activity site
Value to be applied:	As per provisions in the methodology above
Any comment:	–

Data / Parameter table 5.

Data / Parameter:	***$DATE_{hist}$***
Data unit:	date
Description:	Point in time from which the time span of historical date for retrofit, rehabilitation or replacement project activities may start
Source of data:	Project activity site
Value to be applied:	$DATE_{hist}$ is the latest point in time between: (a) The commercial commissioning of the plant/unit; (b) If applicable: the last capacity addition to the plant/unit; or (c) If applicable: the last retrofit or rehabilitation of the plant/unit
Any comment:	–

Data / Parameter table 6.

Data / Parameter:	***EF_{Res}***
Data unit:	$kgCO_2e/MWh$
Description:	Default emission factor for emissions from reservoirs
Source of data:	Decision at EB 23
Value to be applied:	90 $kgCO_2e/MWh$
Any comment:	

Data / Parameter table 7.

Data / Parameter:	***Cap_{BL}***
Data unit:	W
Description:	Installed capacity of the hydro power plant before the implementation of the project activity. For new hydro power plants, this value is zero
Source of data:	Project site
Value to be applied:	Determine the installed capacity based on manufacturer's specifications or recognized standards
Any comment:	–

Data / Parameter table 8.

Data / Parameter:	***A_{BL}***
Data unit:	m^2
Description:	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full (m^2). For new reservoirs, this value is zero
Source of data:	Project site
Value to be applied:	Measured from topographical surveys, maps, satellite pictures, etc.
Any comment:	–

Data / Parameter table 9.

Data / Parameter:	$GWP_{working\ fluid}$
Data unit:	–
Description:	Global Warming Potential for the Working Fluid used in the binary geothermal plant
Source of data:	IPCC
Value to be applied:	–
Any comment:	–

5. Methodology: Monitoring Component

68. All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

69. In addition, the monitoring provisions in the tools referred to in this methodology apply. Accordingly, $EG_{facility,y}$, $EG_{PJ\_Add,y}$, , $EC_{BESS,y}$, and $EC_{PSP,y}$ should be determined as per BM-T-003, and $PE_{FF,y}$ should be determined as per BM-T-002.

5.1. Data and parameters monitored

Data / Parameter table 10.

Data / Parameter:	$w_{steam,CO2,y}$
Data unit:	t CO_2/t steam
Description:	Average mass fraction of carbon dioxide in the produced steam in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	Non-condensable gases sampling should be carried out in production wells and/or at the steam field-power plant interface using ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis (as applicable to sampling single phase steam only). The CO_2 and CH_4 sampling and analysis procedure consists of collecting non-condensable gases samples from the main steam line with glass flasks, filled with sodium hydroxide solution and additional chemicals to prevent oxidation. H_2S and CO_2 dissolve in the solvent while the residual compounds remain in their gaseous phase. The gas portion is then analyzed using gas chromatography to determine the content of the residuals including CH_4. All alkanes concentrations are reported in terms of methane.
Monitoring frequency:	At least every three months and more frequently, if necessary
QA/QC procedures:	–
Any comment:	Applicable to dry, flash steam and binary geothermal power projects

Data / Parameter table 11.

Data / Parameter:	$\boldsymbol{w_{steam,CH4,y}}$
Data unit:	t CH_4/t steam
Description:	Average mass fraction of methane in the produced steam in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	As per the procedures outlined for $w_{steam,CO2,y}$
QA/QC procedures:	–
Any comment:	Applicable to dry, flash steam and binary geothermal power projects

Data / Parameter table 12.

Data / Parameter:	$\boldsymbol{M_{steam,y}}$
Data unit:	t steam/year
Description:	Quantity of steam produced in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	The steam quantity discharged from the geothermal wells should be measured with a Venturi flow meter (or other equipment with at least the same accuracy). Measurement of temperature and pressure upstream of the Venturi meter is required to define the steam properties. The calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards. The measurement results should be summarized transparently in regular production reports
Monitoring frequency:	Daily
QA/QC procedures:	–
Any comment:	Applicable to dry or flash steam geothermal power projects

Data / Parameter table 13.

Data / Parameter:	$\boldsymbol{TEG_y}$
Data unit:	MWh/year
Description:	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	Electricity meters
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	Calibration records of the electricity meters to be maintained and archived
Any comment:	Applicable to hydro power project activities with a power density greater than 4 W/m^2 and less than or equal to 10 W/m^2

Data / Parameter table 14.

Data / Parameter:	$EG_{PJ,y}$
Data unit:	MWh/year
Description:	Quantity of net electricity generation that is produced and supplied to the grid as a result of the implementation of the ICM project activity in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	Electricity meters or Calculated as follows: $EG_{PJ,y} = TEG_y - Aux_y$
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	Calibration records of the electricity meters to be maintained and archived
Any comment:	In case the on site electricity meter provides direct values for $EG_{PJ,y}$, the same can be used and calculations are not required.

Data / Parameter table 15.

Data / Parameter:	$Aux_{,y}$
Data unit:	MWh/year
Description:	Quantity of electricity that is consumed from the grid or from the electricity generation plant under the ICM project activity in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	Electricity meters
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	Calibration records of the electricity meters to be maintained and archived
Any comment:	

Data / Parameter table 16.

Data / Parameter:	Cap_{PJ}
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the project activity
Source of data:	Project site
Measurement procedures (if any):	Determine the installed capacity based on manufacturer’s specifications or commissioning data or recognized standards
Monitoring frequency:	Once at the beginning of each crediting period
QA/QC procedures:	–
Any comment:	–

Data / Parameter table 17.

Data / Parameter:	A_{PJ}
Data unit:	m^2
Description:	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full
Source of data:	Project site
Measurement procedures (if any):	Measured from topographical surveys, maps, satellite pictures, etc.
Monitoring frequency:	Once at the beginning of each crediting period
QA/QC procedures:	–
Any comment:	–

Data / Parameter table 18.

Data / Parameter:	$M_{inflow,y}$
Data unit:	t steam/year
Description:	Quantity of steam entering the geothermal plant in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	The steam quantity entering the power plant should be measured with a Venturi flow meter (or other equipment with at least the same accuracy). Measurement of temperature and pressure upstream of the Venturi meter is required to define the steam properties. The calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards. The measurement results should be summarized transparently in regular production reports
Monitoring frequency:	Continuous
QA/QC procedures:	The flow meter must be calibrated according to the national, international, or manufacturer’s instructions. The recorded data must be stored daily in a central database with backup
Any comment:	–

Data / Parameter table 19.

Data / Parameter:	$M_{outflow,y}$
Data unit:	t steam/year
Description:	Quantity of steam leaving the geothermal plant in year *y*
Source of data:	Project activity site
Measurement procedures (if any):	The steam quantity entering the power plant should be measured with a Venturi flow meter (or other equipment with at least the same accuracy). Measurement of temperature and pressure upstream of the Venturi meter is required to define the steam properties. The calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards.
Monitoring frequency:	Continuous

QA/QC procedures:	The flow meter must be calibrated according to the national, international, or manufacturer's instructions. The recorded data must be stored daily in a central database with backup
Any comment:	–

Data / Parameter table 20.

Data / Parameter:	$M_{working\ fluid,y}$
Data unit:	t working fluid/year
Description:	Quantity of working fluid leaked/reinjected in year *y*
Source of data:	Project site
Measurement procedures (if any):	Measured via log books and maintenance reports of the plant
Monitoring frequency:	Annually
QA/QC procedures:	Measured from the amount of working flow reinjected to the binary system of the geothermal plant. Cross check with the purchase invoices
Any comment:	–

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

Ministry of Power

Ministry of Environment,

Forest and Climate Change

METHODOLOGY

BM EN01.002

Hydrogen production from electrolysis of water

Publication Date:

Version 1.0

Sectoral scope(s): Energy & Industries

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AM0124 (as valid from 27 September 2023).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical projects	Production of hydrogen through electrolysis of water using electricity from a captive renewable power plant only, or from a mix of electricity predominantly from a captive renewable plant and residually from the electric grid. The hydrogen produced is supplied to an existing dedicated consumer.
Type of GHG emissions mitigation action	• Fuel or feedstock switch • Renewable energy

2. Definitions

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

   (a) **Captive power plant :** a facility that provides electricity to a captive consumer to meet its entire or partial electricity demand. The captive power plant may or may not be operated in a grid-connected mode;

   (b) **Existing dedicated consumer:** an existing facility that has consumed grey hydrogen as a feedstock in a chemical process prior to the implementation of the project activity, and switches to the project hydrogen (green hydrogen) under the project activity. Examples of facilities include, among others, ammonia plants and oil refineries

   (c) **Electrolyser hydrogen production plant:** a facility that produces hydrogen from the electrolysis of water. Under this methodology, the hydrogen production plant includes the desalted water station, electrolytic cell, hydrogen compressor, gas-liquid processor, hydrogen purification unit and other ancillary equipment;

   (d) **Gasification of coal:** an industrial process where coal is converted into syngas through a process of gasification;

   (e) **Steam reforming of syngas:** an industrial process where the syngas produced from the gasification of coal or oil reacts with steam in the presence of a catalyst to produce hydrogen, carbon monoxide and releases carbon dioxide as a by-product;

   (f) **Steam reforming of natural gas:** an industrial process where natural gas reacts with steam in the presence of a catalyst to produce hydrogen, carbon monoxide and releases carbon dioxide as a by-product.

(g) In addition, definition of Renewable Energy and OTEC as recognized by Central Government will be applied.

3. Scope & Applicability

3.1. Scope

5. The methodology applies to project activities where hydrogen is produced by electrolysis of water and is supplied to existing dedicated consumer(s). The electricity consumed by the electrolyser hydrogen production plant shall be sourced from a captive renewable power plant only, or from a mix of electricity predominantly from a captive renewable power plant and residually from the electric grid.

3.2. Applicability

6. This methodology is applicable to project activities that include the construction of a new captive renewable power plant and a new electrolyser hydrogen production plant. Retrofitting, rehabilitation (or refurbishment), replacement or capacity addition of an existing electrolyser hydrogen production plant or of an existing captive renewable power plant are not covered by this methodology.

7. The hydrogen produced by the project activity (hereinafter referred as 'project hydrogen') is supplied to (an) existing dedicated consumer(s) located in the host country and identified ex-ante in the project design document (PDD). Prior to the implementation of the project activity, the hydrogen supplied to the existing consumer(s) has been produced through gasification of coal, or steam reforming of natural gas or oil.

8. The captive renewable power plant shall be a renewable energy power plant. Purchase of renewable electricity via renewable electricity certificates are not covered by this methodology.

9. The project activity shall ensure that the ratio between the electricity consumed from the grid ($EC_{PJ,grid,y}$) and the electricity consumed from the captive renewable power plant ($EC_{PJ,captive,y}$) by the electrolyser hydrogen production plant is below 0.1 on an annual basis. The ACVA shall confirm that this ratio requirement is met by comparing the data on the electricity consumed from the two sources annually.

10. The Non-obligated entity shall demonstrate that double counting of emission reductions will not occur, e.g. via a contractual agreement with the dedicated consumer of the hydrogen produced. The steps to be taken to avoid double counting shall be documented in the project design document.

11. The methodology is applicable only if the most plausible baseline scenarios identified after applying "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" are "Production of hydrogen from the steam reforming of syngas produced from the gasification of coal without capture and storage of CO_2", "Production of hydrogen from the steam reforming of natural gas without capture and storage of CO_2" or "Production of hydrogen from the steam reforming of syngas produced from the gasification of oil in general without capture and storage of CO_2".

12. The project shall use no more than 5 per cent of the drinking water available locally, to ensure that the water used in the electrolysis will not displace other uses. This check shall

be made at validation and at each renewal of the crediting period using data from the project activity and from official sources.

13. The applicability conditions included in the tools (section 3.5) below also apply.

3.3. Entry into force

14. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of sectoral scopes

15. For validation and verification of ICM projects by a designated ACVA using this methodology, application of sectoral scope "*01: Energy*" and "*02: Industries*" is mandatory.

3.5. Applicability of approved tools

16. This methodology also refers to the latest approved versions of the following adopted ICM tools:

(a) "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as BM-T-001);

(b) "BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

(c) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

(d) "BM-T-005: Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (hereinafter referred to as BM-T-005);

(e) "BM-T-007: Project and leakage emissions from transportation of freight" (hereinafter referred to as BM-T-007).

4. Methodology: Baseline Component

4.1. Project boundary

17. The spatial extent of the project boundary encompasses:

(a) The electrolyser hydrogen production plant;

(b) The captive renewable power plant;

(c) All power plants/units connected physically to the electric grid to which the hydrogen production plant is connected; and

(d) The existing dedicated consumer of the project hydrogen.

18. The greenhouse gases included in or excluded from the project boundary are shown in Table 2.

Table 2. **Emission sources included in or excluded from the project boundary**

Source		Gas	Included	Justification/Explanation
Baseline	Emissions from hydrogen production	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
Project activity	Emissions from the electricity consumption by the electrolyser hydrogen production plant	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emissions from the consumption of fossil fuels by the electrolyser hydrogen production plant (e.g. by the desalination plant)	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emissions from the consumption of fossil fuels to transport the project hydrogen by road	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification
	Emissions from the consumption of electricity to transport the project hydrogen by pipeline	CO_2	Yes	Might be an important emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

4.2. Identification of the baseline scenario and demonstration of additionality

19. Non-obligated entities shall apply the latest approved version of BM-T-001 to identify the baseline scenario among all reasonable potential alternative scenarios that could provide similar output/services as the proposed project activity and to demonstrate additionality.

20. In applying Step 1 of BM-T-001, baseline alternatives for the production of hydrogen, the Non-obligated entity shall take into consideration, inter alia, the following alternatives:

(a) P1: The proposed project activity undertaken without being registered as a ICM project activity;

(b) P2: Production of hydrogen through electrolysis of water using electricity from the grid only;

(c) P3: Production of hydrogen through electrolysis of water using electricity from a captive power plant that is neither solar nor wind;

(d) P4: Production of hydrogen from the steam reforming of syngas produced from the gasification of coal without capture and storage of CO_2;

(e) P5: Production of hydrogen from the steam reforming of syngas produced from the gasification of coal with capture and storage of CO_2;

(f) P6: Production of hydrogen from the steam reforming of natural gas without capture and storage of CO_2;

(g) P7: Production of hydrogen from the steam reforming of natural gas with capture and storage of CO_2;

(h) P8: Production of hydrogen from the steam reforming of syngas produced from the gasification of oil without capture and storage of CO_2;

(i) P9: Production of hydrogen from the steam reforming of syngas produced from the gasification of oil with capture and storage of CO_2;

(j) P10: Production of hydrogen as a by-product of industrial processes (e.g. as chlor alkali, coking, steel);

(k) P11: Production of hydrogen from chemical raw materials (e.g. methanol, ethanol, liquid ammonia cracking);

(l) P12: Production of hydrogen from photochemical process.

(m) P13: Production of hydrogen from refinery pet coke

4.3. Baseline emissions

21. The baseline emissions are calculated as the product between the quantity of project hydrogen produced and the emission factor of the existing baseline hydrogen production plant, as per the equation below.

$$BE_y = M_{H2,PJ,y} \times EF_{H2,BL}; until\ DATE_{H2\ plant,BL}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (tCO_2)
$M_{H2,PJ,y}$	=	Mass of pure hydrogen produced by project activity and consumed by existing dedicated consumers in year *y* (tH_2)
$EF_{H2,BL}$	=	Emission factor of the existing baseline hydrogen production plant (tCO_2e/tH_2)
$DATE_{H2\ plant,BL}$	=	Date when the existing baseline hydrogen production plant’s lifetime will come to an end (date).

22. The baseline emission factor of the existing baseline hydrogen production plant ($EF_{H2,BL}$) shall be the minimum between (a) and (b) below:

(a) Use the following values derived from IEA (2023)[1]:

(i) 19 tCO_2e/tH_2 if the baseline scenario is the production of hydrogen from coal (scenario P4);

(ii) 9 tCO_2e/tH_2 if the baseline scenario is the production of hydrogen from natural gas (scenario P6) or from oil (scenario P8).

(b) The emission factor determined based on three years historical data of electricity and fossil fuel consumed and hydrogen produced by the existing baseline hydrogen production plant, following the equation below:

$$EF_{H2,BL} = \sum_{t-3}^{t-1} \frac{(EC_{H2,BL,t} \times EF_{EF,BL,t}) + \left(\sum_i FC_{i,BL,t} \times NCV_i \times EF_{CO2,i}\right)}{M_{H2,BL,t}} \quad \text{Equation (2)}$$

Where:

$EC_{H2,BL,t}$	=	Electricity consumed by the existing baseline hydrogen production plant in year *t* (MWh)
$EF_{EF,BL,t}$	=	Emission factor of the electricity source supplying electricity to the existing baseline hydrogen production plant in year *t* (tCO_2e/MWh)
$FC_{i,BL,t}$	=	Fossil fuel type *i* consumed by the existing baseline hydrogen production plant in year *t* (mass or volume units)
NCV_i	=	Net calorific value of the fossil fuel *i* (GJ/mass or volume units)
$EF_{CO2,i}$	=	CO_2 emission factor of the fossil fuel *i* (tCO_2/GJ)

[1] International Energy Agency (IEA). (2023). *Towards hydrogen definitions based on their emissions intensity.* Available at https://iea.blob.core.windows.net/assets/acc7a642-e42b-4972-8893-2f03bf0bfa03/Towardshydrogendefinitionsbasedontheiremissionsintensity.pdf, accessed on 05 July 2023. See pages 9 and 40. For hydrogen produced from oil, the emission factor was conservatively assumed to be equal to the emission factor from the use of natural gas. Upstream emissions related to fossil fuel production have been excluded in the estimation and the values were proposed as follows:

a) For the production of hydrogen through coal, IEA (2023) states that *'Hydrogen production from coal gasification without CCS results in total emissions of 22-26 $kgCO_2e/kg_{H2}$ (…)'*, and *'More than 80% of the emissions intensity of hydrogen production from coal is from direct emissions at the production plant and less than 20% is linked to coal mining, processing and transport.'* A value of 19 $kgCO_2e/kg_{H2}$ is proposed as the product of the share of direct emissions at the production plant (80%) and a median value of emissions from hydrogen produced from coal without CCS of 24 $kgCO_2e/kg_{H2}$;

b) For the production of hydrogen through natural gas, IEA (2023) states that *'Hydrogen production from unabated natural gas results in an emissions intensity in the range of 10-14 $kgCO_2e/kg_{H2}$, with upstream and midstream emissions of methane and CO2 in natural gas production being responsible for 1-5 $kgCO_2e/kg_{H2}$.'* A value of 9 $kgCO_2e/kg_{H2}$ is proposed as the difference of the median value of emissions from hydrogen produced from unabated natural gas (12 $kgCO_2e/kg_{H2}$) and the median value for upstream and midstream emissions of methane and CO_2 in natural gas production (3 $kgCO_2e/kg_{H2}$).

$M_{H2,BL,t}$	=	Mass of pure hydrogen produced by the existing baseline hydrogen production plant in year *t* (tH_2). Follow provisions and equations from paragraphs 23 and 24 below.
t	=	Calendar year of the start date of the project activity

23. If the project activity measures hydrogen production in volume units in standard temperature and pressure (STP), $M_{H2,y}$ is calculated according to the equation below:

$$M_{H2,PJ,y} = \sum_{t=1}^{y} V_{0,t} \times v_{H2,t} \times \frac{2}{22.4} \times 10^{-3}$$ Equation (3)

Where:

$V_{0,t}$	=	The volumetric flow of gas in STP in time interval *t* (Sm^3)
$v_{H2,t}$	=	Volumetric fraction of hydrogen in time interval *t* (m^3H_2/m^3_{gas})
t	=	The time-period of data reading (e.g. minute, hour, month)
22.4	=	Volume of gas in standard conditions (Sm^3/kmol)
2	=	Mass of one mole of hydrogen (kg/kmol)

24. If the project cannot directly monitor the volume of hydrogen under standard conditions, it can be converted through the following formula:

$$V_{0,t} = \frac{V_{H2,t} \times P_{H2,t} \times 273.15}{101{,}325 \times (273.15 + T_{H2,t})}$$ Equation (4)

Where:

$V_{H2,t}$	=	Volumetric flow of hydrogen at operational conditions in the time interval *t* (m^3)
$P_{H2,t}$	=	Pressure of compressed hydrogen in the time interval *t* (Pa)
$T_{H2,t}$	=	Temperature of compressed hydrogen in the time interval *t* (K)

4.4. Project emissions

25. Project emissions include the emissions from electricity consumption other than that from the captive renewable power plant, emissions from any fossil fuel consumed (e.g. by the desalination plant), emissions from the incremental transportation of project hydrogen to existing dedicated consumers and emissions due to physical leaks of hydrogen, and are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{transport,y} + PE_{H2-leaks,y}$$ Equation (5)

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)

$PE_{EC,y}$	=	Project emissions from the consumption of electricity from sources other than the captive renewable power plant to operate the electrolyser hydrogen production plant in year *y* (tCO_2e). Determined as per BM-T-003 and applying the combined margin emission factor[2].
$PE_{FC,y}$	=	Project emissions from the consumption of fossil fuels to operate the electrolyser hydrogen production plant in year *y* (tCO_2e). Determined as per BM-T-002.
$PE_{transport,y}$	=	Project emissions due to incremental transportation of hydrogen to existing dedicated consumers in year *y* (tCO_2e)
$PE_{H2-leaks,y}$	=	Project emissions due to physical leaks of hydrogen in the project activity in year *y* (tCO_2e)

4.4.1. Project emissions due to incremental transportation of hydrogen

26. Project emissions due to incremental road and pipeline transportation of project hydrogen ($\boldsymbol{PE_{transport,y}}$) shall be calculated as follows only if the transportation distance between the baseline hydrogen production plant and the existing dedicated consumer within the host country is shorter than the distane between the project hydrogen production plant and the dedicated consumer:

$$PE_{transport,y} = PE_{road,y} + PE_{pipeline,y} \quad \text{Equation (6)}$$

Where:

$PE_{road,y}$	=	Project emissions due to incremental road transportation of hydrogen in year *y* (tCO_2e)
$PE_{pipeline,y}$	=	Project emissions due to transportation of hydrogen via pipelines in year *y* (tCO_2e)

27. In case the project hydrogen is transported via road, the project emissions shall be calculated based on the BM-T-007, and the parameter $D_{f,m}$ in the tool shall correspond to the difference of the return trip distances between (i) the baseline hydrogen production plant and the existing dedicated consumer and (ii) the electrolysis hydrogen production plant and the dedicated consumer.

28. In case the hydrogen is transported using pipelines, project emissions due to operation of pipelines to transport the hydrogen shall be calculated as follows.

$$PE_{pipeline,y} = EC_{H2,pipeline,y} \times EF_y \quad \text{Equation (7)}$$

Where:

$EC_{H2,pipeline,y}$	=	Electricity consumed for operating pipelines that transport the hydrogen in year *y* (MWh)
EF_y	=	Electricity emission factor in year *y* (tCO_2/MWh) determined as per BM-T-003

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[2] This conservative grid emission factor is used because it is possible that the electricity is mainly used from the grid at times when solar or wind power is not available. Any marginal increase in demand during these times only could affect the mostly GHG emission intensive power generation.

4.4.2. Project emissions due to physical leaks of hydrogen

29. Non-obligated entity shall document in the project design document a plan to minimize physical leaks of hydrogen in its value chain including production, compression, storage, transportation and use. The monitoring report shall demonstrate the implementation of this plan, which should be verified by the designated operating entity through site visits and/or documentation review.

30. If the Non-obligated entity failed to demonstrate full implementation of the plan to minimize physical leaks of hydrogen, then the Non-obligated entity shall calculate the project emissions due to physical leaks of hydrogen from its value chain as follows:

$$PE_{H2-leaks} = M_{H2,PJ,y} \times PL_{H2} \times GWP_{H2}$$ Equation (8)

Where:

PL_{H2}	=	Physical leaks of hydrogen in hydrogen value chain as a percentage of the total production (%)
GWP_{H2}	=	Global warming potential of hydrogen (tCO_2e/t_{H2}).

4.5. Leakage

31. No Leakage is considered under this methodology.

4.6. Emission reductions

32. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$ Equation (9)

Where:

ER_y	=	Emission reductions in year *y* (tCO_2e)
BE_y	=	Baseline emissions in year *y* (tCO_2e)
PE_y	=	Project emissions in year *y* (tCO_2e)
LE_y	=	Leakage emissions in year *y* (tCO_2e)

5. Methodology: Monitoring Component

5.1. Data and parameters not monitored

33. In addition to the parameters listed in the tables below. provisions on data and parameters not monitored that are contained in the tools referred to in this methodology, and which are needed to calculate emission reductions, apply.

Data / Parameter table 1.

Data / Parameter:	$DATE_{H2\ plant,BL}$
Data unit:	Date

Description:	Date when the existing baseline hydrogen production plant's lifetime will come to an end
Source of data:	Information to be sourced from the existing baseline hydrogen production plant
Value to be applied	N/A
Any comment:	

Data / Parameter table 2.

Data / Parameter:	$\boldsymbol{EC_{H2,BL,t}}$
Data unit:	MWh
Description:	Electricity consumed by the existing baseline hydrogen production plant in year *t*
Source of data:	Measured following the provisions of the parameter $EC_{BL,k,y}$ from BM-T-003
Value to be applied	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$\boldsymbol{EF_{EF,BL,t}}$
Data unit:	tCO_2e/MWh
Description:	Emission factor of the electricity source supplying electricity to the existing baseline hydrogen production plant in year *t*
Source of data:	Determined following the provisions of the parameter $EF_{EF,k,y}$ from BM-T-003
Value to be applied	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$\boldsymbol{FC_{i,BL,t}}$
Data unit:	Mass or volume units
Description:	Fossil fuel type *i* consumed by the existing baseline hydrogen production plant in year *t*
Source of data:	Measured following the provisions of the parameter $FC_{i,j,y}$ from BM-T-002.
Value to be applied	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$\boldsymbol{NCV_i}$
Data unit:	GJ/mass or volume units
Description:	Net calorific value of the fossil fuel *i*
Source of data:	Determined following the provisions of the parameter $NCV_{i,y}$ from BM-T-002

Value to be applied	-
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$EF_{CO2,i}$
Data unit:	tCO_2/GJ
Description:	CO_2 emission factor of the fossil fuel *i*
Source of data:	Determined following the provisions of the parameter $EF_{CO2,i,y}$ from BM-T-002
Value to be applied	-
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	$M_{H2,BL,t}$
Data unit:	tH_2
Description:	Mass of pure hydrogen produced by the existing baseline hydrogen production plant in year *t*
Source of data:	Apply provisions and equations from paragraphs 23 and 24
Value to be applied	-
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	PL_{H2}
Data unit:	%
Description:	Physical leaks of hydrogen in hydrogen value chain as a percentage of the total production
Source of data:	A study “Hydrogen emissions from the hydrogen value chain-emissions profile and impact to global warming” by Jasmin Cooper, Luke Dubey, Semra Bakkaloglu, Adam Hawkes, published at “Science of The Total Environment”, by Elsevier B.V. on 15 July 2022.
Value to be applied	5
Any comment:	The Non-obligated entitys may propose another value through a request for revision of this methodology

Data / Parameter table 9.

Data / Parameter:	GWP_{H2}
Data unit:	tCO_2e/t_{H2}
Description:	Global warming potential of hydrogen
Source of data:	IPCC AR4 WG1 as under chapeter 2.10.3.6
Value to be applied	5.8
Any comment:	The GWP value is calculated as an indirect 100-year GWP

5.2. Data and parameters monitored

34. All data collected as part of monitoring should be archived electronically and kept for at least two years after the end of the last crediting period. All of the data in the tables below should be monitored unless otherwise indicated. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

35. In addition to the parameters listed in the tables below, the procedures contained in the tools referred to in this methodology also apply.

Data / Parameter table 10.

Data / Parameter:	$V_{0,t}$
Data unit:	Sm^3
Description:	The volumetric flow of gas in STP in time interval *t*
Source of data:	As per BM-T-005
Measurement procedures (if any):	As per BM-T-005
Monitoring frequency:	As per BM-T-005
QA/QC procedures:	As per BM-T-005
Any comment:	Non-obligated entities shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $V_{t,wb}$ or $V_{t,db}$ from BM-T-005.

Data / Parameter table 11.

Data / Parameter:	$v_{H2,t}$
Data unit:	m^3_{H2}/m^3_{gas}
Description:	Volumetric fraction of hydrogen in time interval *t*
Source of data:	As per BM-T-005
Measurement procedures (if any):	As per BM-T-005
Monitoring frequency:	As per BM-T-005
QA/QC procedures:	As per BM-T-005
Any comment:	Non-obligated entities shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $v_{t,i,wb}$ or $v_{t,i,db}$ from BM-T-005

Data / Parameter table 12.

Data / Parameter:	$V_{H2,t}$
Data unit:	Volumetric flow of the hydrogen at operational conditions in the time interval *t*
Description:	m^3
Source of data:	As per BM-T-005
Measurement procedures (if any):	As per BM-T-005
Monitoring frequency:	As per BM-T-005

QA/QC procedures:	As per BM-T-005
Any comment:	Non-obligated entitys shall specify whether the flow is measured on wet or dry basis and follow the monitoring provisions of the parameters $V_{t,wb}$ or $V_{t,db}$ from BM-T-005

Data / Parameter table 13.

Data / Parameter:	$P_{H2,t}$
Data unit:	Pa
Description:	Pressure of the compressed hydrogen in time the interval t
Source of data:	As per BM-T-005
Measurement procedures (if any):	As per BM-T-005
Monitoring frequency:	As per BM-T-005
QA/QC procedures:	As per BM-T-005
Any comment:	As per BM-T-005

Data / Parameter table 14.

Data / Parameter:	$T_{H2,t}$
Data unit:	K
Description:	Temperature of the compressed hydrogen in the time interval t
Source of data:	As per BM-T-005
Measurement procedures (if any):	As per BM-T-005
Monitoring frequency:	As per BM-T-005
QA/QC procedures:	As per BM-T-005
Any comment:	As per BM-T-005

Data / Parameter table 15.

Data / Parameter:	$PE_{EC,y}$
Data unit:	tCO_2e/year
Description:	Project emissions from the consumption of electricity from sources other than the dedicated renewable power plant (grid electricity) to operate the electrolyser hydrogen production plant in year y
Source of data:	As per BM-T-003
Measurement procedures (if any):	As per BM-T-003
Monitoring frequency:	As per BM-T-003
QA/QC procedures:	As per BM-T-003
Any comment:	Apply a combined margin emission factor as per BM-T-003

Data / Parameter table 16.

Data / Parameter:	$\boldsymbol{PE_{FC,y}}$
Data unit:	tCO_2e/year
Description:	Project emissions from the consumption of fossil fuels to operate the electrolyser hydrogen production plant in year y
Source of data:	As per BM-T-002
Measurement procedures (if any):	As per BM-T-002
Monitoring frequency:	As per BM-T-002
QA/QC procedures:	As per BM-T-002
Any comment:	As per BM-T-002

Data / Parameter table 17.

Data / Parameter:	$\boldsymbol{EC_{PJ,grid,y}}$; $\boldsymbol{EC_{PJ,captive,y}}$; $\boldsymbol{EC_{H2,pipeline,y}}$
Data unit:	MWh
Description:	$EC_{PJ,grid,y}$: Electricity consumed by the hydrogen production plant from the grid in year *y* $EC_{PJ,captive,y}$: Electricity consumed by the hydrogen production plant from the captive renewable power plant in year *y* $EC_{H2,pipeline,y}$: Electricity consumed for operating pipelines that transport the hydrogen in year *y*
Source of data:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from BM-T-003
Measurement procedures (if any):	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from BM-T-003
Monitoring frequency:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from BM-T-003
QA/QC procedures:	The monitoring of these parameters shall follow the monitoring of $EC_{PJ,j,y}$ from BM-T-003
Any comment:	These parameters are used to check the compliance of the project with paragraph 9 of the methodology

Data / Parameter table 18.

Data / Parameter:	$\boldsymbol{PE_{road,y}}$
Data unit:	tCO_2e
Description:	Project emissions due to road transportation of hydrogen in year *y*
Source of data:	As per BM-T-007
Measurement procedures (if any):	As per BM-T-007
Monitoring frequency:	As per BM-T-007
QA/QC procedures:	As per BM-T-007

Any comment:	The parameter $D_{f,m}$ in the tool shall correspond to the difference of the return trip distances between (i) the baseline hydrogen production plant and the existing dedicated consumer and (ii) the electrolysis hydrogen production plant and the dedicated consumer

Data / Parameter table 19.

Data / Parameter:	$\boldsymbol{EF_y}$
Data unit:	tCO_2/MWh
Description:	Electricity emission factor in year *y*
Source of data:	As per BM-T-003
Measurement procedures (if any):	As per BM-T-003
Monitoring frequency:	As per BM-T-003
QA/QC procedures:	As per BM-T-003
Any comment:	As per BM-T-003

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Document information

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

Ministry of Power

Ministry of Environment,

Forest and Climate Change

METHODOLOGY

BM IN02.001

Energy efficiency and fuel switching measures for industrial facilities

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Publication Date:

Version 1.0

Sectoral scope(s): Industries

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AMS-II.D (as valid from 04 October 2013).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Introduction of energy efficiency measures such as efficient motors, pumps, boilers etc. for specific industrial or mining and mineral production processes (such as steel furnaces, paper drying, tobacco curing, etc.) through new installation or retrofit/replacements
Type of GHG emissions mitigation action	Fuel/electricity savings through increase in energy efficiency

2. Definitions

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

(a) **Energy Carrying Medium (ECM)** - the medium carrying the energy in the form of heat or pressure. Examples of ECM include gas, air, water and steam;

(b) **Existing facilities** - existing facilities are those that have been in operation for at least three years immediately prior to the start date of the project activity.[1]

3. Scope & Applicability

3.1. Scope

5. This methodology comprises any energy efficiency improvement measures implemented at a single or several industrial or mining and mineral production facilities. The project activities may involve:

[1] The definition of start date is applicable as defined in the "Detailed Procedure for Offset Mechanism".

Process energy efficiency improvement(s) affecting either a single production step/element process[2] (e.g. furnace, kiln) or a series of production steps/element processes (e.g. industrial process involving many machines) that transform(s) raw materials (e.g. feedstocks) and other inputs into either intermediate forms or final finished outputs (e.g. molten metal, tiles, steel ingots);

Energy efficiency improvement in energy conversion equipment (e.g. boiler, motor) that supplies energy (thermal/electrical/mechanical) within a facility.

6. Fuel switching may also result in energy efficiency improvements. Fuel switching measures that are an integral part of energy efficiency measures may be part of a project activity included in this project category (e.g. switching from steam or compressed air to electricity).

7. Project activities involving fuel switching and energy efficiency improvements may use the applicable methodology “BM IN02.001: Energy efficiency and fuel switching measures for industrial facilities” provided that the emissions reductions associated with each project are conservatively determined and that interactive effects between the efficiency and fuel switching actions are accounted for such that no double counting of emission reductions occurs. The approach shall be sufficiently explained in the PDD.[3]

8. Retrofit/replacement as well as new construction (Greenfield) projects are included under this methodology.

3.2. Applicability

9. This category is applicable to project activities where it is possible to directly measure and record the energy use of the project activity within the project boundary (e.g. electricity and/or fossil fuel consumption and/or the energy contained in the energy carrying medium (ECM) such as steam, hot water, compressed air, etc.) and the quantities of such ECMs utilized in the project boundary. The ‘direct measurement’ in the case of thermal energies (fossil fuel, steam/heat consumption) does not have to involve the metering of energy itself but corresponding parameters such as quantity of fossil fuel consumed, temperature/pressure and quantity amount of steam. The energy flow then can be determined using acceptable engineering methods outlined in recognized national or international standards in an accurate or conservative manner for example ASME PTC 4-

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[2] An element process is a process, with associated equipment, in which an energy source (e.g. fuel, electricity, steam) is used for production purposes to convert raw materials into intermediate or finished product using thermal energy.

[3] As an example to avoid double counting would be that the efficiency savings are calculated ‘first’ and savings are based on emissions of project low carbon fuels. The fuel switch savings are then calculated ‘second’ and savings are based on energy consumption after efficiency project. For example, the efficiency emission reductions are based on going from 100 units of consumed energy to 90 with low carbon fossil fuel and the fuel switch emission reductions are based on 90 units of consumed energy going from high carbon to low carbon fossil fuel.

1998[4] or BS845[5] can be used to determine thermal energy output of a baseline boiler from actual measured baseline data for steam flow, pressure and temperature.

10. This category is applicable to project activities where the impact of the measures implemented (improvements in energy efficiency) by the project activity can be clearly accounted for and documented as well as distinguished from changes in energy use due to other independent variables not influenced by the project activity (signal to noise ratio). Examples of other variables include upstream/downstream process factors, feedstock and product characteristics, and environmental parameters (e.g. ambient temperature, humidity) associated with the baseline or project activity that may influence the energy savings from the project activity.

11. In the case where the independent variables mentioned above may have an impact on emissions reduction greater than approximately five per cent of the total annual emission reduction, then (a) the project boundary shall be extended to cover all such processes that influence the energy savings from project activity; and (b) such independent variables shall be monitored and taken into account in the emissions reduction calculations. Documentation of an assessment of all variables that may be reasonably expected to potentially affect emission reductions calculations shall be included in the project design document.

12. The output (e.g. steam/heat) and product(s) (e.g. ceramic insulators, tiles, steel ingots, aluminium cookware) produced in the industrial facility throughout the crediting period shall be equivalent to the product(s) produced in the baseline.

13. For the purposes of this methodology, equivalent products are defined as output or products having the same use, the same general physical properties, and which function in a similar manner. Product(s) produced in the industrial facility throughout the crediting period shall provide the same, or a better, level of service and be of the same level of quality, or better than the product(s) produced in the baseline. When national or international product standards apply to the product(s), product quality shall be as defined in such standards, otherwise the relevant industrial norms are to be followed.

14. In cases where product output (e.g. hot/fused metal) cannot be measured, the input material (i.e. feedstock) quantities used in the element process can be used as a proxy for determining baseline/project emissions. However, in such cases that input materials are used as a proxy for product output, potential differences in product output characteristics/quality shall be accounted for in the calculation procedures. The calculation procedures shall be sufficiently explained in the PDD (e.g. assumptions, justifications, etc.)

15. The type of input materials used in the project shall be homogeneous and similar to the input material that was used in the baseline and any deviation during the crediting period of input material type, composition, or amount used per unit of product output shall be within the range that does not cause a change in energy consumption per unit of output beyond ±10 per cent of the baseline characteristics and values

[4] American Society of Mechanical Engineers Performance Test Codes for Steam Generators: ASMEPTC 4 – 1998; Fired Steam Generators.

[5] British Standard Methods for Assessing the Thermal Performance of Boilers for Steam, Hot Water and High Temperature Heat Transfer Fluids.

16. The project activity that aims to achieve energy savings through improved maintenance practices, for example through cleaning of filters, repairing valves, correcting system leaks, and using new equipment lubricants, are not covered under this methodology.

17. If the energy-efficient equipment contains refrigerants, then the refrigerant used in the project case shall have no ozone depleting potential (ODP). While this methodology does not provide any credits for reductions in emissions associated with refrigerant reductions or changes, the calculation of project emissions shall include any incremental increases in GHG emissions, as compared to the baseline, associated with refrigerants used in the project equipment.

3.3. Entry into force

18. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of sectoral scopes

19. For validation and verification of ICM projects and by a designated ACVA using this methodology, application of sectoral scope "*02: Industries"* is mandatory.

3.5. Applicability of approved adopted tools

20. This methodology also refers to the latest approved versions of the following tools, methodologies and standards:

(a) "BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion (hereinafter referred to as BM-T-002);

(b) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

(c) "BM-T-006: Tool to determine baseline efficiency of thermal and electricity systems (hereinafter referred to as BM-T-006);

4. Methodology: Baseline Component

4.1. Project boundary

21. The project boundary is the physical, geographical site of the industrial or mining and mineral production facility(ies), including all processes and equipment that are affected by the project activity. The material (feedstock) and/or energy input to and output from the project boundary shall be transparently defined in the PDD. For example if the ECM is used or generated by the project activity, the facilities which produce or consume the ECM should be included in the project boundary.

4.2. Baseline scenario

22. In the case of replacement, modification or retrofit measures, the baseline consists of the energy consumption (or energy consumption per unit of production) that would have occurred in the absence of the project activity for the existing facility or sub-system that is replaced, modified or retrofitted. In the case of project activities involving several facilities,

the baseline needs to be established separately for each facility. In the case of project activities involving multiple energy efficiency measures at individual facilities, the interaction between the measures should be taken into consideration when establishing the baseline.

23. For new facilities and project activities involving capacity additions the energy baseline consists of: (a) the industrial or mining and mineral production facility(ies) that would have been built in the absence of the project activity and/or (b) the particular process that would have been built with the facility in the absence of the project activity. The most plausible baseline scenario for the project activity shall be evaluated based on one of the following:

    (a) Related and relevant requirements in the "Detailed Procedure for Offset Mechanism under CCTS";

    (b) Reference plant approach as described below:

        (i) The Reference plant (technology and fuel type) shall be based on common practice for similar project systems/equipment and fuel sources in the same sector and in the same country or region as the project. The identification of the reference plant shall exclude plants implemented as ICM project activities. In cases where no such plant exists within the region, the economically most attractive technology and fuel type should be identified among those which provide the same service (i.e. thermal energy, manufacturing product) comparable with the proposed ICM project activity, technologically available and in compliance with relevant regulations. The non-obligated entity may exclude scenarios that are not in compliance with legal and regulatory requirements;

        (ii) A clear description of each available technology and fuel type, such as efficiency and technical lifetime, shall be provided in the ICM-PDD. The efficiency of the technology should be selected in a conservative manner (i.e. where several technologies could be used and are similarly economically attractive, the most efficient technology should be defined as the baseline scenario). In addition, the least carbon intensive fuel type should be chosen in case of multiple fuels being possible choices;

        (iii) If one or more scenarios are excluded, an appropriate explanation and documentation to support the exclusion of such scenario shall be provided.

4.3. Baseline emissions calculations

24. For project activities implemented in existing facilities, baseline determination shall be based on relevant operational data for existing system/equipment (assuming that the continuation of current practice is demonstrated to be the baseline scenario) for the immediately prior three years to the start date of the project activity (or the start date of validation with due justification). The data under abnormal operations shall be excluded with due justifications. Abnormal operations shall refer to the periods of shutdown due to repairs, routine maintenance, or specific testing. These shall be defined by the non-obligated entity in the PDD. For project activities with estimated annual average energy savings less than or equal to 600 MWh, a minimum of one year's worth of data are sufficient.

25. For existing facilities having no historical data/information (i.e. less than three years or in the case of micro-scale less than one year) on baseline parameters or for new construction/capacity addition, the baseline parameters shall be determined using baseline measurement campaign or based on manufacturers specifications or based on the actual performance data of baseline plants that are in operation in the country/region as described below:

(a) A baseline measurement campaign shall be carried out (before or in parallel with the project implementation) on the baseline equipment/system, to establish the performance characteristics of the baseline scenario due to all the identified parameters (independent variables) that will have an effect on the performance of the equipment. The baseline measurement campaign would be conducted for a period of time sufficient to capture the range of the independent variables expected to be, or actually, encountered during the crediting period. The non-obligated entity may also follow the relevant provisions of BM-T-006, where applicable;

(b) Conservative baseline parameters based on performance data provided by two or more manufacturers for the baseline equipment (scenario) that would have been implemented in the absence of the ICM project activity (e.g., the lowest specific energy consumption (kWh/ton) full load performance value provided by two or more manufacturers);

(c) The weighted average performance data based on the most recent available data of baseline existing plants producing the same/similar output as the project facilities in the appropriate geographical region (i.e. host country as default).

26. For project activities involving retrofit/replacement/modification the emissions reductions accrue only up to the estimated remaining lifetime of the baseline equipment (i.e. the time when the affected baseline system/equipment would have been replaced in the absence of the project activity). From that point of time onwards, the baseline scenario is assumed to correspond to the project activity, and baseline emissions (BE) are assumed to equal project emissions (PE) and no emission reductions are assumed to occur.

$$EC_{BL} = EC_{HY} \text{ until } DATE_{BaselineRetrofit}$$

$$EC_{BL} = EC_{PJ,\,y} \text{ on/after } DATE_{BaselineRetrofit}$$

27. The following options shall be used to calculate baseline emissions using baseline data obtained from paragraph 25 or 26 above as applicable:

Option 1: Constant load device(s);

Option 2: Variable load device(s);

Option 3: Production efficiency/specific energy consumption (for partial or entire production process).

BE_y	=	Baseline emissions during year *y* of the project activity (t CO_2e/year)
EC_i	=	The amount of electricity consumption by baseline device *i* or process*I*(MWh)

$EF_{E,i}$ = Emission factor of the electricity consumption by baseline device type *I* or process *i* (t CO_2e/MWh). For captive plant(s), it is calculated in accordance with the “Tool to calculate project or leakage CO_2 emissions from electricity consumption"

i = Device *i* or process *i* which consume electricity with constant load in baseline scenario

n = Number of device or processes which consumes electricity in baseline scenario

$FC_{j,k}$ = The volume of the baseline fossil fuel type k consumed by baseline device *j* (Nm3 or tonnes)

NCV_k = The net calorific value of the baseline fossil fuel type *k* (TJ/Nm3 or TJ/tonnes)

$EF_{FF,k}$ = Emission factor of the baseline fossil fuel type *k* (t CO_2e/TJ)

j = Device *j* which consumes fossil fuel in baseline

k = Baseline fossil fuel type *k*

m = Number of devices which consumes fossil fuel in baseline

p = Number of types of the fossil fuel

ECM_l = Flow rate of energy carrying medium (*ECM*) consumed by baseline devices (tonne). For those *ECM* produced by a facility which is included in the project boundary, ECM_i equals zero, if the fossil fuel energy consumption to produce ECM_i has already been taken into account to estimate baseline emissions

$H_{in,l}$ = Enthalpy of the inflow energy carrying medium to the equipment (TJ/tonne)

$H_{out,l}$ = Enthalpy of the outflow energy carrying medium to the equipment (TJ/tonne). If the *ECM* is compressed air the units may be TJ/m^3

$EF_{ECM,l}$ = Emission factor of the *ECM* for equipment *L* or process *L*, t CO_2/TJ

$$\frac{{}_{BL,FF}}{{}_{BL}}$$ Equation (1)

Where:

$EF_{BL,FF}$ = Emission factor of baseline fossil fuel that is used to generate *ECM*. It is obtained from reliable local or national data if available; alternatively, IPCC default emission factors can be used (t CO_2/TJ)

${}_{BL}$ = Efficiency of baseline -device generating *ECM* as determined using the procedure described in the section below

l = Device or process which consumes *ECM* in baseline scenario

q = Number of devices or processes consuming *ECM* in baseline scenario

$Q_{ref,BL}$ = Average annual quantity of refrigerant used in the baseline to replace the refrigerant that has leaked (tonnes/year). Only applies to projects that replace equipment containing ODP refrigerants. Values from Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories may be used

$GWP_{ref,BL}$ = Global Warming Potential of the baseline refrigerant (t CO_2e/t refrigerant), as obtained from the latest IPCC Assessment Report.

28. For all of the options the baseline shall be defined in a way that CCCs cannot be earned for decreases in activity levels outside the project activity or due to force majeure.

4.3.1. Option 1: Constant load device(s)

29. The constant load condition shall be demonstrated by monitoring or using the historical records of energy consumption data for at least one-year period prior to the project implementation. The data recording interval is at least daily (i.e. a minimum of 365 data points). Data are considered to demonstrate a constant rate of energy consumption if 90 per cent of the energy consumption values are within ±10 per cent of the annual mean.

30. The baseline emissions ex ante are calculated as follows:

Equation (2)

$$BE_y = \sum_{i=1}^{n} EC_i \times EF_{E,i} + \sum_{j=1}^{m}\sum_{k=1}^{p} FC_{j,k} \times NCV_k \times EF_{FF,k} + \sum_{l=1}^{q} [ECM_l \times (H_{in,l} - H_{out,l})] \times EF_{ECM,l} + Q_{ref,BL} \times GWP_{ref,BL}$$

Where:

31. See example 1 to illustrate project applying option 1 in the appendix of this document.

32. Efficiency of the baseline equipment shall be determined by using one of the following:

Highest measured operational efficiency over the full range of operating conditions of a unit with similar specifications, using baseline fuel. The efficiency tests shall be conducted following the guidance provided in relevant national/international standards;

Highest of the efficiency values provided by two or more manufacturers for units with similar specifications, using the baseline fuel;

The default values where applicable using option E of BM-T-006.

4.3.2. Option 2: Variable load device(s)

33. This option applies to baseline equipment (scenario) for which the rate of energy consumption varies in response to independent variable(s) such as and quantity, type, and/or quality of final finished output. A mathematical function is developed, using regression techniques, to determine baseline energy consumption as a function of the relevant independent variable(s). The independent variables are measured during the crediting period and used in the regression function to predict baseline energy consumption throughout the crediting period.

34. Baseline emission calculation will apply the same equation (1) used for constant load devices, however, the EC_i, FC_j and ECM_l will be functions of relevant independent

variable(s) associated with device *i, j* and *l*. The relationship between the E_i, FF_j, ECM_l and the independent variable(s) are established by regression analysis.

$$EC_i = f(P_i, X_1, X_2, \ldots X_n) + \varepsilon 1$$

$$FC_j = g\left(P_j, Y_1, Y_2, \ldots Y_n\right) + \varepsilon 2$$

$$ECM_l = h(P_l, Z_1, Z_2, \ldots Z_n) + \varepsilon 3$$

35. The data for the analysis used to develop the mathematical function must cover a period of 12 continuous months or at least a period of time sufficient to cover the full range of actual and expected operating conditions and independent variables. The data measurement interval will depend on the application but is typically 0.25 to 1.0 hour in length.

36. In order to utilize the regression model to determine emission reductions, the t-test associated with relevant independent variables that have a physical influence on energy use has to be at least 1.645 for a 90 per cent confidence. The regression model must be documented with a complete report indicating at least who completed the regression analyses, when it was completed, key assumptions, how the independent variables were selected and basis for including these variables and rejecting others, the regression results, the survey instrument(s), final sample results, and predicted baseline energy consumption with respect to key variables.

37. See example 2 to illustrate project applying option 2 in the appendix of this document.

4.3.3. Option 3: Production efficiency/specific energy consumption (for partial or entire production process)

38. The energy efficiency measures under this option aim to cover overall efficiency improvement of partial or entire production process. The non-obligated entity may establish the average specific energy consumption (production efficiency) for the partial or entire production process included in the project boundary instead of establishing the baseline emissions for each of the devices and/or processes involved.

39. This option is only applicable if it can be conservatively shown that baseline energy use and emissions are only a function of finished product production rates (e.g. number of finished products produced per year or batch) and that the baseline energy use and emissions per unit of production does not vary from an average value by more than +/-10 per cent.

40. The baseline is calculated by using energy consumption per unit of output (specific energy consumption/production efficiency) in the baseline multiplied by the output in project year *y* multiplied by the emission factor for the energy displaced.

41. The baseline emissions are calculated as follows:

$$BE_y = \sum_i \frac{SEC_i \times P_{PJ,i,y}}{(1 - l_y)} \times EF_{CO_2,y} + Q_{ref,BL} \times GWP_{ref,BL}$$ Equation (2)

Where:

SEC_i	=	Specific energy consumption per unit production output in the baseline (MWh/unit/year) for equipment group *i* as calculated using paragraph 44 below. A group is a collection of devices sharing similar sizes, functions, schedules, outputs or loads
$P_{PJ,i,y}$	=	Total quantity of output (e.g. flow rate of a pump, mass flow rate of beverage produced, number of tiles, tonnes of clinker) in project year y for equipment in group *i* in units of weight or volume, kg or m3. In the event that project output in year *y* is greater than the average historical output[6] and the demonstration of the baseline for the incremental capacity is not undertaken, the value of the output in year *y* is capped at the value of the historical average output level. For example, if $P'_{PJ,i,y}$ is the total amount of product produced by the project element process in year *y* (uncapped), then $P'_{PJ,i,y} = P_{PJ,i,y}$ for $P_{PJ,i,y}$ <PHy , and $P_{PJ,i,y} = P_{Hy}$ for $P_{PJ,i,y} > P_{Hy}$. In the case where production output of element process cannot be measured, the quantity of input material (feedstock) used in the element process can be used as a proxy
l_y	=	Applies only in the case of grid electricity savings. Average annual technical grid losses (transmission and distribution) during year *y* for the grid serving the locations where the devices are installed, expressed as a fraction. This value shall not include non-technical losses such as commercial losses (e.g. theft). The average annual technical grid losses shall be determined using recent, accurate and reliable data available for the host country. This value can be determined from recent data published either by a national utility or an official governmental body. The reliability of the data used (e.g. appropriateness, accuracy/uncertainty, especially exclusion of non-technical grid losses) shall be established and documented by the non-obligated entity . A default value of 0.1 shall be used for average annual technical grid losses, if no recent data are available or the data cannot be regarded accurate and reliable

42. For project activities that involve replacing, modifying or retrofitting systems in existing facilities, the average specific energy consumption can be calculated ex ante as follows:

[6] A maximum of ±10 per cent variation is permitted.

Equation (3)

$$SEC_{BL} = \left(\sum EC_{BL,i,j} + \sum_{i,j} FC_{BL,i,j} \times NCV_{CO_2,j} \right) \div P_{Hy}$$

Where:

$EC_{BL,i,j}$	=	Average annual baseline electricity consumption value in the process *I* (MWh)
$FC_{BL,i,j}$	=	Average annual baseline fossil fuel consumption value for fuel type *j* combusted in the process *i*, using volume or weight units[7]
$NCV_{CO_2,j}$	=	Average net calorific value of fuel type *j* combusted, MWh per unit volume or mass unit
P_{Hy}	=	Average annual quantity of output in baseline in units of weight or volume, kg or m^3

43. For new facilities and project activities involving capacity additions, annual specific energy consumption of baseline equipment (scenario) can be determined using one of the options below (in preferential order):

The lowest *SEC* full load performance value provided by two or more manufacturers;

The weighted average SEC values of baseline existing plants producing the same/similar output as the project facilities in the appropriate geographical region (i.e. host country as default).

44. See example 3 to illustrate project applying option 3 in the appendix of this document.

4.4. Project emissions

45. Project emissions are equal to:

The emissions associated with consumption of fossil fuel, electricity and *ECM* within the project boundary by the project systems;

The emissions associated with any refrigerants used in new project cooling equipment (e.g. electrical compression chillers).

46. Project emissions in year *y* is calculated as follows:

$$PE_y = PE_{El,y} + PE_{FF,y} + PE_{ECm,y} + PE_{ref,y}$$ Equation (4)

Where:

PE_y	=	Project emissions in year *y* (t CO_2e)
$PE_{El,y}$	=	Project emissions due to electricity consumption and shall be estimated following the latest version of BM-T-003

7 Volume or weight units will be used depending on which best defines the fuel consumption requirements of the brick making process(es).

$PE_{FF,y}$	=	Project emissions due to fossil fuel and shall be estimated following the latest version of “BM-T-002
$PE_{ECm,y}$	=	Project emissions due to consumption of ECM in year *y* (t CO_2e/y) as determined using paragraph 47/equation 5 below
$PE_{ref,y}$	=	Project emissions from physical leakage of refrigerant from the project equipment in year y (t CO_2e/y) as determined using paragraph 50/equation 6 below

47. $PE_{ECM,y}$ is calculated as follows:

Equation (5)

$$PE_{ECM,y} = \sum_{i=1}^{n} \left[ECM_{PJ,i,y} \times \left(H_{in,i,y} - H_{out,i,y}\right)\right] \times EF_{ECM,i}$$

Where:

$ECM_{PJ,i,y}$	=	Flow rate of energy carrying medium (ECM) consumed by project device *i* (tonne) *ECM*ECM_i equals zero, if the fossil fuel energy consumption to produce ECM_i has already been taken into account to estimate project emissions as $PE_{FF,y}$.
$H_{in,i,y}$	=	Enthalpy of the inflow energy carrying medium to the equipment *i* in year *y* (TJ/tonne)
$H_{out,i,y}$	=	Enthalpy of the outflow energy carrying medium to the equipment *i* in year *y* (TJ/tonne)
$EF_{ECM,i}$	=	Emission factor of the *ECM* for equipment *i* or process *i*, t CO_2/TJ

$$EF_{ECM,l} = \frac{EF_{PJ,FF}}{{}_{PJ}}$$

Where:

$EF_{PJ,FF}$	=	Emission factor of project fossil fuel that is used to generate *ECM*. It is obtained from reliable local or national data if available; alternatively, IPCC default emission factors can be used (t CO_2/MWh)
${}_{PJ}$	=	Efficiency of project equipment generating *ECM*. The project proponent may follow the relevant provisions from BM-T-006 to determine efficiency of project equipment as applicable

i	=	Equipment or process *i* which consumes *ECM* in project scenario
n	=	Number of equipment or processes consuming *ECM* in project scenario

48. Project emissions from physical leakage of refrigerants are accounted for. All greenhouse gases as defined per the latest IPCC Assessment Reports shall be considered.

49. $PE_{ref,y}$ is calculated as follows:

$$PE_{ref,y} = \left(Q_{ref,PJ,y}\right) \times GWP_{ref,PJ}$$ Equation (6)

Where:

$PE_{ref,y}$	=	Project emissions from physical leakage of refrigerant from the project equipment in year *y* (t CO_2e/y)
$Q_{ref,PJ,y}$	=	Average annual quantity of refrigerant used in year *y* to replace refrigerant that has leaked in year *y* (tonnes/year). Values from Chapter 7: Emissions of Fluorinated Substitutes for Ozone Depleting Substances, Volume 3, Industrial Processes and Product Use, 2006 IPCC Guidelines for National Greenhouse Gas Inventories may be used
$GWP_{ref,PJ}$	=	Global Warming Potential of the refrigerant that is used in the project equipment (t CO_2e/t refrigerant)

4.5. Leakage

50. If the energy efficiency technology is equipment transferred from another activity, such that emissions increase in the other facility on account of a new equipment and the use of energy/fuel, leakage is to be considered.

4.6. Emission reduction

51. The emission reduction achieved by the project activity shall be determined as the difference between the baseline emissions and the project emissions and leakage.

$$ER_y = \left(BE_y - PE_y\right) - LE_y$$ Equation (7)

Where:

ER_y	=	Emission reductions in year *y* (t CO_2e)
LE_y	=	Leakage emissions in year *y* (t CO_2e)

5. Methodology: Monitoring Component

5.1. Parameters those are required at Validation (ex ante)

52. Documenting of the technical specification of the equipment/systems displaced or equipment/systems that would otherwise have been built.

5.2. Parameters that are monitored (ex post)

53. The applicable requirements specified in the "Detailed Procedure for Offset Mechanism under CCTS " (e.g. calibration requirements, sampling requirements) are also an integral part of the monitoring guidelines specified below and therefore shall be referred by the non-obligated entity.

54. For projects using option 1 and 2 with constant/variable load characteristics, the monitoring shall consist of metering the energy use of the project system/equipment installed.

55. For projects using option 2 where regression function is applied, the independent variables shall be monitored during the crediting period that are and used in the regression function to determine baseline energy consumption in the crediting period.

56. For projects using option 3 the monitoring shall consist of metering the energy use of element process and annual average production output. In case the output parameter cannot be measured, the quantity of input material (feedstock) used in the element process can be used as a proxy if the conditions indicated in paragraph 11 and 12 are met.

57. For projects using any of the options:

Those external variables that have an impact on emissions reduction greater than (five per cent of total annual emission reduction) shall be monitored and comply with the applicability condition (see paragraph 7 and 8);

Where applicable, *ECM* (its flow and energy density) shall be monitored continuously;

The energy consumption of each element process (included in the project boundary) need not be monitored separately if the performance data (input/output) is determined based on the overall production process covering series of element processes;

In the case of project activities involving several facilities, the monitoring procedure as described above shall apply for each facility.

Appendix 1. Examples of projects applying various options of the methodology

1. Example 1: Project using Option 1

1. An industrial pumping system is used to circulate process fluid with constant volume. Hours of operation vary seasonally and annually depending on production rate. The measure is to replace existing pump motors with premium efficiency units. Monitoring data collected monthly over a one-year period of the rate of energy consumption (kW) demonstrates a constant load condition; 90 per cent of records are ±10 per cent of their mean. Short-term monitoring is conducted for the period of one month and the data are used to establish the baseline demand (kW). Operating hours of the efficient motors are recorded during the crediting period and multiplied by the baseline demand to determine baseline energy use (kWh).

2. Example 2: Project using Option 2

2. A project involves a food processing facility where process cooling in the baseline is provided by distributed chilling units. The project will replace existing chillers with chilled water supplied from a new and efficient central chiller plant. The non-obligated entity will build a baseline model using regression analysis to predict annual kWh use. For this simple example all the distributed units are the same size and are sued for the exact same purpose in the exact same way and thus a single regression model can represent all units. The independent variables driving kWh use are types and amount of food processed. The equation below is the general form of the regression equation determining kWh demand for each unit:

$$kWh_i = \sum_k (b + x_1 \times t + x_2 \times q)_k \quad \text{Equation (1)}$$

Where:

k	=	The k^{th} hour of the cooling season
b	=	Regression coefficient
x_1,x_2	=	Regression coefficients
t	=	Type of food *i* processed
q	=	Quantity of food *i* processed

3. Hourly cooling load data and energy (kWh) use for a sample distributed chiller unit were collected for 12 months. The collection period captured temperatures under peak design conditions and the lower end of the expected cooling range. Daily average kWh use per cooling load per unit was regressed against daily average production and types of production. Daily averages were used instead of hourly values because the resulting model gave a better fit to the data. Using the coefficients and types and quantity of food processed by the regression analysis during the credit period, baseline kWh use is calculated.

3. Example 3: Project using Option 3

4. A project is replacement of an inefficient cooling system within a plastics extrusion plant where chilled water is used to cool the extrusions. The cooling load and energy consumption (kWh) for the cooling equipment is established to be essentially constant by showing that the per unit production cooling energy consumption in the baseline period (e.g. kilogram of extruded plastic) does not vary more than ±10 per cent from the average per unit process cooling energy consumption during the pre-project monitoring period and it is also expected that the relatively constant cooling load will not change throughout the crediting period. In addition, the quality (physical/chemical properties) of feed stocks (i.e. plastic pellets) used in the baseline and in the project cases would not change and is based on national standards. The plant maintains accurate energy consumption records and production records including kilograms of pellets used per day. The recent three years of pellet throughput per day data and electricity consumption data for cooling were collected. The total kWh consumed over the three years is divided by the total number of kilograms of pellets used over the same period. The result is the SEC (cooling kWh/plastic kg) for the process, which is used to estimate baseline emissions (using equation (2)).

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM IN02.002

Hydrogen production using methane extracted from biogas

Publication Date:

Version 1.0

Sectoral scope(s): Industries

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AMS-III.O (as valid from 24 July 2015).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Installation of biogas purification system to isolate methane from biogas for the production of hydrogen displacing LPG as both feedstock and fuel in a hydrogen production unit.
Type of GHG emissions mitigation action	Fuel and feedstock switch: Fuel and feed stock switch to reduce consumption of fossil fuel

2. Scope & Applicability

2.1. Scope

4. The methodology comprises of installation of biogas purification system to isolate methane from biogas to produce hydrogen.

2.2. Applicability

5. The project activity installs

   (a) A biogas purification system to isolate methane from biogas, which is being flared in the baseline situation for the production of hydrogen displacing liquefied petroleum gas (LPG) as both feedstock and fuel in a hydrogen production unit; or

   (b) A biogas purification system in combination with installation of new measures that recover methane from biogenic organic matter from wastewater treatment plants or landfills, using technologies/measures covered in BM WA03.001.

6. Emission reductions resulting from the installation of methane recovery system shall be calculated as per BM WA03.001.

7. There is no diversion of biogas that is already being used for thermal or electrical energy generation or utilized in any other (chemical) process in the baseline.

8. The project activity complies with all local regulations including all safety related measures.

9. This methodology is not applicable to technologies displacing the production of hydrogen from electrolysis.

2.3. Methodology Approval Date

10. The date of adoption of this document shall be effective from XX/XX 2024

2.4. Applicability of sectoral scopes

11. For validation and verification of ICM projects and programme of activities by a designated ACVA using this methodology, application of sectoral scope "*02: Industries*" is mandatory.

2.5. Applicability of approved adopted tools

12. This methodology also refers to the latest approved versions of the following adopted ICM tools:

(a) "BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

(b) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

3. Methodology: Baseline Component

3.1. Project boundary

13. The project boundary is the physical, geographical sites where methane is captured, extracted and hydrogen is produced from biogas and LPG. The boundary also extends to other equipment consuming biogas or methane in the same site where applicable.

3.2. Baseline

14. The baseline emissions are calculated as the summation of the following:

(a) CO_2 generated in reactions of LPG (displaced by methane extracted from biogas in the project scenario) as feedstock during the steam-reforming/shift-reaction;

(b) CO_2 generated in the combustion process of LPG (displaced by methane extracted from biogas in the project scenario) as fuel to the reactors.

15. The composition of LPG for the purpose of baseline emission calculations shall be determined based on the composition analysis of stand-by LPG[1] stock. This shall be based on:

(a) Information provided by the supplier; or

(b) Compositional analysis conducted by an independent certified laboratory; or

[1] Stand-by LPG is essential for process reliability. Standby LPG is the LPG stock stored by the operator to cover situations where biogas is not available in sufficient amount or production of hydrogen from biogas has halted for some reasons. For example in prolonged dry season wastewater treatment facility treating wastewaters such as palm oil mill effluent may not be operating in full capacity and therefore producing less biogas. Other possibilities include temporary non-availability of H2S removal system due to maintenance/ repair.

(c) Product specification statement provided by the national gas supplier of the host-country.

16. The CO_2 emissions generated in reactions of LPG during the steam-reforming/shift-reaction is determined by calculating the CO_2 generation potential per mol of hydrogen produced from the baseline feedstock LPG ($R_{CO2/H2}$) and the molar quantity of hydrogen produced using methane extracted from biogas as feedstock. The $R_{CO2/H2}$ ratio is calculated through analysis of the steam-reforming/shift-reactions specified in paragraph 18, involving the individual molecules contained in LPG (typically propane and butane).

$$BE_{LPG\_FEED} = R_{CO2/H2} \times m_{H2,BIO} \times MW_{CO2} \times C_1 \qquad \text{Equation (1)}$$

Where:

BE_{LPG_FEED}	=	Annual baseline CO_2 emissions from the displaced LPG feedstock in the hydrogen production unit (t CO_2e)
$R_{CO2/H2}$	=	CO_2 generation potential per mol of hydrogen produced with LPG as feedstock as defined in paragraph 25 (kmol-CO_2/kmol-H_2)
$m_{H2,BIO}$	=	Molar quantity of hydrogen produced annually from methane extracted from biogas as defined in paragraph 29 (kmol-H_2)
MW_{CO2}	=	Molecular weight of CO_2 (44 kg/kmol)
C_1	=	Conversion factor kilograms to tonnes (0.001)

17. The generic steam reforming reaction is:

$$C_n H_m + nH_2O \leftrightarrow nCO + \left(\frac{m}{2} + n\right) H_2 \qquad \text{Equation (2)}$$

18. The generic shift reaction is:

$$nCO + nH_2O \leftrightarrow nCO_2 + nH_2 \qquad \text{Equation (3)}$$

19. The net reaction from the above reactions is the sum of the above equations (2) and (3):

$$C_n H_m + 2nH_2O \leftrightarrow nCO_2 + \left(\frac{m}{2} + 2n\right) H_2 \qquad \text{Equation (4)}$$

20. Based on stoichiometric rules:

(a) 1 mol of C_nH_m and 2n mol of H_2O produce n mol of CO_2 and ((m/2)+2n)) mol of H_2;

(b) For example: 1 mol of propane gas (C_3H_8) and 6 mol of H_2O reacts to 3 mol of CO_2 and 10 mol of H_2.

21. For LPG containing m_1 mol of propane and m_2 mol of butane, the reactions are summarized as follow:

Table 2. LPG reactions during hydrogen production

Source Gas	Reaction Type	Ref. Eq.	Reaction
Propane	Steam Reforming	(A)	$C_3H_8 + 3H_2O \leftrightarrow 3CO + 7H_2$
	Shift-Conversion	(B)	$3CO + 3H_2O \leftrightarrow 3CO_2 + 3H_2$
	Sub-total	(C)=(A)+(B)	$C_3H_8 + 6H_2O \leftrightarrow 3CO_2 + 10H_2$
Butane	Steam Reforming	(D)	$C_4H_{10} + 4H_2O \leftrightarrow 4CO + 9H_2$
	Shift-Conversion	(E)	$4CO + 4H_2O \leftrightarrow 4CO_2 + 4H_2$
	Sub-total	(F)=(D)+(E)	$C_4H_{10} + 8H_2O \leftrightarrow 4CO_2 + 13H_2$

22. For 100 mol of LPG mixture containing m_1 mol of propane and m_2 mol of butane, the reactions are:

Table 3. Reactions during hydrogen production from 100 mol of LPG

Source Gas	Composition in 100 mol	Ref. Reaction from	Reactions
Propane	m_1	(C)	$[m_1]C_3H_8 + [6m_1]H_2O \leftrightarrow [3m_1]CO_2 + [10m_1]H_2$
Butane	m_2	(F)	$[m_2]C_4H_{10} + [8m_2]H_2O \leftrightarrow [4m_2]CO_2 + [13m_2]H_2$
Total	$m_1 + m_2$	(G)	As $100molLPG = [m_1]C_3H_8 + [m_2]C_4H_{10}$, (1) + (2) is $100molLPG + [6m_1 + 8m_2]H_2O \leftrightarrow [3m_1 + 4m_2]CO_2 + [10m_1 + 13$

23. Based on reaction G in Table 3, the *hydrogen production potential per mol of LPG* is defined as:

$$R_{H2/LPG} = \frac{\lfloor 10m_1 + 13m_2 \rfloor}{100}$$ Equation (5)

24. Based on reaction G in Table 3, the *CO_2 generation potential per mol of hydrogen produced* is defined as:

$$R_{CO2/H2} = \frac{\lfloor 3m_1 + 4m_2 \rfloor}{[10m_1 + 13m_2]}$$ Equation (6)

25. The CO_2 emissions from LPG combusted, as fuel in the reactors in the baseline (displaced by methane extracted from biogas in the project scenario) shall be calculated based on:

(a) The specific fuel consumption of the hydrogen production unit using LPG as fuel as described under monitoring methodology; and

(b) The amount of hydrogen produced using methane extracted from biogas as fuel as calculated in paragraphs 29 and 30.

$$BE_{LPG\_FUEL} = SFC_{LPG} \times V_{H2,BIO} \times EF_{LPG} \times C_2$$ Equation (7)

Where:

BE_{LPG_FUEL}	=	Annual baseline CO_2 emission from LPG used as fuel in the reactors that is displaced by methane extracted from biogas in the project scenario (t CO_2e)
SFC_{LPG}	=	Specific fuel consumption of the hydrogen production unit using LPG as fuel (kg-LPG/Nm^3-H_2)
$V_{H2,BIO}$	=	Volume of hydrogen produced from methane extracted from biogas under normal condition. (Nm^3-H_2) annually as defined in paragraphs 30 and 31
EF_{LPG}	=	Emission factor of LPG (kg-CO_2/kg LPG)
C_2	=	Conversion factor kilograms to tones (0.001)

26. The molar amount of hydrogen produced from methane extracted from biogas ($m_{H2,BIO}$) is calculated as the difference between the total molar amount of hydrogen produced ($m_{H2,T}$) and the molar amount of hydrogen produced from the stand-by LPG ($m_{H2,LPG}$).

$$m_{H2,BIO} = m_{H2,T} - m_{H2,LPG}$$ Equation (8)

Where:

$m_{H2,BIO}$	=	Molar amount of hydrogen produced from methane extracted from biogas annually (kmol-H_2)
$m_{H2,T}$	=	Total molar amount of hydrogen produced annually. This parameter shall be based on monitoring of volume of hydrogen produced by the hydrogen production unit. If the volume is reported as normal volume, the equivalent molar amount can be calculated using ideal gas relationship described in paragraph 31 (kmol-H_2)
$m_{H2,LPG}$	=	Molar amount of hydrogen produced from LPG annually as calculated in paragraph 30 (kmol-H_2)

27. The molar amount of hydrogen produced from LPG ($m_{H2,LPG}$) should be calculated through monitored amount of LPG used as feedstock to the reaction (M_{LPG}) multiplied by the hydrogen production potential calculated in equation (5).

$$m_{H2,LPG} = R_{H2/LPG} \times \frac{M_{LPG}}{MW_{LPG}}$$ Equation (9)

$$MW_{LPG} = m_1 \times MW_{C3H8} + m_2 \times MW_{C4H10}$$ Equation (10)

Where:

$m_{H2,LPG}$	=	Molar amount of hydrogen produced from LPG annually (kmol-H_2)
$R_{H2/LPG}$	=	Hydrogen production potential as define in equation (5) (kmol H_2/kmol-LPG)
M_{LPG}	=	Mass of LPG used as reaction feedstock annually (kg-LPG)
MW_{LPG}	=	Molecular weight of LPG (kg-LPG/kmol-LPG)
m_1	=	% mol of propane in LPG (mol/mol)
MW_{C3H8}	=	Molecular weight of propane (44 kg/kmol)
m_2	=	% mol of butane in LPG (mol/mol)
MW_{C4H10}	=	Molecular weight of butane (66 kg/kmol)

28. The amount of molecules per volume of low-pressure gas is defined by '*ideal gas*' relationship shown in equation (11). Using this relationship, a molar amount of hydrogen can be converted into its equivalent volume of low-pressure gas or vice-versa.

$$P_N.V_N = m_{H2}.R.T_N.C_3$$ Equation (11)

Where:

$V_{N,H2}$	=	Normalized volume of hydrogen produced annually (Nm^3)
P_N	=	Pressure in Pascal at normal condition (Pa)
T_N	=	Temperature in Kelvin at normal condition (273 K)
R	=	Gas constant in SI Unit (8.314 $Pa.m^3.mol^{-1}.K^{-1}$)
C_3	=	Conversion factor kmol to mol (1000)
m_{H2}	=	Molar amount of hydrogen produced (kmol)

3.3. Project Emissions

29. The project emissions are calculated as the summation of the emissions from fossil fuels and/or electricity used, unless it is demonstrated that electricity/steam used is generated from renewable energy sources with no possibility for emissions:

(a) The emissions from fossil fuels and/or electricity used to generate steam for the purpose of regeneration of the biogas purification system for operating the biogas purification system calculated in accordance with the methods specified in BM-T-002 and BM-T-003

30. If additional chemicals or energy is used to regenerate the adsorbent or absorbent for purpose of biogas purification, contribution of the used chemicals to GHG emissions during the lifecycle shall be taken into account, if not already included in paragraph 32.

3.4. Leakage

31. If the project equipment is transferred from another activity, or if the displaced equipment is transferred to another activity, such that emissions increase in the other facility on account of a new equipment and the use of energy/fuel, leakage is to be considered.

3.5. Emission reductions

32. The emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (12)}$$

Where:

ER_y	=	Emission reductions in the year *y* (t CO_2e)
PE_y	=	Project activity emissions in year *y* (t CO_2e)
LE_y	=	Leakage in year *y* (t CO_2e)

4. Methodology: Monitoring Component

4.1. Data and Parameters not monitored

Data / Parameter table 1.

Data / Parameter:	***EF_{LPG}***
Data unit:	kg-CO_2/kg LPG
Description:	Emission factor of LPG
Source of data:	-
Measurement procedures (if any):	The emission factor is based on; (a) evaluation of carbon content of LPG or (b) IPCC default value
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	***SFC_{LPG}***
Data unit:	kg-LPG/Nm^3-H_2
Description:	Specific fuel consumption of baseline process
Source of data:	-

Measurement procedures (if any):	Specific fuel consumption of LPG is should be based on one of the following options: (a) Measurements during crediting period when the hydrogen plant is operated with LPG as fuel; (b) Minimum 1 year historical data; (c) Manufacturer's specification.
Any comment:	Option (b) and (c) can only be used if (a) is not the case, i.e. LPG is not used as a fuel during the crediting period.

4.2. Data and Parameters monitored

33. The non-obligated entities shall maintain a biogas (or methane) balance based on:

(a) Continuous measurement of biogas produced by the waste water, treatment system, landfill gas capture system or other process producing biogas; and

(b) Continuous measurement of biogas used for various purposes in the project activity: e.g. heat, electricity, flare, and hydrogen production. The difference is considered as loss due to physical leakage and deducted from the emission reductions. The method of monitoring should follow the provisions specified in either BM WA03.001 or provisions of the "Project emissions from flaring" in the event of flaring (where applicable).

Data / Parameter table 3.

Data / Parameter:	V_{H2BIO}
Data unit:	Nm^3-H_2
Description:	Volume of hydrogen produced from methane extracted from biogas under normal condition
Source of data:	-
Measurement procedures (if any):	Continuous metering of on volumetric basis
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	M_{LPG}
Data unit:	kg-LPG
Description:	LPG used as feedstock to hydrogen production unit
Source of data:	-
Measurement procedures (if any):	Continuous metering
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	m_1
Data unit:	*%*
Description:	*% mol of Propane in LPG*
Source of data:	-
Measurement procedures (if any):	LPG molar composition analysis performed every quarter
Any comment:	

Data / Parameter table 6.

Data / Parameter:	m_2
Data unit:	*%*
Description:	*% mol of butane in LPG*
Source of data:	-
Measurement procedures (if any):	LPG molar composition analysis performed every quarter
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	PE_{Elec}
Data unit:	tCO_2/year
Description:	Project emissions from electricity consumption in year y
Source of data:	As per BM-T-003
Measurement procedures (if any):	As per BM-T-003
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	PE_{FF}
Data unit:	tCO_2/year
Description:	Project emissions from fossil fuel consumption in year y
Source of data:	As per BM-T-002
Measurement procedures (if any):	As per BM-T-002
Any comment:	-

34. The methodology is applicable to a programme of activities. No additional leakage estimations are necessary other than that indicated under the leakage section above.

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM WA03.001

Landfill Methane Recovery

Publication Date:

Version 1.0

Sectoral scope(s): Waste Handling and Disposal

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AMS-III.G (as valid from 14 July 2019).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Capture and combustion of methane from landfills used for disposal of residues including municipal, industrial and other solid wastes containing biodegradable organic matter
Type of GHG emissions mitigation action	Greenhouse gas (GHG) destruction. Destruction of methane and displacement of more-GHG-intensive energy generation

2. Scope & Applicability

2.1. Scope

4. This methodology comprises measures to capture and combust methane from landfills (i.e. solid waste disposal sites) used for the disposal of residues from human activities including municipal, industrial, and other solid wastes containing biodegradable organic matter.

2.2. Applicability

5. The proposed project activity does not reduce the amount of organic waste that would have been recycled in the absence of the project activity.

6. This methodology is not applicable if the management of the solid waste disposal site (SWDS) in the project activity is deliberately changed in order to increase methane generation compared to the situation prior to the implementation of the project activity (e.g. other than to meet a technical or regulatory requirement). Such changes may include, for example, the addition of liquids to a SWDS, pre-treating waste to seed it with bacteria for the purpose of increasing the rate of anaerobic degradation of the SWDS or changing the shape of the SWDS to increase methane production.

2.3. Methodology Approval Date

7. The date of adoption of this document shall be effective from XX/XX 2024.

2.4. Applicability of sectoral scopes

8. For validation and verification of ICM projects and by a designated ACVA using this methodology,

(a) If the recovered Land Fill Gas (LFG) is only flared and not used for any other purpose, the application of sectoral scope *“03: Waste handling and disposal”* is mandatory;

(b) If the recovered LFG is used for any purpose other than flaring, then application of sectoral scope *“03: Waste handling and disposal”* and sectoral scope “*01: Energy”* is mandatory.

2.5. Applicability of approved methodologies and tools

9. This methodology also refers to the latest approved versions of the following approved methodology and methodological tools:

(a) “BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion” (hereinafter referred to as BM-T-002);

(b) “BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (hereinafter referred to as BM-T-003);

(c) “BM-T-004: Project emissions from flaring (hereinafter referred to as BM-T-004);

(d) “BM-T-006: “Tool to determine baseline efficiency of thermal and electricity systems” (hereinafter referred to as BM-T-006);

(e) “BM-T-011: “Emissions from solid waste disposal sites” (hereinafter referred to as BM-T-011);

(f) “BM-T-012: “Positive lists of technologies” (hereinafter referred to as BM-T-012).

3. Methodology: Baseline Component

3.1. Project boundary

10. The project boundary is the physical, geographical site of the landfill where the gas is captured and destroyed/used.

3.2. Simplified additionality and baseline

11. Non-obligated entity may apply the following simplified procedure for additionality demonstration and baseline:

(a) Demonstrate additionality by referring to the requirements in BM-T-012.

(b) If the LFG is used for heat and electricity generation within the project boundary, that component of the project activity may use a corresponding methodology under project activities:

(i) If all or part of the electricity generated by the project activity is exported to the grid, the baseline scenario for all or the part of the electricity exported to the grid is assumed to be electricity generation in existing and/or new grid-connected power plants. If all or part of the electricity is supplied to off-grid application, the baseline electricity generation equipment is assumed to correspond to the default emission factor from BM-T-003;

(ii) The baseline scenario for heat is assumed to be a new natural-gas-fired heat generation equipment with a default baseline efficiency of 100 per cent or with a default baseline efficiency as provided in BM-T-006.

3.3. Baseline scenario and baseline emissions

12. The baseline scenario is the situation where, in the absence of the project activity, biomass and other organic matter are left to decay within the project boundary, and methane is emitted to the atmosphere, possibly with capture of LFG and destruction through flaring to comply with regulations or contractual requirements. Baseline emissions shall exclude methane emissions that would have to be removed to comply with national or local safety requirements or legal regulations. Flaring of LFG shall be included in the baseline if the same is required as per local regulations. In addition, the effect of methane oxidation that is present in the baseline and absent in the project shall be taken into account:[1]

$$BE_y = \eta_{PJ} \times BE_{CH4,SWDS,y} - (1\text{-}OX) \times F_{CH4,BL,y} \times GWP_{CH4}$$ Equation (1)

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e)
$BE_{CH4,SWDS,y}$	=	Methane emission potential of a solid waste disposal site (in t CO2e) calculated using BM-T-011. This tool may be used: • With the factor “f=0.0” because the amount of LFG that would have been captured and destroyed is already accounted for in this equation. • With the definition of year x as ‘the year since the landfill started receiving wastes, x runs from the first year of landfill operation (x=1) to the year for which emissions are calculated (x=y)’. The amount of waste type *j* deposited each year *x* ($W_{j,x}$) shall be determined by sampling (as specified in the above-mentioned tool), in the case that waste is generated during the crediting period. Alternatively, for existing SWDS, if the pre-existing amount and composition of the wastes in the landfill are unknown, they can be estimated by using parameters related to the serviced population or industrial activity, or by comparison with other landfills with similar conditions at regional or national level

[1] $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a portion of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in BM-T-011. In addition to this effect, the installation of an LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, for example when the suction pressure is high, this air may cause a reduction in the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used, this effect is considered to be very small, as the operators of SWDS have an incentive in most cases to achieve a high methane concentration in the LFG. For this reason, this effect is neglected for conservativeness.

OX	=	Oxidation factor (reflecting the amount of methane from SWDS that is oxidised in the soil or other material covering the waste) (dimensionless). A default value of 0.1 may be used
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity. It is used for ex ante estimation only. A default value of 50 per cent may be used
$F_{CH4,BL,y}$	=	Methane emissions that would be captured and destroyed to comply with national or local safety requirement or legal regulations in the year *y* (t CH_4). The relevant procedures in "BM WA03.002: Flaring or use of landfill gas" may be followed, as well as taking into account the compliance with the relevant local laws and regulation if such laws and regulations exist
GWP_{CH4}	=	Global Warming Potential for methane

3.4. Project emissions

13. Project emissions consist of:

(a) CO_2 emissions from fossil fuel or electricity used by the project activity facilities ($PE_{power,y}$);

(b) Emissions from flaring or combustion of the gas stream ($PE_{flare,y}$);

(c) Emissions from the landfill gas upgrading process ($PE_{process,y}$), where applicable.

$$PE_y = PE_{Power,y} + PE_{flare,y} + PE_{process,y} \quad \text{Equation (2)}$$

Where:

PE_y	=	Project emissions 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)
$PE_{flare,y}$	=	Emissions from flaring or combustion of the landfill gas stream in the year *y* (t CO_2e)
$PE_{process,y}$	=	Emissions from the landfill gas upgrading process in the year *y* (t CO_2e).

14. Project emissions from electricity consumption are determined as per the procedures described in BM-T-003. For project emissions from fossil fuel consumption, BM-T-002 shall be used. The emission factor for the fossil fuel shall be used (t CO_2/tonne). Local values are to be used. If local values are difficult to obtain, IPCC default values may be used. If recovered landfill gas is used to power auxiliary equipment of the project activities (e.g. landfill gas extraction, cleaning, compression) it should be taken into account accordingly, using zero as its emission factor.

15. If flaring (single or multiple) is used to destroy all or part of the recovered landfill gas, project emissions from flaring in year *y* ($PE_{flare,y}$ in t CO_2e) shall be determined for each flare following the procedure described in BM-T-004.

3.5. Leakage

16. If the methane recovery technology is equipment transferred from another activity, such that emissions increase in the other facility on account of a new equipment and the use of energy/fuel, leakage effects are to be considered.

3.6. Emission reductions

17. The emission reduction achieved by the project activity can be estimated ex ante in the project design document (PDD) by:

$$ER_{y,estimated} = BE_y - PE_y - LE_y \quad \text{Equation (3)}$$

18. The actual emission reduction achieved by the project activity during the crediting period will be calculated using the amount of methane recovered and destroyed/gainfully used by the project activity, calculated as:

$$ER_{y,calculated} = (1\text{-OX}) \times (F_{CH4,PJ,y} - F_{CH4,BL,y}) \times GWP_{CH4} - PE_y - LE_y \quad \text{Equation (4)}$$

Where:

$F_{CH4,PJ,y}$	=	Methane captured and destroyed/gainfully used by the project activity in the year *y* (tCH_4)

$$F_{CH4,PJ,y} = D_{CH4,y} \times w_{CH4,y} \times \sum_i LFG_{i,y} \quad \text{Equation (5)}$$

Where:

$LFG_{i,y}$	=	Landfill gas destroyed via method *i* (flaring, fuelling, combustion, injection to a grid, etc.) in year *y* (m^3LFG). The flow or volume measurement shall be made either on a dry basis or at the same humidity as $w_{CH4,y}$
$w_{CH4,y}$	=	Methane content in landfill gas in year *y* (volume fraction, m^3CH_4/m^3LFG). Landfill gas composition shall be measured either on a dry basis or at the same humidity as used to determine $LFG_{i,y}$
$D_{CH4,y}$	=	Density of methane at the temperature and pressure of the landfill gas in year *y* (tonnes/m^3). If $LFG_{i,y}$ is reported at normal conditions of temperature and pressure, the density of methane is also determined at normal conditions

19. For project activities that utilize the recovered methane for power generation, $F_{CH4,PJ,y}$ may be calculated as follows, based on the amount of monitored electricity generation, without monitoring methane flow and concentration:

Equation (6)

$$F_{CH4,PJ,y} = \frac{EG_y \ x\ 3600}{NCV_{CH4} \ x\ EE_y} \ x\ D_{CH4} \ x\ GWP_{CH4}$$

Where:

EG_y	=	Electricity generation in year *y* (MWh)
3600	=	Conversion factor (1 MWh = 3600 MJ)
NCV_{CH4}	=	NCV of methane (MJ/Nm3) use default value: 35.9 MJ/Nm3
EE_y	=	Energy Conversion Efficiency of the project equipment determined from one of the following options: • Specification provided by the equipment manufacturer specifically for biogas fuel only if the equipment is designed to utilize biogas as fuel. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation • Default efficiency of 40 per cent

20. Non-obligated shall provide evidence to a validating Accredited Carbon Verification Agency (ACVA) that only the landfill gas recovered in the project is used for power generation; no other gas or fuels except a start-up fuel[2] are used.

21. The methods to be used for the integration of the values calculated from the above in equations to obtain the results for one year of measurements within the confidence level, as well as the methods and instruments used for metering, recording and processing the data obtained, shall be described in the project design document and monitored during the crediting period.

22. Project activities where a portion of the recovered landfill gas is destroyed through flaring and the other portion is used for energy may consider applying the flare efficiency value to the portion of the landfill gas used for energy if separate measurements of the respective flows are not performed. When the amount of methane combusted for energy and the amount that is flared are monitored separately, or when only the landfill gas flow to the flare is monitored and the landfill gas used for energy is calculated based on electricity generation, a destruction efficiency of 100 per cent can be used for the amount that is combusted for energy.[3]

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[2] If a fuel is defined as a start-up fuel, it should not represent more than 1 per cent of the total fuel utilized in the process, on energy basis.

[3] The energy component shall be included in the project boundary with the energy output being monitored.

4. Methodology: Monitoring Component

23. Flow meters, sampling devices and gas analysers shall be subject to regular maintenance, testing and calibration to ensure accuracy.

24. Relevant parameters shall be monitored by the non-obligated entity as indicated in the tables below.

4.1. Parameters for monitoring during the crediting period

Data / Parameter table 1.

Data / Parameter:	$PE_{power,y}$
Data unit:	t CO_2e
Description:	Parameters related to emissions from electricity and/or fuel consumption
Measurement procedures:	The value is determined by assuming that all relevant electrical equipment operate at full rated capacity, plus 10 per cent to account for distribution losses, for 8760 hours per year
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$PE_{flare,y}$
Data unit:	t CO_2e
Description:	Emissions from flaring or combustion of the landfill gas stream in the year *y*
Measurement procedures:	As per BM-T-004
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$PE_{process,y}$
Data unit:	t CO_2e
Description:	Emissions from the landfill gas upgrading process
Measurement procedures:	
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	***$LFG_{i,y}$***
Data unit:	m^3
Description:	Landfill gas destroyed via method *i* in year *y*
Measurement procedures:	In all cases, the amount of landfill gas recovered, fuelled, flared or otherwise utilized (e.g. injected into a natural gas distribution grid or distributed via a dedicated piped network) shall be monitored ex post, using continuous flow meters. The methane content measurement shall be carried out close to a location in the system where the landfill gas flow, temperature and pressure measurements are carried out, and at the same humidity content (dry or at known or measured/corrected for humidity content)
Monitoring frequency:	Continuous flow measurement with accumulated volume recording (e.g. hourly/daily accumulated reading)
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$w_{CH4,y}$
Data unit:	%, volume basis
Description:	Methane content in landfill gas in the year *y*
Measurement procedures:	The fraction of methane in the gas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or, alternatively, with periodical measurements at a 90/10 confidence/precision level. It shall be measured using equipment that can directly measure methane content in the landfill gas - the estimation of methane content of landfill gas based on measurement of other constituents of landfill gas such as CO_2 is not permitted. The methane content measurement shall be carried out close to the location in the system where the landfill gas flow, temperature and pressure measurements are carried out, and at the same humidity content (dry or at known or measured/corrected for humidity content)
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	***T***
Data unit:	^oC
Description:	Temperature of the landfill gas
Measurement procedures:	The temperature of the gas is required to determine the density of the methane combusted. If the landfill gas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of landfill gas, then there is no need for separate monitoring of pressure and temperature of the landfill gas. Otherwise, landfill gas temperature measurement shall be made close to where the gas flow is measured
Monitoring frequency:	Shall be measured at the same time when methane content in landfill gas ($w_{CH4,y}$) is measured

Any comment:	-

Data / Parameter table 7.

Data / Parameter:	***P***
Data unit:	Pa
Description:	Pressure of the landfill gas
Measurement procedures:	The pressure of the gas is required to determine the density of the methane combusted. If the landfill gas flow meter employed measures flow, pressure and temperature and displays or outputs the normalised flow of landfill gas, then there is no need for separate monitoring of pressure and temperature of the landfill gas. Otherwise, the landfill gas pressure measurement shall be made close to where the gas flow is measured
Monitoring frequency:	Shall be measured at the same time when methane content in landfill gas ($w_{CH4,y}$) is measured
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	EG_y
Data unit:	MWh
Description:	Electricity generation in year *y*
Measurement procedures:	Only required for project activities which utilize the recovered methane for power generation as per paragraph 18 above
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	EE_y
Data unit:	%
Description:	Energy Conversion Efficiency of the project equipment
Measurement procedures:	As per paragraph 19 above. Specification provided by the equipment manufacturer. The equipment shall be designed to utilize biogas as fuel, and the efficiency specification is for biogas. If the specification provides a range of efficiency values, the highest value of the range shall be used for the calculation
Monitoring frequency:	-
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	GWP_{CH4}
Data unit:	t CO_2e/t CH_4

Description:	Global warming potential of methane
Source of data:	IPCC Sixth Assessment Report (AR6)
Value to be applied:	Value: 29.8 t CO_2e/t CH_4
Any comment:	The GWP value will be updated in line with the latest available IPCC Assessment Reports.

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MA₹KET

METHODOLOGY

BM WA03.002

Flaring or use of landfill gas

Publication Date:

Version 1.0

Sectoral scope(s): Waste Handling and Disposal

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology ACM0001 (as valid from 14 June 2019)

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical projects	Capture of landfill gas (LFG) and its flaring and/or use to produce energy and/or use to supply consumers
Type of GHG emissions mitigation action	GHG destruction: Destruction of methane emissions and displacement of a more-GHG-intensive service

2. Definitions

4. For the purpose of this methodology the following definitions apply:

(a) **Biogas processing facility** - the facility which processes, upgrades and compresses/liquefies the biogas collected from a Solid Waste Disposal Site (SWDS) with the purpose of supplying it to end-users;

(b) **Continuous brick kiln** - a brick kiln where bricks are loaded continuously into the kiln, rather than in batches. Continuous brick kilns are distinguished as moving ware kilns and moving fire annular kilns. Moving ware kilns include tunnel and vertical shaft kilns. Moving fire annular kilns use Hoffmann, Bull's trench and Zig-zag technologies;

(c) **Existing LFG capture system** - a system that has been in operation in the last calendar year prior to the start of the operation of the project activity.

(d) **LFG capture system** - a system to capture LFG. The system may be passive, active or a combination of both active and passive components. Passive systems capture LFG by means of natural pressure, concentration, and density gradients. Active systems use mechanical equipment to capture LFG by providing pressure gradients. Captured LFG can be vented, flared or used.

(e) **Intermittent brick kiln** - bricks are loaded into the kiln and fired in batches. Types include Clamp, Scotch and Scove technologies.

(f) **Landfill gas (LFG)** - the gas generated by decomposition of waste in a SWDS. LFG is mainly composed of methane, carbon dioxide and small fractions of ammonia and hydrogen sulphide;

(g) **Reference conditions** - reference conditions are defined as 0 ^{o}C (273.15 K, 32 ^{o}F) and 1 atm (101.325 kN/m2, 101.325 kPa, 14.69 psia, 29.92 in Hg, 760 torr);

(h) **Solid waste** - material that is unwanted and insoluble (including gases or liquids in cans or containers). Hazardous waste is not included in the definition of solid waste;

(i) **Solid waste disposal site (SWDS)** - designated areas intended as the final storage place for solid waste.

3. Scope & Applicability

3.1. Scope

5. This methodology applies to project activities that include the destruction of methane emissions and displacement of a more-GHG-intensive service by capturing landfill gas from the landfill site and/or flaring and/or using to produce energy (i.e. electricity, thermal energy); and/or using to supply consumers through natural gas distribution network**,** dedicated pipeline or trucks.

3.2. Applicability

6. The methodology is applicable under any of the following conditions:

(a) Install a new LFG capture system in an existing or new (Greenfield) SWDS where no LFG capture system was or would have been installed prior to the implementation of the project activity; or

(b) Make an investment into an existing LFG capture system to increase the recovery rate or change the use of the captured LFG, provided that:

(i) The captured LFG was vented or flared and not used prior to the implementation of the project activity; and

(ii) In the case of an existing active LFG capture system for which the amount of LFG cannot be collected separately from the project system after the implementation of the project activity and its efficiency is not impacted on by the project system: historical data on the amount of LFG capture and flared is available;

(c) Flare the LFG and/or use the captured LFG in any (combination) of the following ways:

(i) Generating electricity;

(ii) Generating heat in a boiler, air heater or kiln (brick firing only) or glass melting furnace;[1] and/or

(iii) Supplying the LFG to consumers through a natural gas distribution network;

(iv) Supplying compressed/liquefied LFG to consumers using trucks;[2]

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[1] For claiming emission reductions for other heat generation equipment (including other products in kilns), a non-obligated entity may submit a revision to this methodology.

[2] If other means of transportation are used, a revision to this methodology may be requested.

(v) Supplying the LFG to consumers through a dedicated pipeline;

Activities should not reduce the amount of organic waste that would be recycled in the absence of the project activity.

Box 1. Non-binding best practice example 1: demonstration of the applicability condition 3(d)

1. When demonstrating compliance with requirement (d) above, the non-obligated entity may:
   (a) Describe the prevailing waste management practices pertinent to organic waste recycling in the area that is served by the landfill. The area served by the landfill should be clearly identified in the PDD, with supporting evidence (e.g. by providing contracts or licenses);
   (b) Identify any facility(ies) that recycle the organic fraction of the waste in the area identified in (a) above.; and
   (c) If there are facilities identified in (b) above, explain whether the project activity will impact the amount of organic waste which is recycled in the absence of the project.
   (d) If the facility(ies) identified in (c) above is(are) not operating at its maximum capacity, explain, with supporting evidence (e.g. by providing a balance of processed waste or receipts for transported waste), why the organic fraction of the solid waste would not have been treated in this(ese) facility(ies).
2. In doing so, the non-obligated entity may conduct interviews with authorities, refer to national/local statistics or studies related to MSW management in the area, and obtain opinion from relevant local experts.

7. The methodology is only applicable if the application of the procedure to identify the baseline scenario confirms that the most plausible baseline scenario is:

(a) Atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons; and

(b) In the case that the LFG is used in the project activity for generating electricity and/or generating heat in a boiler, air heater, glass melting furnace or kiln:

(i) For electricity generation: that electricity would be generated in the grid or in captive fossil fuel fired power plants; and/or

(ii) For heat generation: that heat would be generated using fossil fuels in equipment located within the project boundary;

(c) In the case of LFG supplied to the end-user(s) through natural gas distribution network, trucks or the dedicated pipeline, the baseline scenario is assumed to be displacement of natural gas.

(d) In the case of LFG from a Greenfield SWDS, the identified baseline scenario is atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

8. This methodology is not applicable:

(a) In combination with other approved methodologies. For instance, BM WA03.002 cannot be used to claim emission reductions for the displacement of fossil fuels in a kiln or glass melting furnace, where the purpose of the ICM project activity is to implement energy efficiency measures at a kiln or glass melting furnace;

(b) If the management of the SWDS in the project activity is deliberately changed during the crediting in order to increase methane generation compared to the situation prior to the implementation of the project activity.

9. The applicability conditions included in the tools referred to below also apply.

3.3. Methodology Approval Date

10. The date of adoption of this document shall be effective from XX/XX 2024

3.4. Applicability of sectoral scopes

11. For validation and verification of ICM projects and programme of activities by a designated ACVA using this methodology:

(a) If the recovered Land fill gas (LFG) is only flared and not used for any other purposes the application of sectoral scope *"03: Waste handling and disposal"* is mandatory;

(b) If the recovered LFG is used for any other purposes than flaring, then application of sectoral scope *"03: Waste handling and disposal"* and sectoral scope *"01: Energy"* is mandatory.

3.5. Applicability of approved adopted methodology and tools

12. The methodology also refers to the latest approved version of the following methodological tools:

(a) "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as BM-T-001);

(b) "BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

(c) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

(d) "BM-T-004: Project emissions from flaring" (hereinafter referred to as BM-T-004);

(e) "BM-T-005: Tool to determine the mass flow of a greenhouse gas in a gaseous stream" (hereinafter referred to as BM-T-005);

(f) "BM-T-006: Tool to determine baseline efficiency of thermal and electricity systems" (hereinafter referred to as BM-T-006);

(g) "BM-T-007: Project and leakage emissions from transportation of freight" (hereinafter referred to as BM-T-007).

(h) "BM-T-011: "Emissions from solid waste disposal sites" (hereinafter referred to as BM-T-011);

(i) "BM-T-012: Positive lists of technologies" (hereinafter referred to as BM-T-012).

4. Methodology: Baseline Component

4.1. Project boundary

13. The project boundary of the project activity shall include the site where the LFG is captured and, as applicable:

(a) Sites where the LFG is flared or used (e.g. flare, power plant, boiler, air heater, glass melting furnace, kiln, natural gas distribution network, dedicated pipeline or biogas processing facility);

(b) Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity to the project activity;

(c) Captive power plant(s) (including emergency diesel generators) or power generation sources connected to the grid, which are supplying electricity in the baseline that is displaced by electricity generated by captured LFG in the project activity;

(d) Heat generation equipment or sources which are supplying heat in the baseline that is displaced by heat generated by captured LFG in the project activity; and

(e) The transportation of the compressed/liquefied LFG from the biogas processing facility to consumers.

Table 2. Summary of greenhouse gases and sources included in and excluded from the project boundary

Source		Gas	Included	Justification/Explanation
Baseline	Emissions from decomposition of waste at the SWDS site	CH_4	Yes	The major source of emissions in the baseline
		N_2O	No	N_2O emissions are small compared to CH_4 emissions from SWDS. This is conservative
		CO_2	No	CO_2 emissions from decomposition of organic waste are not accounted since the CO_2 is also released under the project activity
	Emissions from electricity generation	CO_2	Yes	Major emission source if power generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative

Source		Gas	Included	Justification/Explanation
	Emissions from heat generation	CO_2	Yes	Major emission source if heat generation is included in the project activity
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
	Emissions from the use of natural gas	CO_2	No	Excluded for simplification. This is conservative
		CH_4	Yes	Major emission source if supply of LFG through a natural gas distribution network, dedicated pipeline or using trucks is included in the project activity
		N_2O	No	Excluded for simplification. This is conservative
Project activity	Emissions from fossil fuel consumption for purposes other than electricity generation or transportation due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from electricity consumption due to the project activity	CO_2	Yes	May be an important emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from flaring	CO_2	No	Emissions are considered negligible
		CH_4	Yes	May be an important emission source
		N_2O	No	Emissions are considered negligible
	Emissions from distribution of LFG using trucks and dedicated pipelines	CO_2	Yes	May be an important emission source
		CH_4	Yes	May be an important emission source
		N_2O	No	Emissions are considered negligible

4.2. Procedure for the selection of the most plausible baseline scenario and demonstrate additionality

14. Non-obligated entity may either apply the simplified procedures in section 4.2.1 below or the procedures in section 4.2.2 to select the most plausible baseline scenario and demonstrate additionality.

4.2.1. Simplified procedures to identify the baseline scenario and demonstrate additionality

15. For the simplified procedure to demonstrate additionality, the non-obligated entity shall refer to the methodological tool BM-T-012.

16. The baseline scenario for LFG is assumed to be the atmospheric release of the LFG or capture of LFG and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons.

17. If all or part of the electricity generated by the project activity is exported to the grid, the baseline scenario for all or the part of the electricity exported to the grid is assumed to be electricity generation in existing and/or new grid-connected power plants. If all or part of the electricity is supplied to off-grid application, the baseline electricity generation equipment is assumed to correspond to the default emission factor from BM-T-003.

18. The baseline scenario for heat is assumed to be a new natural-gas-fired heat generation equipment with a default baseline efficiency of 100 per cent or with a default baseline efficiency as provided in BM-T-006.

4.2.2. Procedures according to the "Combined tool to identify the baseline scenario and demonstrate additionality"

19. Identify the baseline scenario and demonstrate additionality using BM-T-001 and following the requirements below.

20. In applying Step 1 of the tool, baseline alternatives for the destruction of LFG, shall take into consideration, inter alia, the following alternatives:

    (a) LFG1: The project activity implemented without being registered as a ICM project activity (i.e. capture and flaring or use of LFG);

    (b) LFG2: Atmospheric release of the LFG or capture of LFG in a managed SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons;

    (c) LFG3: Atmospheric release of the LFG or capture of LFG in an unmanaged SWDS and destruction through flaring to comply with regulations or contractual requirements, to address safety and odour concerns, or for other reasons;

    (d) LFG4: LFG generation is partially avoided because part of the organic fraction of the solid waste is recycled and not disposed in the SWDS;

    (e) LFG5: LFG generation is partially avoided because part of the organic fraction of the solid waste is treated aerobically and not disposed in the SWDS;

    (f) LFG6: LFG generation is partially avoided because part of the organic fraction of the solid waste is incinerated and not disposed in the SWDS.

Box 2. Non-binding best practice example 2: elimination of alternative LFG scenarios 20(c), (d) and (e)

1. When considering any of the alternatives above, the non-obligated entity may:
   (a) Describe the prevailing waste management practices pertinent to organic waste in the area that is served by the landfill. The area served by the landfill should be clearly identified in the PDD, with supporting evidence (e.g. by providing contracts);
   (b) Provide information on the existence of any facility(ies) that:
      (i) recycle the organic fraction of the waste (regarding alternative "LFG3") in the area identified in (a) above;
      (ii) aerobically treat the organic fraction of the waste, such as composting plants (regarding alternative "LFG4"), in the area identified in (a) above;
      (iii) incinerate the organic fraction of the waste (regarding alternative "LFG5"), in the area identified in (a) above;
   (c) If there is(are) facility(ies) identified, indicate which is the processing capacity of each facility (tonnes/day, tonnes/month, tonnes/year). If the facility(ies) is(are) operating at its maximum capacity, then the alternative scenario can be excluded. The rationale is that in the absence of the project, the organic fraction of the waste would not be recycled or aerobically treated or incinerated, for example, because the recycling or aerobic treatment or incineration plant(s) located in the region that is served by the landfill would not be able to receive more waste.
   (d) If the facility(ies) identified in (c) above is(are) not operating at its maximum capacity, explain, with supporting evidence (e.g. by providing a balance of processed waste or receipts for transported waste), why the organic fraction of the solid waste would not have been treated in this(ese) facility(ies)
2. In doing so, the non-obligated entity may conduct interviews with authorities, refer to national/local statistics or studies related to MSW management in the area, and obtain opinion from relevant local experts.

21. In addition to the alternative baseline scenarios identified for the destruction of LFG, alternative scenarios for the use of LFG shall also be identified (if this is an aspect of the project activity):

(a) For electricity generation, alternative(s) shall include, inter alia:

(i) E1: Electricity generation from LFG, undertaken without being registered as ICM project activity;

(ii) E2: Electricity generation in existing or new renewable or fossil fuel based captive power plant(s);

(iii) E3: Electricity generation in existing and/or new grid-connected power plants;

(b) For heat generation, alternative(s) shall include, inter alia:

(i) H1: Heat generation from LFG undertaken without being registered as ICM project activity;

(ii) H2: Heat generation in existing or new fossil fuel fired cogeneration plant(s);

(iii) H3: Heat generation in existing or new renewable based cogeneration plant(s);

(iv) H4: Heat generation in existing or new fossil fuel-based boiler(s), air heater(s), glass melting furnace(s) or kiln(s);

(v) H5: Heat generation in existing or new renewable energy-based boiler(s), air heater(s), glass melting furnace(s) or kiln(s);

(vi) H6: Any other source, such as district heat; and

(vii) H7: Other heat generation technologies (e.g. heat pumps or solar energy);

(c) For the supply of LFG to a natural gas distribution network and/or dedicated pipeline and/or distribution of compressed/liquefied using trucks, the baseline is assumed to be the supply with natural gas.

22. To identify the baseline fuel for electricity generation by captive fossil fuel fired power plants and/or heat generation:

(a) Non-obligated entity shall demonstrate that the identified baseline fuel used for generation of electricity and/or heat is available in India and there is no supply constraint. In case of partial supply constraints (seasonal supply), the non-obligated entity shall consider, for the period of partial supply, the potential alternative fuel(s) with the lowest baseline emissions;

(b) Detailed justifications shall be provided and documented in the ICM-PDD for the selected baseline fuel. As a conservative approach, the lowest carbon intensive fuel, such as natural gas, may be used throughout all period of the year.

4.3. Baseline emissions

23. Baseline emissions are determined according to equation (1) and comprise the following sources:

(a) Methane emissions from the SWDS in the absence of the project activity;

(b) Electricity generation using fossil fuels or supplied by the grid in the absence of the project activity;

(c) Heat generation using fossil fuels in the absence of the project activity; and

(d) Natural gas used from the natural gas network in the absence of the project activity.

$$BE_y = BE_{CH4,y} + BE_{EC,y} + BE_{HG,y} + BE_{NG,y} \quad \text{Equation (1)}$$

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2e/yr)
$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
$BE_{EC,y}$	=	Baseline emissions associated with electricity generation in year *y* (t CO_2/yr)
$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
$BE_{NG,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2/yr)

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

24. Baseline emissions of methane from the SWDS are determined as follows, based on the amount of methane that is captured under the project activity and the amount that would be captured and destroyed in the baseline (such as due to regulations). In addition, the effect of methane oxidation that is present in the baseline and absent in the project is taken into account:

$$BE_{CH4} = \left(\left(1 - OX_{top\_layer}\right) \times F_{CH4,PJ,y} - F_{CH,BL,y}\right) \times GWP_{CH4} \quad \text{Equation (2)}$$

Where:

$BE_{CH4,y}$	=	Baseline emissions of methane from the SWDS in year *y* (t CO_2e/yr)
OX_{top_layer}	=	Fraction of methane in the LFG that would be oxidized in the top layer of the SWDS in the baseline (dimensionless)
$F_{CH4,\,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,\,BL,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* (t CH_4/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

4.3.1.1. Ex post determination of $F_{CH4,PJ,y}$

25. During the crediting period, $F_{CH4,PJ,y}$ is determined as the sum of the quantities of methane flared and used in power plant(s), boiler(s), air heater(s), glass melting furnace(s), kiln(s) and natural gas distribution, as follows:

$$F_{CH4,\,PJ,y} = F_{CH4,\,flared,\,y} + F_{CH4,\,EL,\,y} + F_{CH4,\,HG,\,y} + F_{CH4,\,NG,y} \quad \text{Equation (3)}$$

Where:

$F_{CH4,\,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$F_{CH4,\,flared,\,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,\,EL,\,y}$	=	Amount of methane in the LFG which is used for electricity generation in year *y* (t CH_4/yr)
$F_{CH4,\,HG,\,y}$	=	Amount of methane in the LFG which is used for heat generation in year *y* (t CH_4/yr)
$F_{CH4,\,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network and/or dedicated pipeline and/or to the trucks in year *y* (t CH_4/yr)

26. $F_{CH4,EL,y}$, $F_{CH4,HG,y}$ and $F_{CH4,NG,y}$ are determined using BM-T-005 and monitoring the working hours of the power plant(s), boiler(s), air heater(s), glass melting furnace(s) and kiln(s), so that no emission reduction are claimed for methane destruction during non-working hours. This is taken into account by monitoring the hours that the equipment utilizing the LFG is operating in year *y* ($Op_{j,h,y}$).

27. The following requirements apply:

(a) As per the gaseous stream tool, if the LFG is used for multiple purposes (e.g. flaring or energy generation), and all methane destruction devices are verified to be operational (e.g. by means of flame detectors records, energy generated), a single flow meter may be used to record the flow into multiple destruction devices. The destruction efficiency of the least efficient among the destruction devices shall be used as the destruction efficiency for all destruction devices monitored by this flow meter. If there are any periods for which one or more destruction devices are not operational, BM-T-006 shall be followed;

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

(c) The simplification offered for calculating the molecular mass of the gaseous stream is valid;

(d) The mass flow should be calculated on an hourly basis for each hour *h* in year *y*;

(e) The mass flow calculated for hour *h* is 0 if the equipment is not working in hour *h* ($Op_{j,h}$=not working), the hourly values are then summed to a yearly unit basis.

28. $F_{CH4,flared,y}$ is determined as the difference between the amount of methane supplied to the flare(s) and any methane emissions from the flare(s), as follows:

$$F_{CH4,\,flared,y} = F_{CH4,\,sent\_flare,y} - \frac{PE_{flare,y}}{GWP_{CH4}}$$ Equation (4)

Where:

$F_{CH4,\,flared,y}$	=	Amount of methane in the LFG which is destroyed by flaring in year *y* (t CH_4/yr)
$F_{CH4,\,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)
$PE_{flare,y}$	=	Project emissions from flaring of the residual gas stream in year *y* (t CO_2e/yr)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

29. $F_{CH4,sent\_flare,y}$ is determined directly using BM-T-005, applying the requirements described above where the gaseous stream the tool shall be applied to is the LFG delivery pipeline to the flare(s).

30. $PE_{flare,y}$ shall be determined using the methodological BM-T-004. If LFG is flared through more than one flare, then $PE_{flare,y}$ is the sum of the emissions for each flare determined separately.

4.3.1.2. Ex ante estimation of $F_{CH4,PJ,y}$

31. An ex ante estimate of $F_{CH4,PJ,y}$ is required to estimate baseline emission of methane from the SWDS (according to equation (2)) in order to estimate the emission reductions of the proposed project activity in the ICM-PDD. It is determined as follows:

$$F_{CH4,PJ,y} = \eta_{PJ} \times BE_{CH4,SWDS,y} / GWP_{CH4}$$ Equation (5)

Where:

$F_{CH4,PJ,y}$	=	Amount of methane in the LFG which is flared and/or used in the project activity in year *y* (t CH_4/yr)
$BE_{CH4,SWDS,y}$	=	Amount of methane in the LFG that is generated from the SWDS in the baseline scenario in year *y* (t CO_2e/yr)
η_{PJ}	=	Efficiency of the LFG capture system that will be installed in the project activity
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2e/t CH_4)

32. $BE_{CH4,SWDS,y}$ is determined using BM-T-011. The following guidance should be taken into account when applying the tool:

(a) f_y in the tool shall be assigned a value of 0 because the amount of LFG that would have been captured and destroyed is already accounted for in equation (2) of this methodology;

(b) In the tool, *x* begins with the year that the SWDS started receiving wastes (e.g. the first year of SWDS operation); and

(c) Sampling to determine the fractions of different waste types is not necessary because the waste composition can be obtained from previous studies.

4.3.1.3. Determination of $F_{CH4,BL,y}$

33. This section provides a procedure to determine the amount of methane that would have been captured and destroyed (by flaring) in the baseline due to regulatory or contractual requirements, to address safety and odour concerns, or for other reasons (collectively referred to as requirement in this section). The four cases in Table 3 are distinguished. The appropriate case should be identified, and the corresponding instructions followed.

Table 3. Cases for determining methane captured and destroyed in the baseline

Situation at the start of the project activity	Requirement to destroy methane	Existing LFG capture and destruction system
Case 1	No	No
Case 2	Yes	No
Case 3	No	Yes
Case 4	Yes	Yes

4.3.1.3.1. Case 1: No requirement to destroy methane exists and no existing LFG capture system

34. In this situation:

$$F_{CH4,\,BL,y} = 0 \quad \text{Equation (6)}$$

4.3.1.3.2. Case 2: Requirement to destroy methane exists and no existing LFG capture system

35. In this situation:

$$F_{CH4,\,BL,y} = F_{CH4,\,BL,\,R,y} \quad \text{Equation (7)}$$

36. $F_{CH4,BL,R,y}$ should be determined based on the information contained in the requirement to destroy methane, as follows:

(a) If the requirement specifies the amount of methane that must be flared then that amount is $F_{CH4,BL,R,y}$;

(b) If the requirement specifies a percentage of the captured LFG that is required to be flared, the amount shall be calculated as follows:

$$F_{CH4,\,BL,\,R,\,y} = \rho_{reg,y} \times F_{CH4,\,PJ,\,capt,y} \quad \text{Equation (8)}$$

Where:

$F_{CH4,\,BL,\,R,\,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (t CH_4/yr)
$\rho_{reg,y}$	=	Fraction of LFG that is required to be flared due to a requirement in year *y*
$F_{CH4,\,PJ,\,capt,y}$	=	Amount of methane in the LFG which is captured in the project activity in year *y* (t CH_4/yr)

37. Non-obligated entity may choose to calculate $F_{CH4,PJ,capt,y}$ by either of the two options:

(a) **Option 1:** Calculate using BM-T-005, applying the following requirements:

(i) The gaseous stream tool shall be applied to the LFG pipeline immediately downstream of the LFG capture system and before any split in the gaseous flow to different uses or flares;

(ii) CH_4 is the greenhouse gases for which the mass flow should be determined;

(iii) The simplification offered for calculating the molecular mass of the gaseous stream is valid; and

(iv) The mass flow should be calculated on an hourly basis for each hour *h* in year *y*.

(b) **Option 2:** Calculate as the sum of the amount of methane that is sent to the flare, electricity generating or heat generating equipment in year *y* as measured in section 4.4.3.1, however, not taking into account the working hours of the equipment;

(i) If the requirement does not specify the amount or percentage of LFG that should be destroyed but requires the installation of a capture system, without requiring the captured LFG to be flared then:

$$F_{CH4,BL,R,y} = 0 \qquad \text{Equation (9)}$$

(ii) If the requirement does not specify any amount or percentage of LFG that should be destroyed, but requires the installation of a system to capture and flare the LFG, then a typical destruction rate of 20 per cent is assumed:[3]

$$F_{CH4,BL,R,y} = 0.2 \times F_{CH4,PJ,capt,y} \qquad \text{Equation (10)}$$

4.3.1.3.3. Case 3: No requirement to destroy methane exists and an LFG capture system exists

38. In this situation:

$$F_{CH4,BL,y} = F_{CH4,BL,sys,y} \qquad \text{Equation (11)}$$

39. If the amount of methane captured with the existing system can be monitored separately from the amount captured under the project, and the efficiency of the existing system is not impacted on by the project system during the crediting period(s), then $F_{CH4,BL,sys,y}$ is determined as follows:

$$F_{CH4,BL,sys,y} = F_{CH4,sent\_flare,y} \qquad \text{Equation (12)}$$

Where:

$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (t CH_4/yr)
$F_{CH4,sent\_flare,y}$	=	Amount of methane in the LFG which is sent to the flare in year *y* (t CH_4/yr)

40. $F_{CH4,sent\_flare,y}$ is determined using BM-T-005 and applying the requirements described in section 4.4.3.1, where the gaseous stream the tool shall be applied to is the pipeline collecting LFG from the existing LFG capture system.

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[3] This default value of 20 per cent is based on assuming a situation in which: the efficiency of the LFG capture system in the project is 50 per cent; the efficiency of the LFG capture system in the baseline is 20 per cent; and, the amount captured in the baseline is flared using an open flare with a destruction efficiency of 50 per cent (consistent with the default value provided in the tool "Project emissions from flaring"). Non-obligated entity may propose and justify an alternative default value as a request for revision to this methodology.

41. If there is no monitored data available, but there is historic data on the amount of methane that was captured in the year prior to the implementation of the project activity, then in this situation:

$$F_{CH4,\,BL,\,sys,\,y} = F_{CH4,\,hist,\,y} \quad \text{Equation (13)}$$

42. In determining $F_{CH4,hist,y}$ it is assumed that the fraction of LFG that was recovered in the year prior to the implementation of the project activity will be the same fraction recovered under the project activity:

$$F_{CH4,\,hist,\,y} = \frac{F_{CH4,\,BL,\,x-1}}{F_{CH4,\,x-1}} \times F_{CH4,\,PJ,\,y} \quad \text{Equation (14)}$$

Where:

$F_{CH4,\,hist,\,y}$	=	Historical amount of methane in the LFG which is captured and destroyed (t CH_4/yr)
$F_{CH4,\,BL,\,x-1}$	=	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity (t CH_4/yr)
$F_{CH4,\,x-1}$	=	Amount of methane in the LFG generated in the SWDS in the year prior to the implementation of the project activity (t CH_4/yr)
$F_{CH4,\,PJ,\,y}$	=	Amount of methane in the LFG which is captured in the project activity in year *y* (t CH_4/yr)

43. $F_{CH4,x-1}$ shall be estimated using BM-T-011. The guidance and requirements described in section 4.4.3.2 for applying the tool shall be followed. The year *y* in the tool is equivalent to the year prior to the implementation of the project activity.

44. If there is no monitored or historic data on the amount of methane that was captured in the year prior to the implementation of the project situation, then:

$$F_{CH4,\,BL,\,sys,\,y} = 0.2 \times F_{CH4,\,PJ,\,y} \quad \text{Equation (15)}$$

45. The 20 per cent default factor is consistent with the default factor given in equation (10).

4.3.1.3.4. Case 4: Requirement to destroy methane exists and LFG capture system exists

46. $F_{CH4,BL,y}$ shall be determined based on information in contract of regulation requirements and data related to the existing LFG capture system, as follows:

$$F_{CH4,\,BL,y} = max\{F_{CH4,\,BL,\,R,\,y};F_{CH4,\,BL,\,sys,y}\} \quad \text{Equation (16)}$$

Where:

$F_{CH4,\,BL,\,R,\,y}$	=	Amount of methane in the LFG which is flared in the baseline due to a requirement in year *y* (t CH_4/yr)

$F_{CH4,BL,sys,y}$	=	Amount of methane in the LFG that would be flared in the baseline in year *y* for the case of an existing LFG capture system (t CH_4/yr)

47. $F_{CH4,BL,R,y}$ and $F_{CH4,BL.sys,y}$ shall be determined according to the respective procedures for Case 2 and Case 3 above.

4.3.2. Baseline emissions associated with electricity generation ($BE_{EC,y}$)

48. The baseline emissions associated with electricity generation in year *y* ($BE_{EC,y}$) shall be calculated using BM-T-003. When applying the tool:

(a) The electricity sources *k* in the tool correspond to the sources of electricity generated identified in the selection of the most plausible baseline scenario; and

(b) $EC_{BL,k,y}$ in the tool is equivalent to the net amount of electricity generated using LFG in year *y* ($EG_{PJ,y}$).

4.3.3. Baseline emissions associated with heat generation ($BE_{HG,y}$)

49. The baseline emissions associated with heat generation in year *y* ($BE_{HG,y}$) are determined based on the amount of methane in the LFG which is sent to the heat generation equipment in the project activity (boiler, air heater, glass melting furnace(s) and/or kiln), as follows:

$$BE_{HG,y} = NCV_{CH4} \times \sum_{j=1}^{n} \left(R_{efficiency,j,y} \times F_{CH4,HG,dest,j,y} \times EF_{CO2,BL,HG,j}\right) \quad \text{Equation (17)}$$

Where:

$BE_{HG,y}$	=	Baseline emissions associated with heat generation in year *y* (t CO_2/yr)
NCV_{CH4}	=	Net calorific value of methane at reference conditions (TJ/t CH_4)
$R_{efficiency,j,y}$	=	Ratio of the project and baseline efficiency of heat equipment type *j* in year *y*
$F_{CH4,HG,dest,j,y}$	=	Amount of methane in the LFG which is destroyed for heat generation by equipment type *j* in year *y* (t CH_4/yr)
$EF_{CO2,BL,HG,j}$	=	CO_2 emission factor of the fossil fuel type used for heat generation by equipment type *j* in the baseline (t CO_2/TJ)
j	=	Heat generation equipment (boiler, air heater, glass melting furnace(s) or kiln)
N	=	Number of different heat generation equipment used in the project activity

4.3.3.1. Determination of $R_{efficiency,j,y}$

50. The ratio of the project and baseline efficiency of an air heater, boiler, glass melting furnace or kiln is determined as follows:

$$R_{efficiency,\,j,y} = min\left\{1; \frac{\eta_{HG,\,PJ,\,j,y}}{\eta_{HG,\,BL,\,j}}\right\}$$ Equation (18)

Where:

$R_{efficiency,\,j,y}$	=	Ratio of the project and baseline efficiency of equipment type *j* in year *y*
$\eta_{HG,\,BL,\,j}$	=	Efficiency of the heat generation equipment type *j* used in the baseline
$\eta_{HG,\,PJ,\,j,y}$	=	Efficiency of the heat generation equipment type *j* used in the project activity in year *y*
j	=	Heat generation equipment type (boiler, air heater, glass melting furnace(s) or kiln)

51. To estimate the baseline energy efficiency of an air heater, boiler, glass melting furnace(s) or kiln ($\eta_{HG,BL,j}$) Non-obligated entity shall apply BM-T-006.

4.3.3.2. Determination of $F_{CH4,HG,dest,j,y}$

52. The amount of methane that is destroyed in the LFG that is sent to heat generation equipment *j* is determined with equation (19) if *j* is a boiler or air heater, or glass melting furnace, or with equation (20) if *j* is a brick kiln. For the particular case of intermittent brick kilns, non-obligated entity may choose to apply either equation (19) or (20).

$$F_{CH4,\,HG,\,dest,j,y} = fd_{CH4,\,HG,\,j,\,default} \times F_{CH4,\,HG,\,j,\,y}$$ Equation (19)

Where:

$F_{CH4,\,HG,\,dest,j,y}$	=	Amount of methane in the LFG which is destroyed for heat generation by equipment type *j* in year *y* (t CH_4/yr)
$fd_{CH4,\,HG,\,j,\,default}$	=	Default value for the fraction of methane destroyed when used for heat generation equipment type *j*
$F_{CH4,\,HG,\,j,\,y}$	=	Amount of methane in the LFG which is used for heat generation equipment type *j* in year *y* (t CH_4/yr)

53. $F_{CH4,HG,j,y}$ is determined according to section 4.4.3.1, where *j* is each item of heat generation equipment.

$$F_{CH4,\,HG,\,dest,\,j,y} = \sum_{h=1}^{8{,}760} \left(fd_{CH4,\,kiln,\,h} \times F_{CH4,\,HG,\,kiln,\,h}\right)$$ Equation (20)

54. With: $fd_{CH4,kiln,h}$ = 1 if $Q_{O2,kiln,h}$ > 0, and otherwise $fd_{CH4,kiln,h}$ = 0.

Where:

$F_{CH4,\,HG,\,dest,\,j,y}$	=	Amount of methane in the LFG which is destroyed for heat generation by brick kiln in year *y* (t CH_4/yr)
$fd_{CH4,\,kiln,\,h}$	=	Fraction of methane destroyed when used for heat generation in a brick kiln in hour *h*
$F_{CH4,\,HG,\,kiln,\,h}$	=	Amount of methane in the LFG which is used for heat generation by brick kiln in hour *h* (t CH_4/hr)
$Q_{O2,kiln,h}$	=	Average volumetric fraction of oxygen in the exhaust gas flow of the kiln in hour *h* (volume of O_2/volume of the gas stream)
H	=	Hours in year *y*

55. $F_{CH4,HG,kiln,h}$ is determined using BM-T-005, following the requirements given in section 4.4.3.1 for *j* = kiln, except that the mass flow should be summed to an hourly (not yearly) unit basis (t CH_4/hr).

4.3.4. Baseline emissions associated with natural gas use ($BE_{NG,y}$)

56. $BE_{NG,y}$ is estimated as follows:

$$BE_{NG,\,y} = 0.0504 \times F_{CH4,\,NG,y} \times EF_{CO2,NG,y} \quad \text{Equation (21)}$$

Where:

$BE_{NG,\,y}$	=	Baseline emissions associated with natural gas use in year *y* (t CO_2e/yr)
$EF_{CO2,NG,y}$	=	Average CO_2 emission factor of natural gas in the natural gas network or dedicated pipeline or in the trucks in year *y* (t CO2e/TJ)
$F_{CH4,\,NG,y}$	=	Amount of methane in the LFG which is sent to the natural gas distribution network or dedicated pipeline or to the trucks in year *y* (t CH_4/yr)

57. $EF_{CO2,NG,y}$ is determined using BM-T-002.

4.4. Project emissions

58. Project emissions are calculated as follows:

$$PE_y = PE_{EC,y} + PE_{FC,y} + PE_{DT,y} + PE_{SP,y} \quad \text{Equation (22)}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2/yr)
$PE_{EC,y}$	=	Emissions from consumption of electricity due to the project activity in year *y* (t CO_2/yr)
$PE_{FC,y}$	=	Emissions from consumption of fossil fuels due to the project activity, for purpose other than electricity generation, in year *y* (t CO_2/yr)
$PE_{DT,y}$	=	Emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr)
$PE_{SP,y}$	=	Emissions from the supply of LFG to consumers through a dedicated pipeline, in year *y* (t CO_2/yr)

59. The project emissions from consumption of electricity by the project activity ($PE_{EC,y}$) shall be calculated using BM-T-003. When applying the tool:

(a) $EC_{PJ,k,y}$ in the tool is equivalent to the amount of electricity consumed by the project activity in year *y* ($EC_{PJ,y}$); and

(b) If in the baseline a proportion of LFG is destroyed ($F_{CH4,BL,y}$>0), then the electricity consumption in the tool ($EC_{PJ,j,y}$) should refer to the net quantity of electricity consumption (i.e. the increase due to the project activity). The determination of the amount of electricity consumed in the baseline shall be transparently documented in the ICM-PDD.

60. The project emissions from fossil fuel combustion for purposes other than electricity generation ($PE_{FC,y}$) shall be calculated using BM-T-002. When applying the tool:

(a) Processes *j* in the tool correspond to the sources of fossil fuel consumption due to the project activity other than for electricity generation or and any on-site transportation by trucks or cars;

(b) If in the baseline a proportion of LFG is captured and flared ($F_{CH4,BL,y}$> 0), then the fossil fuels consumption used in calculation ($FC_{i,j,y}$) should refer to the net of that consumed in the baseline. The determination of the amount of fossil fuels consumed in the baseline shall be transparently documented in the ICM-PDD.

61. The project emissions from the distribution of compressed/liquefied LFG using trucks ($PE_{DT,y}$) is determined by the sum of emissions arising from the transportation of LFG using trucks and possible leaks during the transportation, as follows:

$$PE_{DT,y} = PE_{TR,y} + PE_{leaks,y} \quad \text{Equation (23)}$$

Where:

$PE_{DT,y}$	=	Project emissions from the distribution of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr)
$PE_{TR,y}$	=	Emissions from the transportation of compressed/liquefied LFG using trucks, in year *y* (t CO_2/yr)
$PE_{leaks,y}$	=	Emissions from CH_4 leaks during the transportation of compressed/liquefied LFG, in year *y* (t CO_2/yr)

62. The project emissions from the transportation of compressed/liquefied LFG using trucks ($PE_{TR,y}$) shall be accounted using the methodological tool “Project and leakage emissions from transportation of freight”. When applying the tool the following must be considered:

(a) Transportation activity *f* in the tool corresponds to the distribution of compressing/liquefied LFG from the biogas processing plant to consumer(s) through using trucks;

(b) The freight transported is the compressed/liquefied LFG.

63. In addition to project emissions from transportation of freight, methane leak emissions from transport of the compressed/liquefied LFG by trucks shall also be computed as follows:

$$PE_{leaks,y} = GWP_{CH4} \times (F_{CH4,NG\,TR,y} - F_{CH4,NG-cons,y}) \quad \text{Equation (24)}$$

Where:

$PE_{leaks,y}$	=	Emissions from CH_4 leaks during the transportation of compressed/liquefied LFG, in year *y* (t CO_2/yr)
GWP_{CH4}	=	Global Warming Potential of CH_4
$F_{CH4,NG\,TR,y}$	=	Amount of methane in the LFG which is sent to trucks in year *y*
$F_{CH4,NG-cons,y}$	=	Amount of methane in the LFG which is delivered to consumers using trucks in year *y* (t CH_4/yr)

64. The project emissions from the supply of LFG through a dedicated pipeline ($PE_{SP,y}$) shall be determined as follows:

$$PE_{SP,y} = 0.0504 \times DEFT_{SP,y} \times F_{CH4,NG,y} \quad \text{Equation (25)}$$

Where:

$PE_{SP,y}$	=	Project emissions from the supply of LFG to consumers due to physical leakage from the dedicated pipeline, in year *y* (t CO_2/yr)
$DEFT_{SP,y}$	=	Default emission factor for the supply of LFG to consumers due to physical leakage through the dedicated pipeline (tCO_2e/TJ)[4]
$F_{CH4,NG,y}$	=	Amount of methane in the LFG which is sent to the consumer through a dedicated pipeline in year *y* (tCH4/yr)

4.5. Leakage

65. No leakage effects are accounted for under this methodology.

4.6. Emission reductions

66. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (26)}$$

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_2/yr)

[4] This default value (2.2 tCO_2e/TJ) is based on BM-T-009: Upstream leakage emissions associated with fossil fuel use

67. Non-obligated entity should provide an ex ante estimate of emissions reductions in the ICM-PDD. This requires projecting the future GHG emissions of the SWDS for the calculation of baseline emissions.

68. If the energy component is intended to be implemented after the first year of the project activity, then Non-obligated entity may exclude the energy component from the ex ante estimation of baseline emissions. This avoids overestimating ex ante estimate of emissions if energy generation is not implemented, or a lower capacity is implemented than originally envisaged. This exclusion is not applicable to the determination of the baseline or demonstration of additionality.

4.7. Data and parameters not monitored

69. In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter table 1.

Data / Parameter:	OX_{top_layer}
Data unit:	Dimensionless
Description:	Fraction of methane that would be oxidized in the top layer of the SWDS in the baseline
Source of data:	Consistent with how oxidation is accounted for in BM-T-011
Value to be applied:	0.1
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable to section 4.3.1 $OX_{top\text{-}layer}$ is the fraction of the methane in the LFG that would oxidize in the top layer of the SWDS in the absence of the project activity. Under the project activity, this effect is reduced as a part of the LFG is captured and does not pass through the top layer of the SWDS. This oxidation effect is also accounted for in the methodological tool “Emissions from solid waste disposal sites”. In addition to this effect, the installation of an LFG capture system under the project activity may result in the suction of additional air into the SWDS. In some cases, such as with a high suction pressure, the air may decrease the amount of methane that is generated under the project activity. However, in most circumstances where the LFG is captured and used this effect was very small, as the operators of the SWDS have in most cases an incentive to maintain a high methane concentration in the LFG. For these reasons, the oxidation factor shall be included in the calculation of baseline emissions whereas the effect of oxidation is, as a conservative assumption, neglected under the project activity.

Data / Parameter table 2.

Data / Parameter:	$F_{CH4,BL,x-1}$
Data unit:	t CH_4/yr

Description:	Historical amount of methane in the LFG which is captured and destroyed in the year prior to the implementation of the project activity
Source of data:	Information recorded by the SWDS operator
Value to be applied:	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	

Data / Parameter table 3.

Data / Parameter:	$\boldsymbol{GWP_{CH4}}$
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of CH_4
Source of data:	IPCC Sixth Assessment Report (AR6)
Value to be applied:	29.8 t CO_2e/t CH_4
Monitoring frequency:	The GWP value will be updated in line with the latest available IPCC Assessment Reports.
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$\boldsymbol{NCV_{CH4}}$
Data unit:	TJ/t CH_4
Description:	Net calorific value of methane at reference conditions
Source of data:	Technical literature
Value to be applied:	0.0504
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$\boldsymbol{EF_{CO2,BL,HG,j}}$
Data unit:	t CO_2/TJ
Description:	CO_2 emission factor of the fossil fuel type used for heat generation by equipment type *j* in the baseline
Source of data:	Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories
Value to be applied:	The lower limit of the 95 per cent confidence interval of the default values provided in table 1.4 of reference above shall be used
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable to section 4.4.3

Data / Parameter table 6.

Data / Parameter:	η_{PJ}
Data unit:	Dimensionless
Description:	Efficiency of the LFG capture system that will be installed in the project activity
Source of data:	-
Value to be applied:	Technical specifications of the LFG capture system to be installed (if available) or a default value of 50 per cent
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	Applicable to section 4.4.3.2

Data / Parameter table 7.

<table>
<tr><td>Data / Parameter:</td><td>$fd_{CH4,HG,j,default}$</td></tr>
<tr><td>Data unit:</td><td>-</td></tr>
<tr><td>Description:</td><td>Default value for the fraction of methane destroyed when used for heat generation equipment type j</td></tr>
<tr><td>Source of data:</td><td>The values for boilers and air heaters are based on default values provided in the 2006 IPCC Guidelines (Tier 3 approach for Chapter 2: Stationary Combustion of Volume 2: Energy Use).
The value for intermittent brick kilns is based on the assumption that combustion temperatures in the kiln will exceed 600 °C and that the time of exposure is sufficiently long to support 90 per cent combustion</td></tr>
<tr><td>Measurement procedures (if any):</td><td>Select the appropriate factor for the fraction of methane destroyed from the following table:

Table 4. Fraction of CH_4 destroyed by equipment type
<table>
<tr><th>Fraction of CH_4 destroyed</th><th>Equipment type j</th></tr>
<tr><td>1</td><td>Boilers</td></tr>
<tr><td>1</td><td>Air heaters</td></tr>
<tr><td>1</td><td>Glass melting furnaces</td></tr>
<tr><td>0.9</td><td>Intermittent brick kiln</td></tr>
</table></td></tr>
<tr><td>Monitoring frequency:</td><td>-</td></tr>
<tr><td>QA/QC procedures:</td><td>-</td></tr>
<tr><td>Any comment:</td><td>Applicable to calculating $F_{CH4,HG,dest,j,y}$ using equation (19) in section 4.4.3.2. For intermittent brick kilns, Non-obligated entity may choose to instead determine $F_{CH4,HG,dest,j,y}$ using equation (20)</td></tr>
</table>

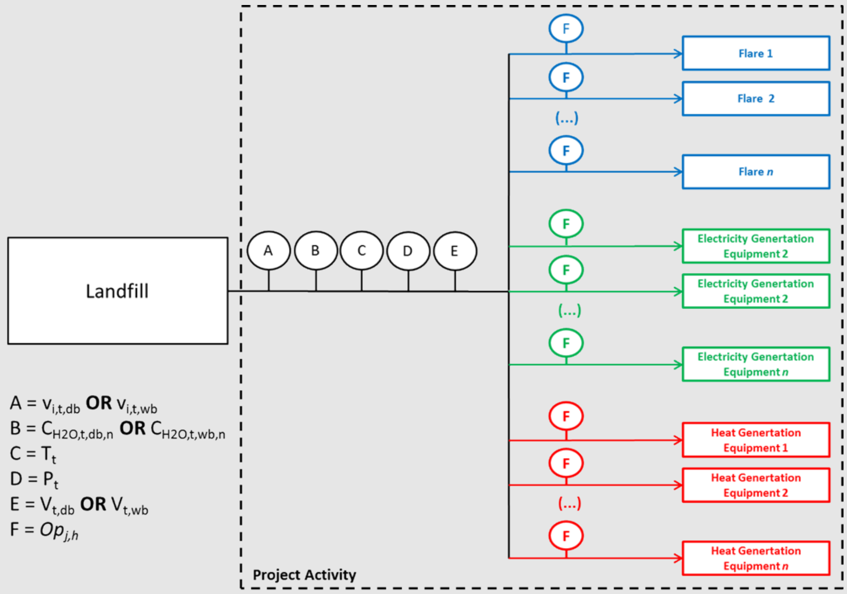
5. Methodology: Monitoring Component

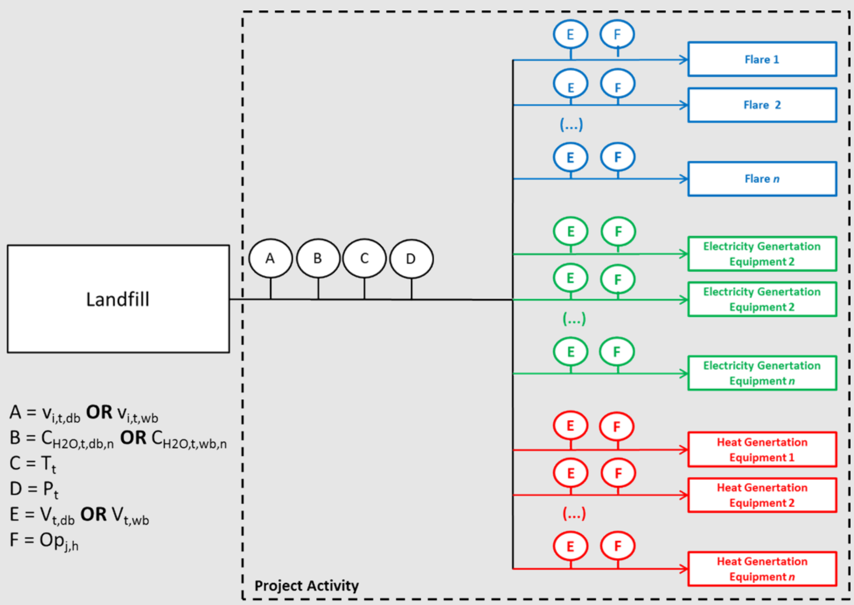
5.1. Data and parameters monitored

70. In addition to the parameters listed in the tables below, the provisions on data and parameters monitored in the tools referred to in this methodology apply.

Box 3. Non-binding best practice example 3: monitoring of the gaseous streams

1. The monitoring of gas flow rate, gas composition, moisture content, temperature, and pressure, following the requirements from paragraphs 27 (a) and 29, may be made at the common header as per the diagram below. However, all methane destruction devices should be verified to be operational (e.g. by means of flame detectors records, energy generated).





Data / Parameter table 8.

Data / Parameter:	Management of SWDS
Data unit:	-
Description:	Management of SWDS
Source of data:	Use different sources of data: (a) Original design of the landfill; (b) Technical specifications for the management of the SWDS; (c) Local or national regulations
Measurement procedures (if any):	Non-obligated entity should refer to the original design of the landfill to ensure that any practice to increase methane generation have been occurring prior to the implementation of the project activity. Any change in the management of the SWDS after the implementation of the project activity should be justified by referring to technical or regulatory specifications
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 9.

Data / Parameter:	$F_{CH4,BL,R,y}$
Data unit:	t CH_4/yr
Description:	Amount of methane in the LFG which is flared due to a requirement in year *y*
Source of data:	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable to Case 2 of section 4.4.1.3

Data / Parameter table 10.

Data / Parameter:	$\rho_{reg,y}$
Data unit:	Dimensionless
Description:	Fraction of LFG that is required to be flared due to a requirement in year *y*
Source of data:	Information of the host country's regulatory requirements relating to LFG, contractual requirements, or requirements to address safety and odour concerns
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable to Case 2 of section 4.4.1.3

Data / Parameter table 11.

Data / Parameter:	$\eta_{HG,PJ,j.y}$
Data unit:	Dimensionless
Description:	Efficiency of the heat generation equipment used in the project activity in year *y*
Source of data:	Use one of the following options to determine the efficiency: (a) Measured efficiency during monitoring; (b) Manufacturer's information on the efficiency; or (c) Use a default value of 60 per cent
Measurement procedures (if any):	If measurements are conducted, use recognized standards for the measurement of the heat generator efficiency, such as the "*British Standard Methods for Assessing the thermal performance of boilers for steam, hot water and high temperature heat transfer fluids*" (BS845). Where possible, use preferably the direct method (dividing the net heat generation by the energy content of the fuels fired during a representative time period), as it is better able to reflect average efficiencies during a representative time period compared to the indirect method (determination of fuel supply or heat generation and estimation of the losses). Document measurement procedures and results and manufacturer's information transparently in the ICM-PDD
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	Applicable to section 4.4.3.1

Data / Parameter table 12.

Data / Parameter:	$Op_{j,h}$
Data unit:	-
Description:	Operation of the equipment that consumes the LFG
Source of data:	Non-obligated entity
Measurement procedures (if any):	For each equipment unit *j* using *the LFG* monitor that the plant is operating in hour *h* by the monitoring any one or more of the following three parameters: (a) Temperature. Determine the location for temperature measurements and minimum operational temperature based on manufacturer's specifications of the burning equipment. Document and justify the location and minimum threshold in the PDD; (b) Flame. Flame detection system is used to ensure that the equipment is in operation; (c) Products generated. Monitor the generation of steam for the case of boilers and air-heaters and glass for the case of glass melting furnaces. This option is not applicable to brick kilns. $Op_{j,h}$=0 when: (a) One of more temperature measurements are missing or below the minimum threshold in hour *h* (instantaneous measurements are made at least every minute); (b) Flame is not detected continuously in hour *h* (instantaneous measurements are made at least every minute); (c) No products are generated in the hour *h.*

	Otherwise, $Op_{j,h}$=1
Monitoring frequency:	Hourly
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	$EG_{PJ,y}$
Data unit:	MWh
Description:	Amount of electricity generated using LFG by the project activity in year *y*
Source of data:	Electricity meter
Measurement procedures (if any):	Monitor net electricity generation by the project activity using LFG
Monitoring frequency:	Continuous
QA/QC procedures:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Any comment:	This parameter is required for calculating baseline emissions associated with electricity generation ($BE_{EC,y}$) using BM-T-003

Data / Parameter table 14.

Data / Parameter:	$EG_{EC,y}$
Data unit:	MWh
Description:	Amount of electricity consumed by the project activity in year *y*
Source of data:	Electricity meter
Measurement procedures (if any):	Sources of consumption shall include, where applicable, electricity consumed for the operation of the LFG capture system, for any processing and upgrading of the LFG, for transportation of the LFG to the flare or other applications (boilers, power generators), for the compression of the LFG into the natural gas network, etc.
Monitoring frequency:	Continuous
QA/QC procedures:	Electricity meter will be subject to regular (in accordance with stipulation of the meter supplier) maintenance and testing to ensure accuracy. The readings will be double checked by the electricity distribution company
Any comment:	This parameter is required for calculating project emissions from electricity consumption due to an alternative waste treatment process *t* $PE_{EC,y}$) using BM-T-003

Data / Parameter table 15.

Data / Parameter:	$F_{CH4,NG\text{-}cons,y}$
Data unit:	t CH_4/yr
Description:	Amount of methane in the LFG which is delivered to consumers using trucks in year *y*

Source of data:	-
Measurement procedures (if any):	Determined using BM-T-005
Monitoring frequency:	Per batch and aggregated annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 16.

Data / Parameter:	$F_{CH4,NG\ TR,y}$
Data unit:	t CH_4/yr
Description:	Amount of methane in the LFG which is sent to trucks in year *y*
Source of data:	-
Measurement procedures (if any):	Determined using BM-T-005
Monitoring frequency:	Per batch and aggregated annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 17.

Data / Parameter:	**CAPEX and OPEX**
Data unit:	Currency (USD, EUR, etc.)
Description:	Total investment to implement the project and total cost to operate the project
Source of data:	Engineering, procurement and construction contracts; and maintenance contracts
Measurement procedures (if any):	-
Monitoring frequency:	At the first issuance request after each phase of the project is fully implemented
QA/QC procedures:	Audited by professional, independent financial auditors. The ACVA should only verify that the data provided corresponds to the data from independent financial auditors
Any comment:	The information provided for CAPEX shall indicate the investment made: (i) in the collection and flaring system; (ii) in the power plant and connection to the grid (if applicable); and (iii) in the purchase of the new boiler or refurbishment of the existing one and in the steam/hot air pipeline if steam/hot air is exported out of the project boundary (if applicable). The information supplied for OPEX shall indicate the costs for: (i) staff and maintenance involved in the operation of the collection and flaring system; and (ii) staff and maintenance involved in the operation of the collection and power generation system. The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality

Data / Parameter table 18.

Data / Parameter:	Tariff of electricity exported
Data unit:	INR/KWh
Description:	Tariff of the electricity exported
Source of data:	Power purchase agreement
Measurement procedures (if any):	-
Monitoring frequency:	At the first issuance request after each phase of the project is fully implemented
QA/QC procedures:	Audited by professional, independent financial auditors. The ACVA should only verify that the data provided corresponds to the data from independent financial auditors
Any comment:	The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality

Data / Parameter table 19.

Data / Parameter:	Revenues from the sale of heat / Savings based on the heat generated and consumed on-site
Data unit:	INR
Description:	(a) Revenues from the heat sold outside of the project boundary; or (b) (ii) Savings based on the heat consumed on-site, which would have been generated outside of the project boundary
Source of data:	(a) Heat supply agreement; (b) Monthly average expenses of heat purchased during the previous year prior to the implementation of the project activity
Measurement procedures (if any):	-
Monitoring frequency:	At the first issuance request after each phase of the project is fully implemented
QA/QC procedures:	Audited by professional, independent financial auditors. The ACVA should only verify that the data provided corresponds to the data from independent financial auditors
Any comment:	The monitoring of this parameter is only required for projects applying the simplified procedures to identify the baseline scenario and demonstrate additionality

Data / Parameter table 20.

Data / Parameter:	$F_{CH4,NG,y}$
Data unit:	tCH_4/yr
Description:	Amount of methane in the LFG which is sent to the natural gas distribution network or dedicated pipeline or to the trucks in year *y*
Source of data:	-
Measurement procedures (if any):	Determined using BM-T-005

Monitoring frequency:	Continuous and aggregated annually in case of natural gas distribution network and dedicated pipeline. Pre-batch and aggregated annually in case of trucks
QA/QC procedures:	-
Any comment:	-

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM AG04.001

Production of Biofuel

Publication Date:

Version 1.0

Sectoral scope(s): Agriculture

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology ACM0017 (as valid from 31 May 2024).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Construction and operation of a biofuel production plant for production of (blended) biofuel that is used as fuel in existing stationary installations (e.g. diesel generators) and/or in vehicles.
Type of GHG emissions mitigation action	Renewable energy: Displacement of more-GHG-intensive fossil fuel for combustion in vehicles and/or stationary installations

2. Definitions

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

(a) **Biodiesel** - is a diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters which is produced by esterification of vegetable oils and/or waste oil/fat with alcohols from biogenic and/or fossil origin;

(b) **Bioethanol** - is an alcohol produced through the fermentation of sugars or starches, followed by a distillation process and, if required, a dehydration processes;

(c) **Biofuel production plant** - is the plant where feedstock (e.g. oil, waste oil/fat sugar, starch) is processed to biofuel;

(d) **Biogenic** - means that the oils and/or fats originate from either vegetable or animal biomass, but not from mineral (fossil) sources;

(e) **Blended biofuel** - blend of fossil fuel and biofuels;

(f) **Dedicated plantations -** are plantations that are newly established as part of the project activity for the purpose of supplying feedstock to the project plant. In case the dedicated plantation is a forestry ICM project, then the procedures of the approved forestry methodology apply;

(g) **Esterification** - denotes the formation of an ester compound from carbonic acid and alcohol. Transesterification denotes the exchange of one alcohol in an ester against another (for example glycerol against methanol). In this methodology, “esterification” is used to denote both esterification and transesterification for simplicity;

(h) **Mill** - is a plant where seeds or crops are processed into starch/sugar;

(i) **Oil production plant** - is a plant where oil seeds from plants are processed to vegetable oil;

(j) **Oil seeds** - are seeds of plants from which oil can be derived;

(k) **Petrodiesel** - is 100% fossil fuel diesel**;**

(l) **Vegetable oil** - is oil of biogenic origin that is produced from oil seeds from plants;

(m) **Waste oil/fat** - is defined as a residue or waste stream of biogenic origin from restaurants, agro and food industry, slaughterhouses or related commercial sectors.

3. Scope & Applicability

3.1. Scope

5. This methodology comprises project activities involving production of biofuel that is used as fuel in existing stationary installations (e.g. diesel generators) and/or in vehicles.

3.2. Applicability

6. The methodology is applicable to project activities that reduce emissions through the production of blended biofuels to be used in existing stationary installations and/or in vehicles.

7. The biofuel is produced from one or a combination of the following feedstock:

   (a) Waste oil/fat;

   (b) Seeds or crops that are cultivated in dedicated plantations;

   (c) Biomass residues (e.g. agricultural residues, wood residues, organic wastes).

8. In order to avoid double counting of emission reductions, the methodology ensures that the CCCs can only be issued to the producer of the biofuel. The project proponent shall demonstrate that double counting of emission reductions will not occur e.g. via a contractual agreement with the end-user(s), feedstock producer or other stakeholder involved in the supply chain.

9. The following conditions apply to the methodology:

   (a) Feedstock inputs:

      (i) For all biofuels: if the biofuel in the project plant is only **partly** produced from the sources specified in paragraph 7 above, any volumes of biofuel that are also produced in the project plant but from other feedstock sources, are not included in the quantity of biofuel for which emission reductions are claimed;

      (ii) For biodiesel: the alcohol used for esterification is methanol from **fossil origin**. Volumes of biodiesel produced with alcohols other than methanol (for example, ethanol) are not included in the quantity of biodiesel for which emission reductions are claimed.[1]

(b) Dedicated plantations:

(i) If the biofuel is produced from seeds or crops that are cultivated in dedicated plantations, the project activity shall comply with the provisions of the tool “BM-T-010: Project and leakage emissions from biomass”;

(c) Biofuel plant and products:

(i) The fossil fuels, the biofuels and the blended biofuels comply with national regulations (if existent) or with suitable international standards;

(ii) The project activity involves construction and operation of a biofuel production plant;

(iii) Any by-product (e.g. glycerol) is not disposed of or left to decay. It should be either incinerated or used as raw material for industrial consumption or sold;

(iv) If biomass or biofuel is used at the project plant(s) (processing, production or blending plant) as fuel (e.g. for heat or electricity generation), then at least 95% of the biomass or biofuels used in these plants should be either biomass residues from the dedicated plantations established under the project activity or biofuel generated in the project plant. The amount of biofuel used should not be included in the quantity of biofuel for which emission reductions are claimed;

(d) Consumption of biofuel:

(i) The (blended) biofuel is used by consumers within the host country in existing stationary installations (e.g. captive generators) and/or in vehicles;

(ii) In case of vehicles, the target consumer group (e.g. captive fleet of vehicles, gas stations, bulk consumers) and distribution system of the biofuel shall be identified and described in the ICM-PDD;

(iii) If the (blended) biofuels are consumed in stationary facilities, the consumer and the producer of the (blended) biofuel are bound by a contract that allows the producer to monitor the consumption of (blended) biofuel and that states that the consumer shall not claim CCCs resulting from its consumption;

(iv) If the (blended) biofuels are sold to an identified consumer group within the host party, the buyer and the producer of the (blended) biofuel are bound by a contract that allows the producer to monitor the sale of (blended) biofuel and that states that the consumer shall not claim CCCs resulting from its consumption;

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[1] Only methanol from fossil origin is included because the methodology does not provide procedures for estimating emissions associated with the use of other alcohols than methanol from fossil origin. Project proponents are invited to propose procedures to estimate the emissions associated with the production of other alcohols that could be used for esterification, such as ethanol or methanol from renewable sources, as a revision to this methodology.

(v) If the biofuel is blended but neither used in stationary facilities nor sold to an identified consumer group, the blender and the producer of the biofuel are bound by a contract that allows the producer to monitor the blending of biofuel to ensure that blending proportions and amounts are monitored and meet all regulatory requirements, and that states that no CCCs resulting from its consumption will be claimed;

(vi) In any case where the host party exports beyond the national boundary (blended) biofuels of the same type(s) as the biofuel(s) produced in the project plant, the consumption of the produced (blended) biofuel shall be monitored in order to ensure that no double counting occurs. The consumer and the producer of the (blended) biofuel shall be bound by a contract that allows the producer to monitor the consumption of (blended) biofuel and that states that the consumer shall not claim CCCs resulting from its consumption;

(vii) In case of stationary installations, biofuels with any blending fraction between 0 and 100% can be used. In case of vehicles, the blending proportion must be appropriate to ensure that the technical performance characteristics of the blended biofuels do not differ significantly from those of fossil fuels;

(viii) For biodiesel, the condition in 6.d.vii above is assumed to be met if the blending proportion is up to 20 per cent by volume (B20).[2] If the non-obligated entity use a blending proportion of more than 20 per cent, they shall demonstrate in the ICM-PDD that the technical performance characteristics of the blended biodiesel do not differ significantly from those of petrodiesel and comply with all local regulations;

(ix) Only biofuel consumed in excess of mandatory regulations is eligible for the purpose of the project activity.

10. In addition, the applicability conditions included in the tools referred to above apply.

3.3. Methodology Approval Date

11. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of sectoral scopes

12. For validation and verification of ICM projects by a designated ACVA using this methodology, following application of sectoral scope/(s) is mandatory.

(a) If biofuel is produced from waste oil/fat or biomass residues as a feedstock for:

(i) Stationary applications, then “*2:Industries”* and : ”*1: Energy”* apply;

(ii) Transportation, then “*2:Industries”* and “*6:Transport”* apply.

[2] 2009 Biodiesel Handling and Use Guidelines, U.S. Department of Energy.

(b) If biofuel is produced from anything other than waste oil/fat or biomass residues as a feedstock for:

(i) Stationary applications, then "*2:Industries*" , "*1: Energy*" and "*4: Agriculture*" apply;

(ii) Transportation, then "*2:Industries*" , "*6:Transport*", and "*4: Agriculture*" apply.

3.5. Applicability of approved tools

13. The methodology also refers to the latest version of the following tools:

(a) "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as BM-T-001);

(b) ""BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

(c) "BM-T-010: Project and leakage emissions from biomass" (hereinafter referred to as BM-T-010);

(d) "BM-T-AR-0007: Apportioning emissions from production processes between main product and co and by-product" (hereinafter referred to as BM-T-AR-0007);

4. Methodology: Baseline Component

4.1. Project boundary

14. The spatial extent of the project boundary encompasses:

(a) Where applicable, transportation of:

(i) Raw materials (e.g. seeds and/or biomass residues) to the projectplant(s);

(ii) Feedstock (e.g. vegetable oil and/or waste oil/fats) to the biofuel production plant; and

(iii) The biofuels to the site where it is blended with fossil fuels;

(b) The biofuel production plant at the project site, comprising the processing unit(s) (e.g. esterification, fermentation, hydrolysis) plus other installations on the site (e.g. storage, refining, blending, etc.);

(c) The feedstock processing plant(s) (e.g. oil production plant, mill) on-site or off-site;

(d) If blended biofuel is produced: the facility where the biofuel is blended with fossil fuel (regardless of the ownership of the blending facility);

(e) Where applicable, vehicles or gas stations and existing stationary combustion installations where the (blended) biofuel is consumed;

(f) If the feedstock is sourced from plants produced in dedicated plantations: the geographic boundaries of the dedicated plantations.

Note: Production of fossil fuels leads to emissions, which would occur in the absence of project activity. These emissions are considered in the leakage section, as the production of the fossil fuels is not included in the project boundary. Similarly, emissions associated with the production of methanol used for esterification, or chemicals used for pre-treatment and/or hydrolysis of lignocellulosic biomass are excluded from the project boundary, but are accounted for as leakage.

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/Explanation
Baseline	Vehicles and stationary combustion installations consuming fossil fuels	CO_2	Yes	Main source of baseline emissions
		CH_4	No	Excluded for simplification. CH4 and N2O emissions are assumed to be very small. No systematic difference to project activity
		N_2O	No	
Project activity	On-site energy consumption at biofuel production plant and the feedstock production plant(s)	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Combustion of fossil fuel derived methanol in the biodiesel ester	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Transportation of feedstock	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Transportation of biofuel to blending facility	CO_2	Yes	May be a significant emissions source
		CH_4	No	Excluded for simplification. CH_4 emissions are assumed to be very small
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small

Source		Gas	Included	Justification/Explanation
	Anaerobic wastewater treatment in feedstock production.	CO_2	No	Excluded for simplification. CO_2 emissions are assumed to be very small
		CH_4	Yes	May be a significant emissions source
		N_2O	No	Excluded for simplification. N_2O emissions are assumed to be very small
	Cultivation of biomass in a dedicated plantation[3]	CO_2	Yes	May be a significant emissions source
		CH_4	Yes	May be a significant emissions source
		N_2O	Yes	May be a significant emissions source

4.2. Procedure for the selection of the baseline scenario

15. The baseline scenario shall be separately identified among all realistic and credible alternative(s) for the following elements:

(a) **Production of fuels (P)**: what would have happened at the production level in the absence of the ICM project activity?

(b) **Consumption (C):** which fuel would have been consumed in the absence of the ICM project activity?

(c) **Material (M)**: what would have happened to the material used as input for production of biofuel in the absence of the ICM project activity?

16. If the biofuel is produced from seeds or crops from plants cultivated in dedicated plantations, the following element should be taken into account:

(a) **Land used for plantations (L):** what would be the land use in the absence of the ICM project activity?

17. For the **fuel production (P)**, non-obligated entity shall identify the most likely baseline scenario among all realistic and credible alternative(s), applying steps of the latest approved version of BM-T-001. Step 3 should be used to assess which of these alternatives is to be excluded from further consideration (i.e. alternatives where barriers are prohibitive, or which are clearly economically unattractive) and Step 2 should be applied for all remaining alternatives. In case project proponent is a company already producing fuels other than biofuels then only Step 2 should be applied for all options identified (barrier analysis is not allowed). Include a sensitivity analysis applying Sub-step 2d of the latest version of BM-T-001. If the sensitivity analysis is conclusive (for a realistic range of assumptions), then the most cost effective scenario is the baseline scenario. In

[3] This emission source does not need to be included in the project boundary, if the complete land area of the dedicated plantation is included in the project boundary of one or several registered ICM forestry project activities.

case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the alternatives that are the most economically attractive according to the investment analysis and the sensitivity analysis.

18. At the production level the realistic and credible alternative(s) may include, inter alia:

(a) P1: Continuation of current practices with no investment in biofuel production capacity;

(b) P2: The project activity implemented without the ICM; and

(c) P3: Investment in any other alternative fuel replacing partially or totally the baseline fuel.

19. For the **consumption of fuel (C)**, the baseline should be determined as follows:

4.2.1. Step 1: Identify all realistic and credible alternatives for the fuel used by end consumers

20. Non-obligated entity should at least consider the following alternatives with respect to the intended consumer of blended biofuel:

(a) C1: Continuation of fossil fuel consumption or blended biofuel consumption (in case of mandatory regulations);

(b) C2: Consumption of biofuel from other producers;

(c) C3: Consumption of other single alternative fuel such as CNG or LPG, etc.;

(d) C4: Consumption of a mix of above alternative fuels;

(e) C5: Consumption of biofuel from the proposed project plant.

4.2.2. Step 2: Eliminate alternatives that are not complying with applicable laws and regulations

21. Eliminate alternatives that are not in compliance with all applicable legal and regulatory requirements. Apply Sub-step 1b of the latest version of BM-T-001.

4.2.3. Step 3: Eliminate alternatives that face prohibitive barriers

22. Scenarios that face prohibitive barriers (e.g. technical barrier) should be eliminated by applying Step 3 of the latest version of BM-T-001.

4.2.4. Step 4: Compare economic attractiveness of remaining alternatives

23. Compare the economic attractiveness for all the remaining alternatives by applying Step 2 of the latest version of BM-T-001. Provide all the assumptions in the ICM-PDD.

24. Include a sensitivity analysis applying Sub-step 2d of the latest version of BM-T-001. If the sensitivity analysis is conclusive (for a realistic range of assumptions), then the most cost effective scenario is the baseline scenario. In case the sensitivity analysis is not fully conclusive, select the baseline scenario alternative with least emissions among the alternatives that are the most economically attractive according to the investment analysis and the sensitivity analysis.

25. For the **material (M)** level, the previous Steps 1 through 4 shall be taken.

26. Non-obligated entity should at least consider the following alternatives:

(a) M1: Use of material for production of biofuel (by the project proponent or by others);

(b) M2: Use for material production of substances other than fuel;

(c) M3: Incineration of material for the purpose of energy recovery;

(d) M4: Incineration of material without energy recovery;

(e) M5: Disposal of material in an anaerobic or aerobic manner.

27. For the **land use where the dedicated plantations are established (L)**, the baseline scenario should be determined as follows:

4.2.5. Step 1: Identify all realistic and credible alternatives for the land use

28. Non-obligated entity should at least consider the following alternatives with respect to the baseline scenario for the use of the land where the dedicated plantations are established:

(a) L1: Continuation of current land use, i.e. continued absence of agricultural and forestry activities on degraded or degrading lands;

(b) L2: Conversion to dedicated seed or crop plantations without ICM;

(c) L3: Conversion to another plantation (annual or perennial).

4.2.6. Steps 2 – 4: Eliminate scenarios which are not in legal compliance or face prohibitive barriers or are not economically attractive, as described above for the fuel consumption scenarios

29. The non-obligated entity should demonstrate that the most plausible scenario is continuation of current land use (L1), by assessing the attractiveness of the plausible alternative land uses in terms of benefits to the non-obligated entity, consulting with stakeholders for existing and future land use, and identifying barriers for alternative land uses. This can be done by demonstrating that similar lands in the vicinity are not planned to be used for alternative land uses other than L1. Show that apparent financial and/or other barriers, which prevent alternative land uses can be identified.

30. If the biofuel is produced from waste oil/fat or biomass residues this methodology is applicable for the baseline scenario which combines P1, C1, and any one of the M scenarios. For material scenarios M1, M2 and M3, possible leakage from the displacement of existing uses of waste oil/fat or biomass residues needs to be assessed, as stated in the leakage section.

31. If the biofuel is produced from feedstock cultivated in dedicated plantations, this methodology is applicable for the baseline scenario which combines P1, C1 and L1.

4.3. Additionality

32. The additionality of the project activity shall be demonstrated and assessed using the latest version of BM-T-001.

33. Where Investment Analysis of BM-T-001 is used, the investment analysis shall include a sensitivity analysis of the biofuel sales price, the feedstock costs and fuel costs.

34. Guidance for the Barriers Analysis when the dedicated plantation (or part of) is covered under a forestry ICM project activity:

(a) If the forestry ICM activity and the activity covering the production, sale and consumption of blended biofuel are two independent project activities (which may imply also that project proponents are different) then:

(i) A barrier related to the implementation of the plantation cannot be used for the project activity covering the production, sale and consumption of blended biofuel;

(b) If the forestry ICM project activity and the project activity covering the production, sale and consumption of blended biofuel are part of an integrated development project (which means that the same project proponents are to be involved in the two ICM activities) then:

(i) A barrier related to the implementation of the plantation can also be used by the production, sale and consumption of blended biofuel activity.

35. Investment in the establishment of dedicated plantations must be considered, whether or not the establishment of such plantations is part of a forestry ICM project activity, if there is no market for the feedstock. By definition, CCCs from forestry ICM activities, whose plantations are part of the biofuel project, implemented under this methodology and CCCs accruing from ICM project activities under this methodology must not be included in the investment analysis performed in order to identify the baseline scenario.

4.4. Baseline emissions

36. Baseline emissions from displaced fossil fuel are determined as follows:

$$BE_y = BF_y \times NCV_{BF,y} \times EF_{CO2,FF} \quad \text{Equation (1)}$$

With

$$BF_y = \left[min\left\{ \left(P_{BF,y} - P_{BF,on-site,y}\right); \left(\sum_i f_{PJ,i,y} \times C_{BF,i,y}\right) \right\} - P_{BF,other,y} \right] \times \left[\frac{\sum_i C_{BF,i,y} \times \left(\frac{f_{PJ,i,y} - f_{reg,y}}{f_{PJ,i,y}}\right)}{\sum_i C_{BF,i,y}} \right] \quad \text{Equation (2)}$$

Where:

BE_y	=	Baseline emissions during the year *y* (tCO_2)
BF_y	=	Quantity of biofuel eligible for crediting in year *y* (t)
$NCV_{BF,y}$	=	Net calorific value of biofuel produced in year *y* (GJ/t)
$EF_{CO2,FF}$	=	Carbon dioxide emissions factor for displaced fossil fuel (tCO_2/GJ)

$P_{BF,y}$	=	Quantity of biofuel produced in the project plant in year *y* (t)
$P_{BF,on-site,y}$	=	Quantity of biofuel consumed at the project plant(s) (biofuel production and/or feedstock processing) in year *y* (t)
$PD_{BF,other,y}$	=	Quantity of biofuel that is either produced with alcohols other than methanol from fossil origin or produced using feedstock or waste oil(s)/fat(s) other than those eligible under this methodology according to the applicability conditions in year *y* (t)
$C_{BF,i,y}$	=	Quantity of biofuel type *i* consumed/sold/blended in year *y* (t)
$f_{PJ,i,y}$	=	Fraction of biofuel in the blended biofuel type *i* in year *y* (ratio)
$f_{reg,y}$	=	Fraction of biofuel in the blended biofuel which is required by mandatory regulations of the host country in year *y* (ratio)
i	=	Blended biofuel type (e.g. B5, B10, B20, B50 etc.)

37. Non-obligated entity shall determine $C_{BF,i,y}$ as follows:

(a) For (blended) biofuels that are consumed in stationary installations, $C_{BF,i,y}$ shall be based on the monitored amount of biofuels consumed;

(b) For (blended) biofuels that are sold to an identified consumer group, $C_{BF,i,y}$, shall be based on the monitored amount of (blended) biofuel sold;

38. For biofuels that are blended but neither used in stationary facilities nor sold to an identified consumer group, $\boldsymbol{C_{BF,i,y}}$ shall be based on the amount of biofuel blended at the blending facility(ies).

4.5. Project Emissions

39. Project emissions include are calculated as follows:

$$PE_y = PE_{Biomass,y} + AF_{1,y} \times PE_{MeOH,y}$$ Equation (3)

Where:

PE_y	=	Project emissions in year *y* (tCO_2)
$PE_{Biomass,y}$	=	Project emissions associated with the biomass and biomass residues in year *y* (tCO_2)
$PE_{MeOH,y}$	=	Project emissions from fossil carbon in the biodiesel due to esterification with methanol of fossil origin in year *y* (tCO_2)
$AF_{1,y}$	=	Allocation factor for the production of biofuel in year *y* (fraction)

4.5.1. Determination of $PE_{Biomass,y}$

40. $PE_{Biomass,y}$ shall be determined by applying the provisions of BM-T-010 and involve the following emission sources:

(a) Project emissions resulting from the cultivation of biomass in a dedicated plantation if the biofuel is produced from feedstock that is cultivated in dedicated plantations (e.g. seeds) (PE_{BC});

(b) Project emissions resulting from the transportation of biomass (e.g. raw feedstock such as seeds) from the cultivation site to the biomass processing facility (e.g. oil production plant(s)/mill(s)), and from the transportation of biomass (e.g. vegetable oil, waste oil/fats) from the biomass processing facility to the biodiesel production plant (PE_{BT});

(c) Project emissions resulting from the biomass processing facility (e.g. the oil production plant(s) and/or mill(s)) and from the biomass production plant (PE_{BP});

41. These emission sources are only partly allocated to the production of biofuel, through the allocation factor $AF_{1,y}$ in the equation above and in the equation below. Where applicable, project emissions associated with the cultivation of land are allocated between the different products produced from the plants expressed through the allocation factor $AF_{2,y}$. The Allocation factors are estimated as per BM-T-AR-0007” .

$$PE_{Biomass,y} = AF_{1,y} \times \left[PE_{BP,y} + PE_{BT,y} + \left(AF_{2,y} \times PE_{BC,y}\right)\right] \quad \text{Equation (4)}$$

Where:

$PE_{BP,y}$	=	Project emissions resulting from the biomass processing facility and from the biodiesel production plant (tCO_2e)
$PE_{BT,y}$	=	Project emissions resulting from the transportation of biomass from the cultivation site to the biomass processing facility, and from the biomass processing facility to the biodiesel production plant (tCO_2e)
$AF_{2,y}$	=	Allocation factor for the land cultivation in year *y* (fraction)
$PE_{BC,y}$	=	Project emissions resulting from the cultivation of biomass in a dedicated plantation (tCO_2e)

42. Non-obligated entity may alternatively choose a simplified approach to calculate $PE_{BC,y}$ using conservative **default values** for the emissions associated with the cultivation of lands. This approach can only be used for **palm, cassava, jatropha, soy, corn, sugarcane or pongamia** based on the equation below:

$$PE_{BC,y} = PE_{SOC,y} + \sum_{s} A_{s,y} \times EF_{s,y} \quad \text{Equation (5)}$$

Where:

$PE_{BC,y}$	=	Project emissions associated with the cultivation of land to produce biomass feedstock in year *y* (tCO_2)
$PE_{SOC,y}$	=	Emissions resulting from loss of soil organic carbon, in year *y* (t CO2e) to be estimated as per the methodological tool: “Project and leakage emissions from biomass”.
$A_{s,y}$	=	Area in which feedstock type *s* is cultivated for use in the project plant in year *y* (ha)
$EF_{s,y}$	=	Default emission factor for the GHG emissions associated with the cultivation of land to produce feedstock type *s* (tCO_2e/ha). See Table 3 below for available values.

Table 3. Conservative default emission factors for the GHG emissions associated with the cultivation of land to produce biomass feedstock

Feedstock type s	Fresh palm fruit bunches	Cassava roots	Jatropha nuts	Soybeans	Corn Seed	Sugarcane	Pongamia
$\boldsymbol{EF_{s,y}}$ (tCO_2e/ha)	2.5	1.9	2.6	0.8	2.1	2.3	1.5

4.5.2. Determination of $PE_{MeOH,y}$

43. Under the current applicability of the methodology, methanol of fossil origin is used for the esterification of vegetable oil or waste oil/fats. In the esterification process, the carbon from the methanol remains in the esters. Thus, a fraction of the carbon in the biodiesel is of fossil origin and need to be accounted as project emissions. These emissions are estimated as follows:

$$PE_{MeOH,y} = MC_{MeOH,y} \times EF_{C,MeOH} \times \frac{44}{12}$$ Equation (6)

Where:

$PE_{MeOH,y}$	=	Project emissions from fossil carbon in the biodiesel due to esterification with methanol of fossil origin in year *y* (tCO_2)
$MC_{MeOH,y}$	=	Quantity of methanol consumed in the biodiesel plant, including spills and evaporations on-site in year *y* (tMeOH)
$EF_{C,MeOH}$	=	Carbon emissions factor of methanol, based on molecular weight (tC/tMeOH)
$44/12$	=	Molecular weight ratio to convert t of carbon into t of CO_2 (tCO_2/tC)

4.6. Leakage

44. This methodology estimates the following sources of leakage:

(a) Emissions associated with the production of the methanol used for esterification or the chemicals used for pre-treatment and/or hydrolysis of lignocellulosic biomass;

(b) If the biofuel is produced from waste oil/fat or biomass residues, diversion of existing applications of waste oil/fat or biomass residues that may result in increased demand for fossil fuels elsewhere;

(c) Positive leakage associated with the avoided production and transportation of fossil fuel.

45. The leakage emissions are calculated as follows:

$$LE_y = LE_{MeOH,y} + LE_{BR,y} - LE_{FF,y}$$ Equation (7)

Where:

LE_y	=	Leakage emissions in year *y* (tCO_2)

$LE_{MeOH,y}$	=	Leakage emissions associated with production of methanol used in biodiesel production in year *y* (tCO_2)
$LE_{BR,y}$	=	Leakage emissions from displacement of existing uses of waste oil/fat or biomass residues in year *y* (tCO_2)
$LE_{FF,y}$	=	Leakage related to the avoided production of fossil fuel in year *y* (tCO_2)

46. Please note that the overall leakage emissions shall not be less than zero. In cases where, in year *y*, LE_y is less than zero, consider it as zero.

4.6.1. Leakage from methanol/chemicals production

47. Emissions from production of methanol that is used in the esterification process to produce the biodiesel are estimated as follows:

$$LE_{MeOH,y} = MC_{MeOH,y} \times EF_{MeOH,PC} \quad \text{Equation (8)}$$

Where:

$LE_{MeOH,y}$	=	Leakage emissions associated with production of methanol used in biodiesel production in year *y* (tCO_2)
$MC_{MeOH,y}$	=	Quantity of methanol consumed in the biodiesel plant, including spills and evaporation on-site in year *y* (t MeOH)
$EF_{MeOH,PC}$	=	Pre-combustion (i.e. upstream) emissions factor for methanol production (tCO_2/t MeOH)

48. Emissions from production of chemicals that are used for pre-treatment and/or hydrolysis of lignocellulosic biomass to produce cellulosic ethanol are estimated in accordance with BM-T-003.

4.6.2. Leakage from the diversion of existing applications of waste oil/fat and/or biomass residues.

49. Leakage emissions from the diversion of existing applications of waste oil/fat and/or biomass residues are estimated in accordance with BM-T-010.

50. These emissions will only be estimated if the biofuel is produced from waste oil/fat and/or biomass residues. For material scenarios M1, M2 and M3, non-obligated entity shall demonstrate that the use of these materials by the project activity ACVAs not result in increased fossil fuel consumption elsewhere. For this purpose, non-obligated entity shall monitor the total supply of waste oil/fat or biomass residues used in the project plant.

$$WOF_{L,y} = \begin{Bmatrix} \frac{(1.25 \times WOF_{D,y}) - WOF_{S,y}}{1.25} \text{ if } (1.25 \times WOF_{D,y}) > WOF_{S,y} \\ \text{or} \\ 0 \text{ if } (1.25 \times WOF_{D,y}) \leq WOF_{S,y} \end{Bmatrix}$$

51. In the case that overall emission reductions from the project activity are negative in a given year because of the leakage emissions, CCCs are not issued to non-obligated entity for the year concerned and in subsequent years, until emission reductions from subsequent years have compensated the quantity of negative emission reductions from the given year.

4.6.3. Leakage related to the avoided production of fossil fuel

52. The substitution of biofuel for fossil fuel reduces upstream emissions associated with the production of fossil fuel.

53. For the purpose of this methodology, the following upstream emissions stages *i* are considered:

    (a) Production of crude oil. These include emissions from venting, flaring and energy uses;

    (b) Oil refinery. These include emissions from energy uses, production of chemicals and catalysts, disposal of production wastes (including flaring) and direct emissions;

    (c) Long distance transport.[4]

54. Emissions related to infrastructure are not be taken into account either for the production of crude oil (e.g. drilling and maintenance of the oil wells) or for the oil refinery (e.g. construction of the refinery), to keep consistency with the estimation of project emissions from biofuel production where these emission sources are also ignored.

55. Emissions from the distribution to filling stations are not taken into account, as it is assumed that these emissions balance with the emissions of transport of the biofuel to the blending facility.

$$LE_{FF,y} = BF_y \times \sum_x \sum_i \sum_j NCV_{BF,y} \times EF_{i,j,x,y}$$ Equation (9)

Where:

$LE_{FF,y}$	=	Leakage related to the avoided production of fossil fuel in year *y* (tCO_2)
BF_y	=	Quantity of biofuel eligible for crediting in year *y* (t)
$NCV_{BF,y}$	=	Net calorific value of biofuel produced in year *y* (GJ/t)
$EF_{i,j,x,y}$	=	Emission factor for upstream emissions stage i associated with consumption of fossil fuel type *x* from fossil fuel origin j applicable to year y (t CO2e/TJ)

4.7. Emission reductions

56. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y$$ Equation (10)

Where:

ER_y	=	Emission reductions in year *y* (tCO_2)

[4] Emissions from international long-distance transport (transport of crude oil to the refinery) will not be taken into account. If long distance transport occurs within the host country where the project activity takes place, these emissions will be accounted for.

BE_y = Baseline emissions in year *y* (tCO_2)

PE_y = Project emissions in year *y* (tCO_2)

LE_y = Leakage emissions in year *y* (tCO_2)

4.8. Data and parameters not monitored

Data / Parameter table 1.

Data / Parameter:	NCV_{FF}
Data unit:	GJ/t
Description:	Net calorific value of fossil fuel displaced
Source of data:	2006 IPCC Guidelines for GHG Inventories
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	$EF_{CO2,FF}$
Data unit:	tCO_2/GJ
Description:	Carbon dioxide emissions factor for fossil fuel displaced
Source of data:	Default value may be derived from 2006 IPCC Guidelines, or from national statistics, if available
Measurement procedures (if any):	-
Any comment:	Local or national data should be preferred. Default values from the IPCC may be used alternatively

Data / Parameter table 3.

Data / Parameter:	GWP_{CH4}
Data unit:	tCO_2e/tCH_4
Description:	Global warming potential of CH_4
Source of data:	IPCC
Measurement procedures (if any):	21
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$EF_{C,MeOH}$
Data unit:	tC/tMeOH
Description:	Carbon emissions factor of methanol, based on molecular weight
Source of data:	-

Measurement procedures (if any):	Use the value of 0.375 (calculated as 12/32)
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	EF_{MeOH_PC}
Data unit:	tCO_2/t MeOH
Description:	Pre-combustion (i.e. upstream) emissions factor for methanol production
Source of data:	Apple 1998: <http://edj.net/sinor/SFR4-99art7.html> and 2006 IPCC Guidelines
Measurement procedures (if any):	1.95 tCO_2/t produced methanol
Any comment:	Based on 30 GJ/t energy requirement and average of IPCC emissions factors for natural gas and diesel oil

Data / Parameter table 6.

Data / Parameter:	NCV_L
Data unit:	GJ/t
Description:	Net calorific value of the fossil fuel likely to substitute waste oil / fat or biomass residues.
Source of data:	2006 IPCC Guidelines for GHG Inventories
Measurement procedures (if any):	-
Any comment:	Identification of the fossil fuel shall be made taking into account common practice

Data / Parameter table 7.

Data / Parameter:	$EF_{i,j,x,y}$
Data unit:	tCO_2e/TJ
Description:	Emission factor for upstream emissions stage i associated with consumption of fossil fuel type x from fossil fuel origin j applicable to year y
Source of data:	-
Value to be applied:	$EF_{i,j,x,y}$ shall be determined in accordance with the Methodological tool: “Upstream leakage emissions associated with fossil fuel use”
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	$EF_{CO2,i}$
Data unit:	tCO_2/TJ
Description:	CO_2 emissions factor for fossil fuel type *i*

<table>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:

<table><tr><th>Data source</th><th>Conditions for using the data source</th></tr><tr><td>(a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr><tr><td>(b) Measurements by the non-obligated entity</td><td>If (a) is not available</td></tr><tr><td>(c) Regional or national default values</td><td>If (a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr><tr><td>(d) IPCC default values at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If (a) is not available</td></tr></table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For (a) and (b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td>-</td></tr>
</table>

5. Methodology: Monitoring Component

5.1. Monitoring procedures

57. Describe and specify in the draft ICM-PDD all monitoring procedures, including the type of measurement instrumentation used, the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. All meters and instruments should be calibrated regularly as per industry practices.

58. Biofuel production must apply national industry standards on QA/QC or, if there are no national QA/QC standards yet, apply industry standards from mature biofuel production markets such as in Brazil, Europe or US.

5.2. Specific ICM related monitoring procedures

59. The quality manual necessary under the above-mentioned QA/QC standards shall include a section describing the elements of the ICM related monitoring procedures and how to assure and control their quality. A quality management representative from the non-obligated entity shall ensure that the monitoring procedures are established and that they meet the requirements as specified in this methodology.

60. Monitoring the plant inputs and outputs required for calculating leakage, baseline and project emissions shall be based on a complete documented mass balance, adjusted for stock changes, covering:

(a) Amounts of waste oil/fat or biomass residues purchased and processed, if applicable;

(b) Amounts of feedstock from dedicated plantations purchased and processed; if applicable;

(c) Amounts of catalysts purchased, processed and recovered;

(d) Amounts of methanol purchased and processed;

(e) Amounts of glycerol or other by-products produced and incinerated and/or sold for utilization;

(f) Amounts of blended biofuel consumed, sold or blended.

61. This mass balance shall be based on a combination of purchase/sales records and records of measurements, in accordance with the measuring instruments available at the plant and stationary consumers or fuelling stations of the captive fleet owner in case of use in transport sector. The mass balance serves as a QA/QC instrument to crosscheck results of monitoring parameters as defined in the following section.

62. The following procedure shall be used to verify the actual amount of biofuel from waste oil/fat or biomass residues that is consumed by the end user for displacement of fossil fuel and its correspondence with the produced amount of biofuel from waste oil/fat or biomass residues:

(a) If the biofuel is produced from waste oil/fat or biomass residues the produced amount of biofuel from these sources is recorded by a periodically calibrated metering system;

(b) If the biofuel is produced from feedstock cultivated in dedicated plantations, the produced amount of biofuel from feedstock from dedicated plantations is recorded by a periodically calibrated metering system;

(c) The amount of biofuel produced from waste oil/fat, biomass residues, or from feedstock from dedicated plantations transported to the storage of the blender is recorded by a calibrated metering system at the point of filling the (road) tankers and at the point of delivery at the blender site;

(d) During the process of creating the biofuel blend at the blending station, the blending operation shall be monitored to assure adequate mixing of the products in the specified proportions. This includes measuring and recording the volumes and blend levels as verified through bills of lading, meter printouts or other auditable records of both the biofuel and fossil fuel, which comprise the blended biofuel;

(e) Contractually the biofuel producer has to monitor consumption by the consumer as follows:

(i) The receiving amount of blended biofuel in the gas station or final distributor has to be recorded by a calibrated metering system and the storage fill level is recorded by a calibrated filling level indicator;

(ii) For stationary installations, the amount of the blended biofuel filled into the installation where combustion takes place must be recorded by a calibrated metering system;

(iii) If blending is done by a third party contractual arrangement shall be made, that the receiving amount of biofuel at the blending facility has to be recorded by a calibrated metering system and the storage fill level is recorded by a calibrated filling level indicator.

63. If the biofuel is produced from feedstock cultivated in dedicated plantations, the following specific guidance should be taken into account:

(a) If feedstock is pre-processed off-site, the energy consumption of the corresponding facilities shall be included in the monitoring; ;

(b) Monitoring compliance with the applicability conditions.

5.3. Data Archiving

64. All data need to be archived electronically until two years after end of the crediting period.

5.4. Data and parameters monitored

Data / Parameter table 9.

Data / Parameter:	$f_{PJ,i,y}$
Data unit:	ratio
Description:	Fraction of biofuel in the blended biofuel from the project activity, with blending ratio *i*, in year *y*
Source of data:	Records from blending operations
Measurement procedures (if any):	Recording volumes or flows with calibrated meters
Monitoring frequency:	Every produced blend must be monitored
QA/QC procedures:	During the process of creating the blended biofuel at the blending station, the blending operation shall be monitored to assure adequate mixing of the products in the correct proportions. This includes measuring and recording the volumes and blend levels as verified through bills of lading, meter printouts or other auditable records of both the biofuel and fossil fuel, which comprise the blend
Any comment:	

Data / Parameter table 10.

Data / Parameter:	$f_{reg,y}$
Data unit:	ratio

Description:	Fraction of biofuel in the blended biofuel which is required by mandatory regulations of the host country in year *y*
Source of data:	Regulations in the Host Country
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 11.

Data / Parameter:	Various parameters; Compliance of biofuel with national regulations
Data unit:	Various data units
Description:	Compliance of produced biofuel with national regulation, biofuel properties
Source of data:	Various measurements based on national or international standards
Measurement procedures (if any):	Various methods of measurement and uncertainty analysis
Monitoring frequency:	According to national regulation, at least annually
QA/QC procedures:	According to national or international standards
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	$MP_{Glyc,y}$
Data unit:	t
Description:	Amount of by-product (e.g. glycerol) produced during plant operation
Source of data:	Non-obligated entity
Measurement procedures (if any):	Volumetric flow meter including a volume integrator or load cell to measure the weight of produced by-product
Monitoring frequency:	All quantity of produced by-product must be monitored
QA/QC procedures:	Volumetric flow meter and integrator calibrated periodically Load cell calibrated periodically. Measured amounts to be crosschecked against mass balance of the biofuel production unit
Any comment:	This monitored parameter is used to meet the applicability condition "The by-product (e.g. glycerol) is not disposed of or left to decay. It should be either incinerated or used as raw material for industrial consumption or sold". $MP_{Glyc,y}$ should be equal to $MU_{Glyc,y}$

Data / Parameter table 13.

Data / Parameter:	$MU_{Glyc,y}$
Data unit:	t
Description:	Amount of by-product (e.g. glycerol) incinerated or sold or used
Source of data:	Non-obligated entity, based on sales data and internal records in case of use inside the plant or incinerated

Measurement procedures (if any):	-
Monitoring frequency:	All produced by-product must be tracked via sales data or internal records or its mode of disposal checked by ACVA (incl. visual inspection of facilities and record of incineration or disposal if any)
QA/QC procedures:	ACVA to check the produced by-product was marketed
Any comment:	This monitored parameter is used to meet the applicability condition "The by-product (e.g. glycerol) is not disposed of or left to decay. It should be either incinerated or used as raw material for industrial consumption or sold"

Data / Parameter table 14.

Data / Parameter:	$P_{BF,y}$
Data unit:	t
Description:	Quantity of biofuel produced in the project plant in year *y*
Source of data:	On-site measurements by the non-obligated entity
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	All produced biofuel must be metered
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	-

Data / Parameter table 15.

Data / Parameter:	$P_{BF,on\text{-}site,y}$
Data unit:	t
Description:	Quantity of biofuel consumed at the project biofuel production plant and/or the oil production plant(s) in year *y*
Source of data:	On-site measurements by the non-obligated entity
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	All consumed biofuel must be metered
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	-

Data / Parameter table 16.

Data / Parameter:	$PD_{BF,other,y}$
Data unit:	t
Description:	Quantity of biofuel that is either produced with alcohols other than methanol from fossil origin or produced using feedstock other than those eligible under this methodology according to the applicability conditions in year *y*
Source of data:	On-site measurements by the non-obligated entity
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	All consumed biofuel must be metered

QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	-

Data / Parameter table 17.

Data / Parameter:	$C_{BF,i,y}$
Data unit:	t
Description:	Quantity of biofuel with blending ratio *i*, consumed/sold to identified consumer/blended in year *y*
Source of data:	Metering system at fuelling stations
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning
Monitoring frequency:	Continuous recording of filling consumers´ stationary combustion installations or vehicles. Where such information is not available, quantities may be obtained from invoices and weighbridge receipts.
QA/QC procedures:	Cross check production and consumption data with sales records
Any comment:	Non-obligated entity shall determine $C_{BF,i,y}$ as follows: - For (blended) biofuels that are consumed in stationary installations, $C_{BF,i,y}$ shall be based on the monitored amount of biofuels consumed; - For (blended) biofuels that are sold to an identified consumer group $C_{BF,i,y}$, shall be based on the monitored amount of (blended) biofuel sold; - For biofuels that are blended but neither used in stationary facilities nor sold to an identified consumer group, $C_{BF,i,y}$, shall be based on the amount of biofuel blended at the blending facility(ies).

Data / Parameter table 18.

Data / Parameter:	$NCV_{BF,y}$
Data unit:	GJ/t
Description:	Net calorific value of biofuel produced in year *y*
Source of data:	Laboratory analysis
Measurement procedures (if any):	Measured according to relevant national or international standards regulating determination of NCV by calibrated equipment
Monitoring frequency:	Annually
QA/QC procedures:	Check consistency of measurements and local / national data with default values by the IPCC. If the values differ significantly from IPCC default values, possibly collect additional information or conduct measurements
Any comment:	Analysis has to be carried out by accredited laboratory. A sample is representative if uncertainty of the NCV ACVAs not exceed ±5% at 95% confidence level

Data / Parameter table 19.

Data / Parameter:	***$MC_{MeOH,y}$***
Data unit:	tMeOH
Description:	Quantity of methanol consumed in the biofuel plant, including spills and evaporations on-site in year *y*
Source of data:	Mass meters
Measurement procedures (if any):	Use calibrated measurement equipment that is maintained regularly and checked for proper functioning. The methanol consumption should be net of any water content. Methanol spilled and evaporated on the project site should be considered as consumption for estimating the emissions
Monitoring frequency:	Continuously
QA/QC procedures:	Crosscheck against methanol purchase receipts and calculated stochiometric requirements
Any comment:	Adjust for stock changes when comparing purchase data with consumption data; also used for leakage calculations. Use most conservative values. Any spills on-site and evaporation are accounted as consumption. Please note that data should also report the source of methanol - from fossil fuel or non-fossil fuel sources. As per the applicability only biofuel produced using fossil fuel based methanol can be credited

Data / Parameter table 20.

Data / Parameter:	***$AF_{1,y}$***
Data unit:	Fraction
Description:	Allocation factor for the production of biofuel in year *y*
Source of data:	
Measurement procedures (if any):	Estimated as per BM-T-AR-0007
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 21.

Data / Parameter:	***$AF_{2,y}$***
Data unit:	Fraction
Description:	Allocation factor for the biomass cultivation in dedicated plantations in year *y*
Source of data:	-
Measurement procedures (if any):	Estimated as per BM-T-AR-0007
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 22.

Data / Parameter:	$A_{s,y}$
Data unit:	Ha
Description:	Area in which biomass type *s* is cultivated for use in the project plant in year *y*
Source of data:	Non-obligated entity
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

- - - - -

Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MAR₹KET

METHODOLOGY

BM AG04.002

Methane recovery from livestock and manure management at households and small farms

Publication Date:

Version 1.0

Sectoral scope(s): Agriculture

Tabe of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AMS-III.R (as valid from 24 March 2023).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned

methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Recovery and combustion of methane from manure or a mixture of manure and other agricultural wastes through: • Installation of a methane recovery and combustion system to an existing source of methane emissions; or • Change in the management practice for manure to achieve controlled anaerobic digestion (domestic biogas digester) that is equipped with a methane recovery and combustion system.
Type of GHG emissions mitigation action	GHG destruction: • Combustion of methane and displacement of more-GHG-intensive energy generation

2. Scope & Applicability

2.1. Scope

4. This methodology covers project activities involving the recovery and combustion of methane from manure or a mixture of manure and other agricultural wastes[1] that would decay anaerobically and emit methane to the atmosphere in the absence of the project activity. Recovery and combustion of methane can be achieved either by:

(a) Installing a methane recovery and combustion system to an existing source of methane emissions; or

(b) Changing a manure management practice to achieve controlled anaerobic digestion by installing a domestic biogas digester equipped with a methane recovery and combustion system.

2.2. Applicability

5. The methodology is applicable under the following conditions:

(a) The domestic biogas digester, methane recovery and combustion systems are installed at individual households or small farms ;

(b) This methodology may be applied in combination with other methodologies, as applicable;

(c) This methodology is applicable only to the fraction of the manure which would decay anaerobically in the absence of the project activity. The fraction of the manure decaying anaerobically is established by a survey in accordance with paragraph 12 below;

[1] A small amount of “other agricultural wastes” can be mixed but the baseline emissions arising from “other agricultural waste” cannot be reflected in the emission reductions.

(d) The annual average temperature of the site where manure would have decomposed anaerobically in the baseline is higher than 5 °C.

6. The project activity shall satisfy the following conditions:

(a) Final digestate must be handled aerobically, and the conditions and procedures of the aerobic handling of the final digestate (e.g. land application) shall be described in the project design document (PDD) and subsequently checked upon verification;

(b) Measures shall be used (e.g. combustion in a biogas burner for cooking needs) to ensure that all the methane collected by the recovery system is combusted;

(c) In order to mitigate risks for physical leakage and venting, Non-obligated entity shall provide documentation in the PDD which:

(i) Ensures that biodigesters are appropriately designed in terms of their sizing, considering manure inputs and the thermal energy requirements of households. Justifications shall be provided in the PDD and monitoring reports to demonstrate that gasholders are sufficiently large to capture and store all the biogas that would be generated until consumption;

(ii) Ensures that the construction or installation of biodigesters (in the case of prefabricated plants) complies with relevant national and/or international standards and that a quality assurance/quality control (QA/QC) system is put in place for the construction or installation;

(iii) Ensures that trainings are conducted for all users of biodigesters prior to their commissioning or installation and that the trainings shall be documented in a verifiable manner (e.g. protocol of trainings, documentation of on-site visits);

(iv) Ensures that a plan for periodic inspection and maintenance is in place and rehabilitation services are available throughout the crediting period. Description of such technical support system shall be provided in the PDD and verified by the designated ACVA during verification. If the rehabilitation is undertaken, the details (e.g. parts replaced, specifications followed, personnel conducting the repairs and date of retrofitting) on each domestic biogas digester, methane recovery and combustion system shall be documented.

2.3. Methodology Approval Date

7. The date of adoption of this document shall be effective from XX/XX 2024.

2.4. Applicability of sectoral scopes

8. For validation and verification of ICM projects and programme of activities by a designated ACVA using this methodology, application of sectoral scope “*03: Waste handling and disposal”* is mandatory and sectoral scope “*01: Energy”* is conditional.

2.5. Applicability of approved tools

9. This methodology also refers to the latest approved versions of the following approved methodologies, tools and standard:

   (a) "BM-T-002: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

   (b) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

   (c) "BM-T-008: Project and leakage emissions from anaerobic digesters" (hereinafter referred to as BM-T-008).

   (d) "BM-T-010: Project and leakage emissions from anaerobic digesters" (hereinafter referred to as BM-T-010).

3. Methodology: Baseline Component

3.1. Project boundary

10. The project boundary is the physical, geographical site of the methane recovery and combustion systems.

3.2. Baseline

11. In the absence of the project activity, manure and wastes from agricultural activities are left to decay anaerobically within the project boundary and methane is emitted to the atmosphere.

12. The fraction of total annual volatile solids for each livestock type LT that is treated in a manure management system MS in climate region k ($AWMS_{LT,MS,k}$) is determined by a survey of a sample group of households/small farms participating in the project activity with a 90 per cent confidence interval and 10 per cent margin of error. The survey should determine the baseline animal manure management practices applied. If the livestock is raised in shared centralized farms,[2] the non-obligated entity shall be able to show the baseline animal manure management practices at each farm, either individually or through sampling.

[2] In shared centralized farms systems, multiple households raise their animals in a centralized farm, for example in separate barns of a centralized farm. In the project activity, each family collects the manure of animals raised by it at the centralized farm and uses the collected manures as feedstock for the biodigester situated at the household.

13. Baseline emissions (BE_y) are calculated as follows[3]:

$$BE_y = \sum_{LT,MS,PS,k}\left(N_{LT,PS,y} \times \frac{AM_{LT,PS}}{10^3} \times VS\_rate_{LT,PS} \times 365 \times Bo_{LT,PS} \times \frac{MCF_{LT,MS,k}}{100} \times AWMS_{LT,MS,k}\right) \times GWP_{CH4} \times UF_b$$

Equation (1)

Where:

BE_y	=	Baseline emission during the year *y* (tCO_2e)
$N_{LT,PS,y}$	=	Annual average number of animals of livestock type *LT* in year *y* for productivity system[4] *PS* (i.e. high or low) (numbers), determined as per **Data/parameter table 1**
$AM_{LT,y}$	=	Animal mass for livestock type LT (kilogram (kg) per animal), determined as per **Data/parameter table 2**
$VS\_rate_{LT,PS}$	=	Daily volatile solid excretion per head of livestock type *LT*, for productivity system *PS* (i.e. high or low) (kg VS per 1,000 kg animal mass per day). Use default values as provided in **Table 10.13A** of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
365	=	Days per year
Bo_{LT}	=	Maximum methane producing capacity for manure produced by livestock type LT, (cubic metres (m^3) methane (CH_4) per kg of VS excreted). Use default values as provided in **Table 10.16** of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
0.67	=	Conversion factor of m^3 CH_4 to kg CH_4
$MCF_{LT,MS,k}$	=	Methane conversion factors for each manure management system *MS* by climate region *k* (per cent) Use default values as provided in **Table 10.17** of chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, following the definitions of manure management systems provided in **Table 10.18.**
$AWMS_{LT,MS,k}$	=	Fraction of total annual VS for each livestock type *LT* that is treated in manure management system *MS* in climate region *k*, estimated as per procedures mentioned in **paragraph 12 above**

[3] Refer to the chapter 'Emissions from Livestock and Manure Management' in the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

[4] For the definition of high and low productivity systems, refer to chapter 'Emissions from Livestock and Manure Management' under the volume 'Agriculture, Forestry and other Land use' of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.

GWP_{CH4}	=	Global warming potential (GWP) of CH_4 applicable to the relevant period (t CO_2e/t CH_4)
UF_b	=	Net-to-gross adjustment factor to account for uncertainties. The value applied is 0.89[5]

3.3. Project emissions

14. Project activity emissions consist of:

(a) Physical leakage of biogas ($PE_{PL,y}$);

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

(c) CO_2 emissions from use of electricity for the operation of all the installed facilities ($PE_{EC,y}$);

$$PE_y = PE_{PL,y} + PE_{FC,y} + PE_{EC,y} \quad \text{Equation (2)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2e)
$PE_{PL,y}$	=	Emissions due to physical leakage of biogas in year *y* (tCO_2e)
$PE_{FC,y}$	=	Emissions from the use of fossil fuel for the operation of the system in the year *y* (tCO_2e)
$PE_{EC,y}$	=	Emissions from the use of electricity for the operation of the system in the year *y* (tCO_2e)

15. Project emissions due to physical leakage of methane from biogas digesters are estimated as 10 per cent of the maximum methane-producing potential of the manure fed into the management systems implemented by the project activity:[6] .

$$PE_{PL,y} = 0.10 \times \sum_{LT,MS,PS,k} \left(N_{LT,PS,y} \times \frac{AM_{LT,PS}}{10^3} \times VS\_rate_{LT,PS} \times 365 \times Bo_{LT,P} \frac{MCF_{LT,MS,k}}{100} \times AWMS_{LT,MS,k} \right) \times GWP_{CH4} \quad \text{Equation (3)}$$

16. Project emissions from use of fossil fuels ($PE_{FC,y}$) or electricity ($PE_{EC,y}$) for the operation of the system shall be estimated using BM-T-002 and BM-T-003. When applying the above tools, default values contained in BM-T-008 may be used.

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[5] This is to account for uncertainties of the method (See Annex III (Table of conservativeness factors), FCCC/SBSTA/2003/10/Add.2).

[6] Leakage rate of 0.1 for low quality biogas digesters provided in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories is proposed for conservativeness.

3.4. Leakage

17. The applicable requirements from BM-T-010 shall be followed to calculate leakage related to use of biomass (other agricultural wastes), if applicable.

18. The residual waste from the animal manure management system shall be handled aerobically, otherwise the related emissions shall be taken into account as per relevant procedures of BM-T-008.

3.5. Emission reductions

19. Non-obligated entity shall undertake direct measurement of the amount of biogas consumed by the thermal application. The emission reductions[7] achieved in any year are the lowest value of the following:

$$ER_y = min[(BE_y \times n_{k,y} - PE_{PL,y} - PE_{FC,y} - PE_{EC,y}),(MD_y - PE_{FC,y} - PE_E$$ Equation (4)

Where:

ER_y	=	Emission reductions achieved by the project activity for year *y* (tCO_2e)
$n_{k,y}$	=	Proportion of domestic biogas digester, methane recovery and combustion systems *k* commissioned that remain operating in year *y* (fraction)
MD_y	=	Methane combusted by the project activity in year *y* (tCO_2e)
PE_y	=	Project emissions for year *y* (tCO_2e)
LE_y	=	Leakage for year *y* (tCO_2e)
MD_y	=	Biogas consumed by the thermal application in year *y* (tCO_2e)

20. Methane combusted *(MD_y)* shall be determined as follows.

$$MD_y = \sum_k (N_{k,0} \times n_{k,y} \times UF_b \times BS_{k,y} \times w_{CH4,y} \times D_{CH4,y} \times GWP_{CH4})$$ Equation (5)

Where:

$N_{k,0}$	=	Number of domestic biogas digester, methane recovery and combustion systems of category *k* commissioned (number)
$n_{k,y}$	=	Proportion of domestic biogas digester, methane recovery and combustion systems of category k commissioned that remain operating in year *y* (fraction)
UF_b	=	Net-to-gross adjustment factor. Apply 0.89 [8] in cases where $n_{k,y}$ is determined based on questionnaire survey. In other cases, apply 1.0

[7] The emission reductions achieved by energy displacement are estimated and monitored according to one of the methodologies listed in paragraph 3 (b).

[8] This is to account for uncertainties of the questionnaire survey method, estimated to be in the range 30–50 per cent (See Annex III (Table of conservativeness factors), document FCCC/SBSTA/2003/10/Add.2).

$BS_{k,y}$	=	The average quantity of biogas combusted in domestic biogas digester, methane recovery and combustion systems of category *k* in year *y* (volume units, dry basis)
$w_{CH4,y}$		Methane content[9] of the biogas in year *y* (volume fraction, dry basis)
D_{CH4}		Density of methane at the temperature and pressure of the biogas in year *y* (t/m^3)

4. Methodology: Monitoring Component

21. Emission reductions can only be claimed if the systems are demonstrated to be operational and commissioned in compliance with standards and/or manufacturer's requirements. It shall be verified if the amount of manure generated and fed to the digester, which is estimated as per paragraph 13 above, is consistent with the capacity of the biogas digester system.

22. The proper land application (resulting in negligible methane emissions) of the digestate shall be verified on a sampling basis following requirements in the "Standard for sampling and surveys for ICM project activities and programme of activities".

[9] Biogas volume and methane content measurements shall be on the same basis (wet or dry).

4.1. Data and parameters monitored

Data/parameter table 1.

Data/parameter:	$N_{LT,PS,y}$
Data unit:	Number
Description:	Annual average number of animals of livestock type *LT* in year *y* for productivity system *PS* (i.e. high or low)
Source of data:	-
Measurement procedures (if any):	The project design document should describe the system for monitoring the number of livestock . Photographic evidence with timestamps and geographic information system (GIS) coordinates could also be used to determine average number of animals. The consistency between the value and indirect information (e.g. records of sales, records of feed purchases) should be assessed.
Monitoring frequency:	Annually, based on monthly records
QA/QC procedures:	For all cases where sampling is applied, the “Standard: Sampling and surveys for ICM project activities and programmes of activities” shall be followed.
Any comment:	If the livestock is raised in the shared centralized farms, the non-obligated entity shall also determine the number of families/households sharing the farm and the annual average animal population ($N_{LT,PS,y}$) belonging to each household.

Data/parameter table 2.

Data/parameter:	$AM_{LT,y}$
Data unit:	kg per animal
Description:	Animal mass for livestock type LT
Source of data:	-
Measurement procedures (if any):	Determined using one of the following two options: a) Sampling measurement with a 90% confidence interval and 10% margin of error in accordance with the “Standard for sampling and surveys for ICM project activities and programmes of activities”; b) Use of default values for “*Low PS*” for conservativeness, as provided in Table 10A.5 of the chapter ‘Emissions from Livestock and Manure Management’ in the volume ‘Agriculture, Forestry and other Land use’ of the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.
Monitoring frequency:	For option (a), annually For option (b), once at the beginning of crediting period.
QA/QC procedures:	-
Any comment:	-

Data/parameter table 3.

Data/parameter:	***$N_{k,0}$***
Data unit:	Number
Description:	Number of domestic biogas digester, methane recovery and combustion systems of category *k* commissioned
Source of data:	Installation records
Measurement procedures (if any):	At the time of installation all project activity systems shall be inspected and undergo acceptance testing (commissioning) for proper operation in compliance with specifications. The installation date of each system shall be recorded
Monitoring frequency:	Once, at the time of installation
QA/QC procedures:	-
Any comment:	-

Data/parameter table 4.

Data/parameter:	***$n_{k,y}$***
Data unit:	Fraction
Description:	Proportion of domestic biogas digester, methane recovery and combustion systems of category *k* commissioned that remain operating at year *y* (fraction)
Source of data:	-
Measurement procedures (if any):	Monitoring of operationality of the biogas systems, including domestic biogas digester, methane recovery and combustion system, shall be conducted using one of the following methods: (a) Census of users or survey of the users at randomly selected sample sites; (b) Based on ongoing 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: Sampling and surveys for ICM 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. For the case of measurement campaigns using biogas flow meters which record usage on a daily or more frequent interval, it may be undertaken at randomly selected sample sites in accordance with the "Standard: Sampling and surveys for ICM project activities and programme of activities". For each measurement campaign at each site, continuous measurement shall be carried out 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.
Monitoring frequency:	At least once every two years (biennial) during the crediting period

QA/QC procedures:	Net-to-gross adjustment factor of 0.89 is applicable in cases where the operationality is determined based on a user-reported questionnaire survey (i.e. using option (a) above to account for uncertainties).
Any comment:	If the biogas digester is found to be operating but the associated combustion systems are not, then the entire biogas production of the unit must be considered as project emissions. Equation 1 shall be used to estimate the project emissions from the biogas digester.

Data/parameter table 5.

Data/parameter:	$BS_{k,y}$
Data unit:	Volume units, dry basis
Description:	The average quantity of biogas combusted in domestic biogas digester, methane recovery and combustion systems of category *k* in year *y*
Source of data:	Direct measurement or conservative default
Measurement procedures (if any):	(a) Biogas flow meters shall be used 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: Sampling and surveys for ICM project activities and programme of activities" shall be used for determining the sample size to achieve 90/10 confidence/precision levels; • The selected samples should take into account the need for stratification, as deemed appropriate, of the population according to the capacity, 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); • 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. 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 disjointed periods are not practical or too expensive, then a single period may be chosen, from which an annualized 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.
Monitoring frequency:	Annual
QA/QC procedures:	-
Any comment:	-

Data/parameter table 6.

Data/parameter:	w_{CH4}
Data unit:	%
Description:	Methane content of the biogas in year *y*
Source of data:	Measurements by Non-obligated entity
Measurement procedures (if any):	The fraction of methane in the biogas should be measured with a continuous analyser (values are recorded with the same frequency as the flow) or with periodical measurements at a 90/10 confidence/precision level by following the "Standard for sampling and surveys for ICM project activities and programmes of activities". Alternatively, a default value of 60 per cent methane content can be used. It shall be measured using equipment that can directly measure methane content in the biogas; the estimation of methane content of biogas based on measurement of other constituents of biogas such as CO_2 is not permitted. The methane content measurement shall be carried out close to a location in the system where biogas flow measurement takes place, and on the same basis (e.g. wet or dry).
Monitoring frequency:	Continuously or periodically
QA/QC procedures:	-
Any comment:	The option chosen should be clearly specified in the project design document.

Data/parameter table 7.

Data/parameter:	**Sizing of the digester**
Data unit:	-
Description:	As per paragraph 4 (d) (i) above
Source of data:	Design specification of biogas digesters
Measurement procedures (if any):	Confirm that biodigesters are appropriately designed in terms of their sizing, considering manure inputs and the thermal energy requirements of households. Justifications shall be provided in the project design document and monitoring reports to demonstrate that gasholders are sufficiently large to capture and store all the biogas that would be generated until consumption.
Monitoring frequency:	Once at construction or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 7.

Data/parameter:	**Compliance with standards and QA/QC system**
Data unit:	-
Description:	Check against standards and implementation of a QA/QC system
Source of data:	- Comparison against national and/or international standards followed for biogas digesters - QA/QC system

Measurement procedures (if any):	As per paragraph 4 (d) (ii) above, confirm that the construction or installation of biodigesters (in the case of prefabricated plants) complies with relevant national and/or international standards and that a QA/QC system is put in place for the construction or installation.
Monitoring frequency:	Once at construction or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 8.

Data/parameter:	**Training for all users of biodigesters**
Data unit:	-
Description:	As per paragraph 4 (d) (iii) above
Source of data:	Training records
Measurement procedures (if any):	Confirm that trainings are conducted for all users of biodigesters prior to their commissioning or installation. The trainings shall be documented in a verifiable manner (e.g. protocol of trainings, documentation of on-site visits)
Monitoring frequency:	At least once, prior to commissioning or installation of biogas digesters
QA/QC procedures:	-
Any comment:	-

Data/parameter table 9.

Data/parameter:	**Periodic inspection and maintenance**
Data unit:	-
Description:	Check as per paragraph 4 (d) (iv) above
Source of data:	Project implementation plan and monitoring surveys
Measurement procedures (if any):	Confirm that a plan for periodic inspection and maintenance is in place and rehabilitation services are available throughout the crediting period. Description of such technical support system shall be provided in the project design document and verified by the designated operational entity during verification.
Monitoring frequency:	Once at construction or installation of biogas digesters and annually
QA/QC procedures:	If the rehabilitation is undertaken, the details (e.g. parts replaced, specifications followed, personnel conducting the repairs and date of retrofitting) on each domestic biogas digester, methane recovery and combustion system shall be documented
Any comment:	-

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MA₹KET

METHODOLOGY

BM FR05.001

Afforestation and reforestation of lands except wetlands

Publication Date:

Version 1.0

Sectoral scope(s): Forestry

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AR-ACM0003 (as valid from 04 October 2013).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. This methodology allows afforestation and reforestation of any land that does not fall into the category of wetland. Where the land in its baseline land-use has soil organic carbon (SOC) content that is expected to be higher than that under the land-use of “forestry”, the methodology restricts the extent of soil disturbance in the project to be no more than 10 per cent. The higher SOC content in the baseline may result either because of the nature of the soils (e.g. the soils are organic soils) or because of anthropogenic activities (e.g. soils are not tilled and external organic matter is added as inputs). Apart from this restriction on the extent of soil disturbance in certain types of soils and land-use practices, the methodology has a broad scope of application[1]. Project activities applying this methodology may choose to exclude or include accounting of any of the three carbon pools of dead wood, litter, and soil organic carbon.

2. Definitions

4. The definitions contained in the following documents shall apply:[2]

   (a) “Detailed Procedure for Offset Mechanism under CCTS”;

   (b) “2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories”.

5. For the purpose of this methodology, the following definition shall apply:

   (a) **Soil disturbance -** refers to any activity that results in a decrease in soil organic carbon (SOC), for example ploughing, ripping, scarification, digging of pits and trenches, stump removal, etc.

3. Scope & Applicability

3.1. Scope

6. This methodology excludes from its scope the land that falls into the category of wetland.

3.2. Applicability

7. This methodology is applicable under the following conditions:

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[1] For example, the land to be afforested or reforested does not have to be degraded land.

[2] These documents are available online at the following URLs:

(a) <http://www.ipcc nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.

(a) The land subject to the project activity does not fall in wetland category;

(b) Soil disturbance attributable to the project activity does not cover more than 10 per cent of area[3] in each of the following types of land, when these lands are included within the project boundary:

(i) Land containing organic soils;

(ii) Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology.

8. A project activity applying this methodology shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity.

3.3. Methodology Approval Date

9. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of approved adopted tools

This methodology also refers to the latest approved versions of the following adopted ICM tools.

(i) “BM-T-AR-0001: “Combined tool to identify the baseline scenario and demonstrate additionality in A/R ICM project activities” (hereinafter referred to as BM-T-AR-001);

(ii) “BM-T-AR-004: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R ICM project activities” (hereinafter referred to as BM-T-AR-004);

(iii) “BM-T-AR-003: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R ICM project activities” (hereinafter referred to as BM-T-AR-003);

(iv) “BM-T-AR-006: Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R ICM project activities” (hereinafter referred to as BM-T-AR-006);

(v) “BM-T-AR-002: Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R ICM project activity” (hereinafter referred to as BM-T-AR-002);

(vi) “BM-T-AR-005: Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R ICM project activity” (hereinafter referred to as BM-T-AR-005).

4. Methodology: Baseline and Monitoring Component

4.1. Selection of carbon pools and greenhouse gases accounted

10. The carbon pools selected for accounting of carbon stock changes are shown in table 1.

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[3] For example, digging pits of size 0.50 m × 0.50 m (length × width) at a spacing of 3 m × 3 m is equal to a coverage of 2.78 per cent; continuous ploughing of land is equal to a coverage of 100 per cent.

Table 1. Carbon pools selected for accounting of carbon stock changes

Carbon pool	Whether selected	Justification/Explanation
Above-ground biomass	Yes	This is the major carbon pool subjected to project activity
Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
Dead wood Litter and Soil organic carbon	Optional	Carbon stock in these pools may increase due to implementation of the project activity

11. The emission sources and associated GHGs selected for accounting are shown in table 2.

Table 2. Emission sources and GHGs selected for accounting

Sources	Gas	Whether Selected	Justification/Explanation
Burning of woody biomass	CO_2	No	CO_2 emissions due to burning of biomass are accounted as a change in carbon stock
	CH_4	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology
	N_2O	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology

4.2. Identification of the baseline scenario and demonstration of additionality

12. The non-obligated entity shall identify the baseline and demonstrate that the project activity is additional by using BM-T-AR-001.

4.3. Stratification

13. If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios in order to achieve optimal precision of estimation of net GHG removals by sinks. In particular:

(a) For baseline net GHG removals by sinks, it is usually sufficient to stratify the area according to major vegetation types and their crown cover and/or land use types;

(b) For actual net GHG removals by sinks the stratification for ex ante estimations is based on the project planting/management plan and the stratification for ex post estimations is based on the actual implementation of the project planting/management plan. If natural or anthropogenic impacts (e.g. local fires) or other factors (e.g. soil type) significantly alter the pattern of biomass distribution in the project area, then the ex post stratification is revised accordingly.

4.4. Baseline net GHG removals by sinks

14. The baseline net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} + \Delta C_{LI\_BSL,t} \quad \text{Equation (1)}$$

Where:

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{TREE\_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in BM-T-AR-004"; t CO_2-e
$\Delta C_{SHRUB\_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in BM-T-AR-004; t CO_2-e
$\Delta C_{DW\_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in BM-T-AR-003; t CO_2-e
$\Delta C_{LI\_BSL,t}$	=	Change in carbon stock in baseline litter biomass within the project boundary, in year *t*, as estimated in BM-T-AR-003; t CO_2-e

4.5. Actual net GHG removals by sinks

15. GHG emissions resulting from removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero.

16. The actual net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t} \qquad \text{Equation (2)}$$

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R ICM project activity, in year *t*, as estimated in BM-T-AR-002; t CO_2-e

17. Change in the carbon stocks in project, occurring in the selected carbon pools in year *t* shall be calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta C_{LI\_PROJ,t} + \Delta SOC_{AL,t} \qquad \text{Equation (3)}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$\Delta C_{TREE\_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year *t*, as estimated in BM-T-AR-004"; t CO_2-e
$\Delta C_{SHRUB\_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year *t*, as estimated in BM-T-AR-004"; t CO_2-e
$\Delta C_{DW\_PROJ,t}$	=	Change in carbon stock in dead wood in project in year *t*, as estimated in the tool BM-T-AR-003; t CO_2-e
$\Delta C_{LI\_PROJ,t}$	=	Change in carbon stock in litter in project in year *t*, as estimated in the tool BM-T-AR-003; t CO_2-e
$\Delta SOC_{AL,t}$	=	Change in carbon stock in SOC in project, in year *t*, in areas of land meeting the applicability conditions of BM-T-AR-006; t CO_2-e

4.6. Leakage

18. Leakage emissions shall be estimated as follows:

$$LK_t = LK_{AGRIC,t}$$ Equation (4)

Where:

LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2-e
$LK_{AGRIC,t}$	=	Leakage due to the displacement of agricultural activities in year *t*, as estimated in BM-T-AR-005"; t CO_2-e

4.7. Net anthropogenic GHG removals by sinks

19. The net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$ Equation (5)

Where:

$\Delta C_{AR,t}$	=	Net anthropogenic GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks, in year *t*; t CO_2-e
LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2-e

4.8. Calculation of CCCs

20. The CCCs for a verification period T = $t_2 - t_1$, (where t_1 and t_2 are the years of the start and the end, respectively, of the verification period) shall be calculated as follows:

$$tCCC_{t_2} = \sum_{1}^{t_2} \Delta C_{AR,t}$$ Equation (6)

$$lCCC_{t_2} = \sum_{t_1+1}^{t_2} \Delta C_{AR,t}$$ Equation (7)

Where:

$tCCC_{t_2}$	=	Number of units of temporary Carbon Credit Certificates issuable in year t_2
$lCCC_{t_2}$	=	Number of units of long-term Carbon Credit Certificates issuable in year t_2
$\Delta C_{AR,t}$	=	Net anthropogenic GHG removals by sinks, in year *t*; t CO_{2}-e
t_1, t_2	=	The years of the start and the end, respectively, of the verification period

21. If $ICCC_{t2} < 0$ then $ICCC_{t2}$ represents the number of *ICCCs* that shall be replaced because of a reversal of net anthropogenic greenhouse gas removals by sinks since the previous certification.

5. Monitoring Procedure

5.1. Monitoring plan

22. The monitoring plan shall provide for collection of all relevant data necessary for:

    (a) Verification that the applicability conditions listed under paragraphs 3 and 4 have been met;

    (b) Verification of changes in carbon stocks in the pools selected;

    (c) Verification of project emissions and leakage emissions.

23. The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity.

5.2. Monitoring of project implementation

24. Information shall be provided, and recorded in the project design document (PDD), to establish that the commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded and applied. Use or adaptation of SOPs available from published handbooks, or from the "IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003", is recommended.

5.3. Precision requirements

25. For this methodology, the precision requirements are those listed in BM-T-AR-004".

5.4. Data requirements under the methodology

26. Description of data and parameters can be found in the tools used in this methodology.

27. Data and parameters obtained from measurement shall be monitored as required in the tools.

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment, Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM FR05.002

Afforestation and reforestation of degraded mangrove habitats

Publication Date:

Version 1.0

Sectoral scope(s): Forestry

Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AR-AM0014 (as valid from 04 October 2013).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively

3. This methodology allows afforestation and reforestation of wetland that constitutes degraded mangrove habitat. The methodology allows use of mangrove species and non-mangrove species but in case of more than 10 per cent area being covered by planting of non-mangrove species it prohibits changes in the hydrology of the project area. The methodology restricts the extent of soil disturbance in the project to be no more than 10 per cent. Project activities applying this methodology may choose to exclude or include accounting of any of the carbon pools of dead wood and soil organic carbon, but cannot include the litter carbon pool.

2. Definitions

4. The definitions contained in the following documents shall apply:[1]

   (a) “Detailed Procedure for Offset Mechanism under CCTS”;

   (b) “2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories”

5. For the purpose of this methodology, the following specific definitions also apply:

   (a) **Degraded mangrove habitat -** refers to wetlands where, in their natural state, mangrove vegetation can grow and have soil or sediment that is usually water-logged with water that is saline or brackish, and that were subjected to impacts resulting in decrease of forest cover below that reported by the host Party.

   (b) **Soil disturbance -** refers to any activity that results in a decrease in soil organic carbon (SOC), for example ploughing, ripping, scarification, digging of pits and trenches, stump removal, etc.

3. Scope & Applicability

3.1. Scope

6. This methodology applies to afforestation and reforestation project activities implemented in degraded mangrove habitats.

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[1] These documents are available online at the following URLs:

(a) <http://www.ipcc nggip.iges.or.jp/public/gpglulucf/gpglulucf.html>.

3.2. Applicability

7. This methodology is applicable under the following conditions:

   (a) The land subject to the project activity is degraded mangrove habitat;

   (b) More than 90 per cent of the project area is planted with mangrove species. If more than 10 per cent of the project area is planted with non-mangrove species then the project activity does not lead to alteration of hydrology of the project area and hydrology of connected up-gradient and down-gradient wetland area;

   (c) Soil disturbance attributable to the A/R Indian Carbon Market (ICM) project activity does not cover more than 10 per cent of area.[2]

8. A project activity applying this methodology shall also comply with the applicability conditions of the tools contained within the methodology and applied by the project activity.

3.3. Methodology Approval Date

9. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of approved tools

10. This methodology also refers to the latest approved versions of the following adopted ICM tools:

    (i) "BM-T-AR-0001: "Combined tool to identify the baseline scenario and demonstrate additionality in A/R ICM project activities" (hereinafter referred to as BM-T-AR-001);

    (ii) "BM-T-AR-004: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R ICM project activities" (hereinafter referred to as BM-T-AR-004);

    (iii) "BM-T-AR-003: Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R ICM project activities" (hereinafter referred to as BM-T-AR-003);

    (iv) "BM-T-AR-002: Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R ICM project activity" (hereinafter referred to as BM-T-AR-002);

    (v) "BM-T-AR-005: Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R ICM project activity" (hereinafter referred to as BM-T-AR-005).

4. Methodology: Baseline and Monitoring Component

4.1. Selection of carbon pools and greenhouse gases accounted

11. The carbon pools selected for accounting of carbon stock changes are shown in table 1.

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2 For example, digging pits of size 0.50 m × 0.50 m (length × width) at a spacing of 3 m × 3 m is equal to a coverage of 2.78 per cent; continuous ploughing of land is equal to a coverage of 100 per cent.

Table 1. Carbon pools selected for accounting of carbon stock changes

Carbon pool	Whether selected	Justification/Explanation
Above-ground biomass	Yes	This is the major carbon pool subjected to project activity
Below-ground biomass	Yes	Carbon stock in this pool is expected to increase due to the implementation of the project activity
Litter	No	Litter biomass is subjected to high turnover and displacement due to tidal currents. It is a conservative choice to exclude the pool from accounting because the project activity will not decrease the rate of accumulation of litter
Dead wood and Soil organic carbon	Optional	Carbon stock in these pools may increase due to implementation of the project activity

12. The emission sources and associated greenhouse gases (GHGs) selected for accounting are shown in table 2.

Table 2. Emission sources and GHGs selected for accounting

Sources	Gas	Whether Selected	Justification/Explanation
Burning of woody biomass	CO_2	No	CO_2 emissions due to burning of biomass are accounted as a change in carbon stock
	CH_4	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology
	N_2O	Yes	Burning of woody biomass for the purpose of site preparation, or as part of forest management, is allowed under this methodology

4.2. Identification of the baseline scenario and demonstration of additionality

13. The non-obligated entity shall identify the baseline and demonstrate that the project activity is additional by using BM-T-AR-0001.

4.3. Stratification

14. If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios in order to achieve optimal precision of estimation of net GHG removals by sinks. In particular:

(a) For baseline net GHG removals by sinks, it is usually sufficient to stratify the area according to major vegetation types and their crown cover and/or land use types;

(b) For actual net GHG removals by sinks the stratification for ex ante estimations is based on the project planting/management plan and the stratification for ex post estimations is based on the actual implementation of the project planting/management plan. If natural or anthropogenic impacts (e.g. local fires) or other factors (e.g. soil type) significantly alter the pattern of biomass distribution in the project area, then the ex post stratification is revised accordingly.

4.4. Baseline net GHG removals by sinks

15. The baseline net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{BSL,t} = \Delta C_{TREE\_BSL,t} + \Delta C_{SHRUB\_BSL,t} + \Delta C_{DW\_BSL,t} \quad \text{Equation (1)}$$

Where:

$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks in year *t*; t CO_2-e
$\Delta C_{TREE\_BSL,t}$	=	Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in BM-T-AR-0004"; t CO_2-e
$\Delta C_{SHRUB\_BSL,t}$	=	Change in carbon stock in baseline shrub biomass within the project boundary, in year *t*, as estimated in BM-T-AR-0004; t CO_2-e
$\Delta C_{DW\_BSL,t}$	=	Change in carbon stock in baseline dead wood biomass within the project boundary, in year *t*, as estimated in BM-T-AR-0003"; t CO_2-e

4.5. Actual net GHG removals by sinks

16. GHG emissions resulting from removal of herbaceous vegetation, combustion of fossil fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary, and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero.

17. The actual net GHG removals by sinks shall be calculated as follows:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t} \quad \text{Equation (2)}$$

Where:

$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year *t*; t CO_2-e
$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$GHG_{E,t}$	=	Increase in non-CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R ICM project activity, in year *t*, as estimated in BM-T-AR-0002; t CO_2-e

18. Change in the carbon stocks in project, occurring in the selected carbon pools in year *t* shall be calculated as follows:

$$\Delta C_{P,t} = \Delta C_{TREE\_PROJ,t} + \Delta C_{SHRUB\_PROJ,t} + \Delta C_{DW\_PROJ,t} + \Delta SOC_{PROJ,t} \quad \text{Equation (3)}$$

Where:

$\Delta C_{P,t}$	=	Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; t CO_2-e
$\Delta C_{TREE\_PROJ,t}$	=	Change in carbon stock in tree biomass in project in year *t*, as estimated in BM-T-AR-0004; t CO_2-e
$\Delta C_{SHRUB\_PROJ,t}$	=	Change in carbon stock in shrub biomass in project in year *t*, as estimated in BM-T-AR-0004; t CO_2-e
$\Delta C_{DW\_PROJ,t}$	=	Change in carbon stock in dead wood in project in year *t*, as estimated in BM-T-AR-0003; t CO_2-e
$\Delta SOC_{PROJ,t}$	=	Change in carbon stock in the soil organic carbon (SOC) pool within the project boundary, in year *t*; t CO_2-e

19. The change in carbon stock in the SOC pool within the project boundary, in year *t*, shall be estimated as follows:

$$\Delta SOC_{PROJ,t} = \frac{44}{12} \times \sum_{t=1}^{t} A_{PLANT,t} \times dSOC_t \times 1\ year \qquad \text{Equation (4)}$$

Where:

$\Delta SOC_{PROJ,t}$	=	Change in SOC stock within the project boundary, in year *t*; t CO_2-e
$A_{PLANT,t}$	=	Area planted in year *t*; ha
$dSOC_t$	=	The rate of change in SOC stocks within the project boundary, in year *t*; t C ha^{-1} yr-1. The following default value of is used, unless transparent and verifiable information can be provided to justify a different value: (i) $dSOC_t$= 0.50 t C ha^{-1} yr^{-1} for $t = t_{PLANT}$ to $t = t_{PLANT}$ + 20 years, where t_{PLANT} is the year in which planting takes place; (ii) $dSOC_t$ = 0 t C ha^{-1} yr^{-1} for $t > t_{PLANT}$ +20.

4.6. Leakage

20. Leakage shall be estimated as follows:

$$LK_t = LK_{AGRIC,t} \qquad \text{Equation (5)}$$

Where:

LK_t	=	GHG emissions due to leakage, in year *t*; t CO_2-e
$LK_{AGRIC,t}$	=	Leakage due to the displacement of agricultural activities in year *t*, as estimated in BM-T-AR-0005; t CO_2-e

4.7. Net anthropogenic GHG removals by sinks

21. The net anthropogenic GHG removals by sinks shall be calculated as follows:

$$\Delta C_{AR,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t \qquad \text{Equation (6)}$$

Where:

$\Delta C_{AR,t}$	=	Net anthropogenic GHG removals by sinks, in year t; t CO_2-e
$\Delta C_{ACTUAL,t}$	=	Actual net GHG removals by sinks, in year t; t CO_2-e
$\Delta C_{BSL,t}$	=	Baseline net GHG removals by sinks, in year t; t CO_2-e
LK_t	=	GHG emissions due to leakage, in year t; t CO_2-e

4.8. Calculation of CCCs

22. The tCCCs and lCCCs for a verification period T = $t_2 - t_1$, (where t_1 and t_2 are the years of the start and the end, respectively, of the verification period) shall be calculated as follows:

$$tCCC_{t_2} = \sum_{1}^{t_2} \Delta C_{AR,t} \qquad \text{Equation (7)}$$

$$lCCC_{t_2} = \sum_{t_1+1}^{t_2} \Delta C_{AR,t} \qquad \text{Equation (8)}$$

Where:

$tCCC_{t_2}$	=	Number of units of temporary Carbon Credit Certificates issuable in year t_2
$lCCC_{t_2}$	=	Number of units of long-term Carbon Credit Certificates issuable in year t_2
$\Delta C_{AR,t}$	=	Net anthropogenic GHG removals by sinks, in year t; t CO_2.e
t_1, t_2	=	The years of the start and the end, respectively, of the verification period

23. If $lCCC_{t2} < 0$ then $lCCC_{t2}$ presents the number of *lCCCs* that shall be replaced because of a reversal of net anthropogenic greenhouse gas removals by sinks since the previous certification.

5. Monitoring Procedure

5.1. Monitoring plan

24. The monitoring plan shall provide for collection of all relevant data necessary for:

(a) Verification that the applicability conditions listed under paragraphs 3 and 4 have been met;

(b) Verification of changes in carbon stocks in the pools selected;

(c) Verification of project emissions and leakage emissions.

25. The data collected shall be archived for a period of at least two years after the end of the last crediting period of the project activity.

5.2. Monitoring of project implementation

26. Information shall be provided, and recorded in the project design document (PDD), to establish that the commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. If such principles and practices are not known or available, standard operating procedures (SOPs) and quality control/quality assurance (QA/QC) procedures for inventory operations, including field data collection and data management, shall be identified, recorded and applied. Use or adaptation of SOPs available from published handbooks, or from the "IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry 2003", is recommended.

5.3. Precision requirements

27. For this methodology, the precision requirements are those listed in BM-T-AR-0004.

5.4. Data requirements under the methodology

28. Description of data and parameters can be found in the tools used in this methodology.

29. Data and parameters obtained from measurement shall be monitored as required in the tools.

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM TR06.001

Modal shift in transportation of cargo from road transportation to water or rail transportation

Publication Date:

Version 1.0

Sectoral scope(s): Transport

Table of Contents

1. INTRODUCTION

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AM0090 (as valid from 17 September 2012).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

2. SCOPE AND APPLICABILITY

2.1 Scope

2. This methodology is applicable to project activities that result in modal shift in transportation of a specific cargo (excluding passengers) from road transportation using trucks to water transportation using barges or ships or rail transportation.

2.2 Applicability

The methodology is applicable under the following conditions:

- The owner of the cargo is one of the non-obligated entity. If the entity investing in the ICM project activity is not the owner of the cargo, it should also be a project participant;
- The non-obligated entity should have made at least one of the below listed new investments:
  - Direct investment in new infrastructure, including facilities (new ports, handling areas) and/or equipments[1] (ships, barges, etc.) for water transportation;
  - Direct investment in new infrastructure, including facilities (new ports, handling areas, railway track)[2] and/or equipments[1] (trains, wagons, etc) for rail transportation;
  - Refurbishment/replacement of existing water and rail transportation infrastructure or equipments, with transport capacity expansion.
- The transport infrastructure/equipment in which these new investments are made is at least 50% used by the cargo transported under the project activity, i.e. the cargo transported under the project activity constitutes at least 50% of the cargo transported annually by/with this infrastructure/equipment;
- With respect to fuels, the following conditions[3] apply:

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[1] Investment on intermodal containers is not considered as investment in this case.

[2] Not necessarily the whole railway track, but a part of the track can be built (for example, from the industrial facility to a nearest connecting point).

[3] No provisions to calculate upstream emissions from the production of the fuels are provided in order to keep the methodology simple. Therefore, in order to ensure that the calculated emission reductions are conservative, this applicability condition aims to limit the use of the methodology to cases where the upstream emissions under the project activity are likely to be equal or lower than in the baseline scenario. Note that other methodologies involving fuel switch situations usually require the consideration of upstream emissions. Note also that as this methodology is about a switch from road transportation using trucks to water transportation using barges or ships

- In the case of gaseous fossil fuels, the methodology is applicable if it can be demonstrated that equal or more gaseous fossil fuels are used in the baseline scenario than in the project activity. The methodology is not applicable in its current form if more gaseous fossil fuels are used in the project activity compared to the baseline scenario;[4]
- In the case of biofuels, the methodology is applicable if it can be demonstrated that equal or more biofuels are used in the baseline scenario than in the project activity. The methodology is not applicable in its current form if more biofuels are used in the project activity compared to the baseline scenario.

- The project transportation mode is defined in the ICM-PDD at the validation of the project activity and no change of transportation mode is allowed thereafter;
- The cargo is transported from the same origin (point A) to the same destination (point B) throughout the whole crediting period. These two points and transportation routes are defined in the ICM-PDD at the validation of the project activity and are fixed along the crediting period;
- Under the project activity, the route from origin to destination may combine the different transportation modes: Trucks, ships, barges and/or rail but a part of the route must consist of either ships, barges or rail;
- Both in the baseline and project activity, only one type of cargo, owned by the non-obligated entity, is transported and no mix of cargo is permitted (this condition does not apply to the return trip cargo). The cargo type of the project activity is defined in the ICM-PDD at the validation of the project activity and is fixed along the crediting period;
- The railway infrastructure or waterway has enough capacity to accommodate new transportation demand under the project activity and will not displace other existing transportation demand due to limited capacity of infrastructure.

Finally, this methodology is only applicable if the most plausible baseline scenario, as identified per the section "Selection of the baseline scenario and demonstration of additionality" hereunder, is M1 (Road transportation).

2.3 Entry into force

4. The date of adoption of this document shall be effective from XX/XX 2024.

2.4 Applicability of approved adopted tools

This methodology also refers to the latest approved versions of the following adopted ICM tools:

(a) "BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality" (hereinafter referred to as BM-T-001);

(b) "BM-T-002: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion" (hereinafter referred to as BM-T-002);

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or rail transportation, most project activities can comply with these requirements. If required, project participant may submit a request for revision to this methodology.

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(c) "BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation" (hereinafter referred to as BM-T-003);

3. METHODOLOGY: BASELINE COMPONENT

3.1. Project boundary

The **spatial extent** of the project boundary encompasses the complete route, from origin to destination, involved in the transportation of the cargo described in the ICM-PDD, including complementary modes of transport i.e. from the facility to the port or station and vice versa. The project boundaries do not include production facilities where the cargo is produced or facilities that will use those cargo. Only transportation of the cargo is included within the boundary.

Table 1 illustrates which emission sources are included and which are excluded from the project boundary for the determination of both baseline and project emissions.

Table 1: Overview on emission sources included in or excluded from the project boundary

	Source	Gas	Included?	Justification / Explanation
Baseline	Fuel consumption for cargo transportation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project Activity	Fuel and/or electricity consumption for cargo transportation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification
		N_2O	No	Excluded for simplification

3.2. Selection of the baseline scenario and demonstration of additionality

The selection of the baseline scenario and the demonstration of additionality should be conducted using the latest version of BM-T-001. The following additional guidance should be used when applying the tool.

When applying "Sub-step 1a" of the tool, alternative scenarios for cargo transportation should include all realistic and credible alternatives to the project activity that are consistent with current laws and regulations of the host country.

The following likely scenarios of transportation modes shall be assessed, *inter alia*:

M1: Road transportation;

M2: Rail transportation;

M3: Water transportation;

M4: Other transportation modes (e.g. air transportation, pipelines, electric conveyors, ropeway, if relevant).

All considered scenarios should provide the same service, i.e. they should be able to transport the same amount of cargo as transported under the project activity from the same origin to the same destination.

If the demand for the transportation of cargo is new,[5] it has to be demonstrated that road transportation is a realistic option from a technical point of view and that appropriate road infrastructure is available in the project activity region. It shall also be proved that road transportation is a common practice for the transportation of the project cargo type in the host country or other relevant region as defined in the common practice analysis of the tool.

The Step 3 of the tool, investment analysis, is mandatory regardless of the outcome of Step 2 of the tool. In applying this step, the following guidance should be followed:

- The investment analysis shall be carried out from the perspective of the non-obligated entity, including the owner of the cargo and the investing entity (if different from the owner).
- In the case that the cargo is not transported by the owner of the cargo and the transport service provider is not a project participant, the transport tariffs of this third-party transport service provider shall be used in the investment analysis and verified by the ACVA.
- In case the project activity infrastructure/equipment is only partially used for the cargo transported under the project activity and the same infrastructure/equipment is also used to transport cargo of third parties and/or the cargo owned by the non-obligated entity which are the not included under the project activity (T_y as describe in equation 2 below), then the investment analysis shall consider all revenues generated by the use of this infrastructure for the transport of cargo other than the project cargo, including non ICM transportation activities (including any non ICM return cargo). The cargo transported under the project activity must constitute at least 50% of the total amount of cargo transported.
- If the project activity provides a different quality of service than other alternative scenarios, such as faster or more reliable transportation, these benefits may be monetized and be taken into account in the investment analysis. Any monetization of time or quality of service shall be supported by “revealed/stated preference” type studies to be verified by the ACVA. The typical transport time for the cargo from origin to the destination for both the project activity and baseline scenario shall be estimated and documented in the ICM-PDD.

[5] For the purpose of this methodology, a new demand for transportation means that there is no history of transportation of the same cargo type that is being transported in the project activity between the same points prior to the start of the project activity. For example, transportation of cargo from/to a greenfield industrial facility

3.3. Emission Reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \textbf{(1)}$$

Where:

ER_y	=	Emission reductions in year y (tCO_2)
BE_y	=	Baseline emissions in year y (tCO_2)
PE_y	=	Project emissions in year y (tCO_2)

3.4. Baseline Emissions

The baseline emissions from the transportation of the cargo are calculated based on the amount of cargo transported under the project activity, the distance of the baseline trip route (i.e. the distance between origin and destination for transportation of cargo by trucks) and a baseline emission factor in g CO_2 per kilometer and tonne of cargo transported. The amount of cargo transported under the project activity is monitored along the crediting period. The baseline trip route is determined once at the validation of the project activity and fixed throughout the crediting period. The baseline emission factor can be determined through two options: The first option is applying a conservative default emission factor. This option can, for example, be used if the non-obligated entity do not have historical records of the fuel consumption in trucks. The second option allows non-obligated entity to calculate the emission factor based on historical records of the fuel consumption for transportation of cargo by trucks.

Baseline emissions are calculated as follows:

$$BE_y = T_y \cdot AD \cdot EF_{BL} \cdot 10^{-6} \quad \textbf{(2)}$$

Where:

BE_y	=	Baseline emissions in year y (tCO_2)
T_y	=	Amount of cargo transported by the project transportation mode in year y (tonne)
AD	=	Distance of the baseline trip route (km)
EF_{BL}	=	Baseline emission factor for transportation of cargo (g CO_2 per tonne.km, i.e. g CO_2 per tonne of cargo and km travelled)

Step 1: Determination of the cargo type transported

At the validation stage, non-obligated entity should clearly identify and describe in the ICM-PDD the type of cargo transported under the project activity, including to which category in Table 2 the cargo belongs to.

Step 2: Determination of the distance of the baseline trip route (AD)

At the validation stage, non-obligated entity should clearly identify and document the origin and destination from/to where the cargo is transported. The distance of the baseline trip route (AD) is considered as the one way distance between the origin (point A) and destination (point B) that is travelled in the baseline scenario. If there is a documented historical record of the route used for the transportation of cargo prior to the implementation of the project activity, the historical route should be considered. If such historical records are not available or if more than one route was used prior to the implementation of the project activity, then the non-obligated entity should provide, with justification, a route between origin and destination which lead to the least fuel consumption. The distance of the baseline trip route (AD) should be documented transparently in the ICM-PDD.

Step 3: Determination of baseline emission factor (EF_{BL})

The baseline emission factor (EF_{BL}) for transportation of cargo should be determined using one of the following options:

Option A: Conservative default[6] values

The non-obligated entity can use the default emission factors[7] provided in the table below depending upon the type of cargo transported in the baseline scenario identified in the Step 1 above. These default emissions factors (in **Table 2**) are determined on the basis of trucks consuming petrodiesel. Furthermore, the emission factors can also be used if trucks consume gasoline in the host country (this is conservative as gasoline trucks are less energy efficient than diesel trucks). However, the emission factors shall be adjusted if trucks consume natural gas or if petrodiesel is blended with biofuels in the host country, as follows:

(a) If trucks consume natural gas in the host country, the default values in **Table 2** shall be multiplied by the ratio of the emission factor of natural gas to the emission factor of petrodiesel (both expressed in g CO_2/GJ);

(b) If petrodiesel is blended with biofuels in the host country, the default values in **Table 2** shall be multiplied by the share (fraction) of petrodiesel in blended diesel detrmined on an energy basis.

Table 2: Default emission factors for road transportation depending on the type of cargo transported

Type of cargo transported	Emission factor (g CO_2/tonne.km)
Agricultural products and live animals	83

[6] Project participants wishing to use different default factors for road transportation may propose a revision of this methodology.

[7] These default factors take into account the emissions generated by the empty trips caused by the main trips.

Beverage	61
Groceries	76
Perishable and semi-perishable foodstuff and canned food	94
Other food products and fodder	74
Solid mineral fuels and petroleum products	76
Ores and metal waste	90
Metal products	80
Mineral products	57
Other crude and manufactured minerals and building materials	70
Fertilizers	76
Chemicals	70
Transport equipment	100
Machinery and metal products	119
Glass and ceramic and porcelain products	84
Grouped goods	94
Other manufactured articles	113

Sources: "Repérage des produits les plus concernés par la maîtrise de la demande de transport routier", Beauvais Consultants, ADEME, 2006 and "Le point sur N°25, Les émissions de CO_2 par les poids lourds français entre 1996 et 2006 ont augmenté moins vite que les volumes transportés", Commissariat général du developpement durable,, Ministère de l'écologie, de l'énergie, du développement durable et de la mer, 2009.

Option B: Historical data[8]

The baseline emission factor (EF_{BL}) is calculated based on historical data on the amount of fuels consumed for transportation of the cargo, the net calorific values and CO_2 emission factors of the fuel types used, the amount of cargo transported, the distance of the baseline trip route and a factor to account for non-empty return trips. This option can be applied only if:

- The cargo was transported in dedicated trucks which were not used for other purposes than transportation of cargo; and

[8] This option is not applicable if the demand for the transportation of cargo is new.

- Data on the amount of cargo transported, the amount of fuel consumed and the fuel types used is available for the trucks dedicated to the transportation of the type of cargo (see Table 2).

The baseline emission factor is calculated as follows:

$$EF_{BL} = \frac{\sum_{i} FC_{BL,i,x} \cdot NCV_{i,x} \cdot EF_{CO2,i,x} \cdot F_{RT,BL}}{T_x \cdot AD} \quad \textbf{(3)}$$

Where:

EF_{BL}	=	Baseline emission factor for transportation of cargo (g CO_2 per tonne.km)
$FC_{BL,i,x}$	=	Amount of fuel *i* consumed by the trucks in year *x* (liter or m^3)
$EF_{CO2,i,x}$	=	CO_2 emission factor of fuel *i* consumed by the trucks in year *x* (g CO_2/GJ)[9]
$NCV_{i,x}$	=	Average net calorific value of fuel *i* consumed by the trucks in year *x* (GJ per liter or m^3)
$F_{RT,BL}$	=	Factor to account for non-empty return trips in the baseline scenario (fraction)
T_x	=	Amount of cargo transported in trucks in year *x* (tonne)
AD	=	Distance of the baseline trip route (km)
x	=	Year (365 days) prior to the implementation of the project activity

Determination of $F_{RT,BL}$

The factor to account for non-empty return trips in the baseline scenario ($F_{RT,BL}$) is calculated based on the one year of historical data on the number of empty return trips. In cases where non-obligated entity can demonstrate that all the return trips in year *x* were empty, $F_{RT,BL}$ is 1. In cases where there are non-empty return trips in year *x*, $F_{RT,BL}$ is determined as follows:

$$F_{RT,BL} = \frac{T_x \cdot AD}{T_x \cdot AD + T_{RT,x} \cdot RTD_x} \quad \textbf{(4)}$$

Where:

$F_{RT,BL}$	=	Factor to account for non-empty return trips in the baseline scenario (fraction)
T_x	=	Amount of cargo transported in trucks in year *x* (tonne)
AD	=	Distance of the baseline trip route (km)
$T_{RT,x}$	=	Amount of cargo transported in trucks in the return trips in year *x* (tonne)
RTD_x	=	Distance of the return trip route in year *x* (km)
x	=	Year (365 days) prior to the implementation of the project activity

Project emissions

The project emissions include the emissions resulting from the consumption of fossil fuel in the ships/barges/trains, the consumption of electricity in trains, and the consumption of fossil fuel in

[9] If the fuel is blended with biofuel, the emission factor of the blend shall be calculated assuming an emission factor of zero for the biofuel.

the trucks used for the transportation of cargo in complementary routes[10] under the project activity. If the project transportation mode carries other cargo in the return trips from the destination (point B) to the origin (point A) of the project activity trip, the emissions associated with the transportation of the cargo in the return trips are not accounted for. Project emissions are calculated as follows:

$$PE_y = \left(PE_{FC,y} + PE_{EC,y}\right) \cdot F_{RT,PJ,y} + PE_{CR,y} \quad \textbf{(5)}$$

Where:

PE_y	=	Project emissions in year *y* (tCO_2)
$PE_{FC,y}$	=	Project emissions from fossil fuel combustion in the project activity in year *y* (tCO_2)
$PE_{EC,y}$	=	Project emissions from electricity consumption in the project activity in year *y* (tCO_2)
$F_{RT,PJ,y}$	=	The factor to account for non-empty return trips in the project scenario in year *y* (fraction)
$PE_{CR,y}$	=	Project emissions from transportation of cargo in complementary routes in trucks in year *y* (tCO_2)

Determination of $PE_{FC,y}$

Project emissions from fossil fuel combustion in the project activity in year *y* ($PE_{FC,y}$) are calculated using the latest approved version of BM-T-002, where the sources *j* in the tool correspond to all sources of fossil fuel consumption in the project activity, including the ships/barges/trains used under the project activity and return trips. Fossil fuel consumption, if any, for electricity generation should not be included. Fossil fuel consumption for the transportation of part of the cargo, if any, by the baseline transportation mode (trucks) from origin to destination should not be included. All emission sources should be documented transparently in the ICM-PDD.

Determination of $PE_{EC,y}$

Project emissions from electricity consumption in the project activity in year y ($PE_{EC,y}$) are calculated using the latest version of BM-T-003" where the electricity consumption sources *j* in the tool corresponds to all electricity consumption sources under the project activity, including trains used under the project activity and return trips. In case the project activity consumes electricity from more than one electricity grid, the parameter $EF_{EL,j/k/l,y}$ in the tool shall refer to the emission factor of the grid with highest emission factor among the electricity grids that the project activity consumes the electricity. All emission sources should be documented transparently in the ICM-PDD.

Determination of $F_{RT,PJ,y}$

The factor to account for non-empty return trips in the project scenario in year *y* ($F_{RT,PJ,y}$) is calculated based on amount of cargo transported by the project transportation mode in the

[10] Complementary routes, for the purpose of this methodology, are routes to transport the cargo (i) from the origin point of the cargo (point A), to the point of departure of the ships/barges/trains and return trips, and (ii) from the point of arrival of the ships/barges/trains to the destination point of the cargo (point B) and return trips.

return trips in year *y*. In cases where non-obligated entity cannot demonstrate that the project transportation mode carries other cargo in return trips in year *y,* $F_{RT,PJ,y}$ is 1. In cases where the project transportation mode carries other cargo in return trips from the destination (point B) to the origin (point A) of the project activity trip in year y, $F_{RT,PJ,y}$ is determined as follows:

$$F_{RT,PJ,y} = \frac{T_y}{T_y + T_{RT,y}} \tag{6}$$

Where:

$F_{RT,PJ,y}$	=	The factor to account for non-empty return trips in the project scenario in year *y* (fraction)
T_y	=	Amount of cargo transported by the project transportation mode in year *y* (tonne)
$T_{RT,y}$	=	Amount of cargo transported by the project transportation mode in the return trips in year *y* (tonne)

Determination of $PE_{CR,y}$

Project emissions from transportation of cargo in complementary routes in trucks in year *y* ($PE_{CR,y}$) are calculated using the latest approved version of BM-T-002, where the sources *j* in the tool correspond to fossil fuel consumption in the trucks used for the transportation of cargo in complementary routes[10].

Leakage

Leakage emissions are negligible and are accounted for as zero.

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

Refer to the “Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” (Annex 1 of the “Procedures for renewal of the crediting period of a registered ICM project activity”).[11]

3.5. Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter:	$FC_{BL,i,x}$
Data unit:	liter or m^3
Description:	Amount of fuel *i* consumed by the trucks in year *x*
Source of data:	Historical data from the non-obligated entity
Measurement	-

procedures (if any):	
Any comment:	-

Data / Parameter:	$EF_{CO2,i,x}$
Data unit:	g CO_2/GJ
Description:	CO_2 emission factor of fuel *i* consumed by the trucks in year *x*
Source of data:	The following data sources may be used if the relevant conditions apply:

Data source	**Conditions for using the data source**
a) Values provided by the fuel supplier in invoices	This is the preferred source
b) Measurements by the non-obligated entity	If a) is not available
c) Regional or national default values	If a) is not available. These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)
d) IPCC default values at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories	If a) is not available

Measurement procedures (if any):	For a) and b): Measurements should be undertaken in line with national or international fuel standards
Any comment:	For a): If the fuel supplier provides the CO_2 emission factor on the invoice and the value is based on measurements for this specific fuel, this CO_2 factor should be used. If another source for the CO_2 emission factor is used or no CO_2 emission factor is provided, Options b), c) or d) should be used. If the fuel is blended with biofuel, the emission factor of the blend shall be calculated assuming an emission factor of zero for the biofuel

<table>
<tr><td>Data / Parameter:</td><td>$NCV_{i,x}$</td></tr>
<tr><td>Data unit:</td><td>GJ per liter or m^3</td></tr>
<tr><td>Description:</td><td>Average net calorific value of fuel i consumed by the trucks in year x</td></tr>
<tr><td>Source of data:</td><td>The following data sources may be used if the relevant conditions apply:
<table>
<tr><th>Data source</th><th>Conditions for using the data source</th></tr>
<tr><td>a) Values provided by the fuel supplier in invoices</td><td>This is the preferred source</td></tr>
<tr><td>b) Measurements by the non-obligated entity</td><td>If a) is not available</td></tr>
<tr><td>c) Regional or national default values</td><td>If a) is not available.
These sources can only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances)</td></tr>
<tr><td>d) IPCC default values at the lower limit of the confidence interval with 95% confidence level, as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories</td><td>If a) is not available</td></tr>
</table></td></tr>
<tr><td>Measurement procedures (if any):</td><td>For a) and b): Measurements should be undertaken in line with national or international fuel standards</td></tr>
<tr><td>Any comment:</td><td>QA/QC procedures: Verify that the values under a), b) and c) are within the uncertainty range of the IPCC default values as provided in Table 1.2, Vol. 2 of the 2006 IPCC Guidelines. If the values out of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements. The laboratories in a), b) or c) should have ISO17025 accreditation or justify that they can comply with similar quality standards</td></tr>
</table>

Data / Parameter:	AD
Data unit:	Km
Description:	Distance of the baseline trip route (km)
Source of data:	Historical data or measurement from the non-obligated entity
Measurement procedures (if	-

any):	
Any comment:	-

Data / Parameter:	T_x
Data unit:	tonne
Description:	Amount of cargo transported in trucks in year *x*
Source of data:	Historical data from the non-obligated entity
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$T_{RT,x}$
Data unit:	tonne
Description:	Amount of cargo transported in trucks in the return trips in year *x*
Source of data:	Historical data from the non-obligated entity
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	RTD_x
Data unit:	km
Description:	Distance of the return trip route in year *x*
Source of data:	Historical data from the non-obligated entity
Measurement procedures (if any):	-
Any comment:	In many cases, RTDx will be the same as AD, where the trucks take the same route in the return trip. However, in cases where the trucks take different route (diversion) in the return trip, the RTDx is the actual length of the return trip

4. METHODOLOGY: Monitoring Component

4.1. Monitoring procedures

Describe and specify in the ICM-PDD all monitoring procedures, including the type of measurement instrumentation used and the responsibilities for monitoring and QA/QC procedures that will be applied. Where the methodology provides different options (e.g. use of default values or on-site measurements), specify which option will be used. Meters should be installed, maintained and calibrated according to equipment manufacturer instructions and be in line with relevant standards. If such standards are not available, use national standards. If a national standard is not available, then use international standards.

All monitoring should be attended to by appropriate and adequate personnel, as assessed by the non-obligated entity. All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

In addition, the monitoring provisions in the tools referred to in this methodology apply.

4.2. Data and parameters monitored

Data / Parameter:	PTM_y
Data unit:	
Description:	The project transportation mode in year *y*
Source of data:	Onsite records by non-obligated entity
Measurement procedures (if any):	The non-obligated entity will record the mode of transportation in each trip. The verifying ACVA will check the records for confirmation.
Monitoring frequency:	Each trip
QA/QC procedures:	-
Any comment:	The project transportation mode (either ships, barges or rail) in year *y* should be the same project transportation as defined in the ICM-PDD at the validation of the project activity This monitored parameter is required in order to comply with the following applicability condition: • The project transportation mode is defined in the ICM-PDD at the validation of the project activity and no change of transportation mode is allowed thereafter

Data / Parameter:	OD_y
Data unit:	
Description:	The origin and destination point and transportation route of the cargo transported by the project transportation mode in year *y*
Source of data:	Onsite records by non-obligated entity
Measurement procedures (if any):	The non-obligated entity will record the origin and destination point and transportation route in each trip. The verifying ACVA will check the records for confirmation
Monitoring frequency:	Each trip
QA/QC procedures:	-
Any comment:	The origin and destination point and the transportation routes of the cargo transported by the project transportation mode in year *y* should be the same origin and destination points and transportation route as defined in the ICM-PDD at the validation of the project activity. This monitored parameter is required in order to comply with the following applicability condition:

	• The cargo is transported from the same origin (point A) to the same destination (point B) throughout the whole crediting period. These two points and transportation routes are defined in the ICM-PDD at the validation of the project activity and are fixed along the crediting period
Data / Parameter:	CT_y
Data unit:	
Description:	Type of cargo transported by the project transportation mode in year *y*
Source of data:	Onsite records by non-obligated entity
Measurement procedures (if any):	The non-obligated entity will record the type of cargo transported by the project transportation mode in each trip. The verifying ACVA will check the records for confirmation.
Monitoring frequency:	Each trip
QA/QC procedures:	-
Any comment:	The cargo type transported in year *y* should be the same type as defined in the ICM-PDD at the validation of the project activity. This monitored parameter is required in order to comply with the following applicability condition: • Both in the baseline and project activity, only one type of cargo, owned by the non-obligated entity, is transported and no mix of cargo is permitted (this condition does not apply to the return trip cargo). The cargo type of the project activity is defined in the ICM-PDD at the validation of the project activity and is fixed along the crediting period

Data / Parameter:	T_y
Data unit:	tonne
Description:	Amount of cargo transported by the project transportation mode in year *y*
Source of data:	Onsite measurements by non-obligated entity
Measurement procedures (if any):	The amount of cargo transported under the ICM project by the project transportation mode shall be measured at the point of origin using weight scales. The amount shall be crosschecked with the cargo received at destination
Monitoring frequency:	Daily, summed for a year
QA/QC procedures:	-
Any comment:	The non-obligated entity shall estimate the T_y to be used for *ex ante* calculation in the ICM-PDD and for the investment analysis and document in the PDD. The sensitivity analysis shall be performed as per the procedure in the combined tool. Changes to the value of T_y during the crediting period as compared to the *ex ante* estimate (e.g. by more than 10%) represent a change to the project design document and the relevant procedures shall apply

Data / Parameter:	$T_{RT,y}$
Data unit:	tonne
Description:	Amount of cargo transported by the project transportation mode in the return trips in year *y*
Source of data:	Onsite measurements by non-obligated entity
Measurement procedures (if any):	The amount of cargo transported by the project transportation mode in the return trips shall be measured at the point of origin using weight scales. The amount shall be crosschecked with the cargo received at destination
Monitoring frequency:	Daily, summed for a year
QA/QC procedures:	-
Any comment:	The non-obligated entity shall estimate the $T_{RT,y}$ to be used for *ex ante* calculation in the ICM-PDD and for the investment analysis and document in the PDD. The sensitivity analysis shall be performed as per the procedure in the combined tool. Changes to the value of $T_{RT,y}$ during the crediting period as compared to the *ex ante* estimate (e.g. by more than 10%) represent a change to the project design document and the relevant procedures shall apply.

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________

सत्यमेव जयते

Ministry of Power

Ministry of Environment,

Forest and Climate Change

INDIAN Carbon MARKET

METHODOLOGY

BM TR06.002

Emission reductions by electric and hybrid vehicles

Publication Date:

Version 1.0

Sectoral scope(s): Transport

Table of Contents

1. Introduction

1. This methodology is adopted and refers to the latest approved version of the UNFCCC Clean Development Mechanism Methodology AMS-III.C (as valid from 08 September 2022).

2. It shall be the responsibility of the non-obligated entity and Accredited Carbon Verification Agency (ACVA) to note of any subsequent changes or revisions in the above-mentioned methodology while developing projects and performing validation and/or verification activity respectively.

3. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical project(s)	Operation of electric and hybrid vehicles for providing transportation services
Type of GHG emissions mitigation action	Fuel switch. Displacement of more-GHG-intensive vehicles

2. Definitions

4. For the purpose of this methodology following definitions apply:

(a) **Hybrid vehicle** – is a vehicle which combines an internal combustion engine and one or more electric motors.

3. Scope & Applicability

3.1. Scope

5. This methodology applies to project activities introducing new electric and/or hybrid vehicles that displace the use of fossil fuel vehicles in passenger and freight transportation.

3.2. Applicability

6. The methodology is not applicable for project activities that involve a switch from fossil fuels to biofuels in transportation;

7. In cases where the project vehicles use a replaceable, chargeable battery there must be documented measures in place to ensure that vehicle owners have access to replacement batteries of comparable quality.

8. The project design document (PDD) shall explain the proposed approach for introducing/distributing the electric/hybrid vehicles, which shall allow for tracking of the project vehicles. It shall also explain how the proposed project activity will:

(a) Demonstrate that the baseline vehicles being displaced are those consuming fossil fuels.[1] This can be done, for example, through documentation of the market share

[1] If any biofuel blends are used, blends up to 20 per cent by volume are eligible and emission reductions shall be discounted by the percentage of biofuel in the blend (e.g. 20 per cent in the case of B20).

per fuel type per vehicle category in the project region (e.g. based on representative sample surveys or official data or peer reviewed literature);

(b) Ensure compliance with prevailing regulations pertaining to battery use and disposal.

9. The PDD shall include minimum performance specifications for the batteries to be used such as: depth of discharge, battery cycles, distance travelled per charge, lifetime.

10. The non-obligated entity shall demonstrate that double counting of emission reductions will not occur e.g. via a contractual agreement with the end-user(s), maintenance of comprehensive inventory of project vehicles or unique identification of the vehicles owned by end-user(s). The steps undertaken to avoid double counting shall be documented in the PDD.

11. Types of hybrid/electric vehicles to be introduced include but are not limited to cars, buses, trucks, jeepneys, commuter vans, taxis, motorcycles and tricycles.

12. The non-obligated entity shall demonstrate that the project and baseline vehicles are comparable, using the following means:

(a) Project and baseline vehicles belong to the same vehicle category, e.g. motorcycle, bus, taxi, truck, tricycle;

(b) Project and baseline vehicle categories have comparable passenger/load capacity and power rating with a variation of no more than 20 per cent (comparing the baseline vehicle with the respective project vehicle of same category).

3.3. Methodology Approval Date

13. The date of adoption of this document shall be effective from XX/XX 2024.

3.4. Applicability of sectoral scopes

14. For validation and verification of ICM projects and programme of activities by a designated ACVA using this methodology, application of sectoral scope “06: Transport” is mandatory.

3.5. Applicability of approved tools and methodologies

15. This methodology also refers to the latest approved versions of the following tool and methodologies:

(a) “BM-T-001: Combined tool to identify the baseline scenario and demonstrate additionality” (hereinafter referred to as BM-T-001);

(b) “BM-T-003: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (hereinafter referred to as BM-T-003);

4. Methodology: Baseline Component

4.1. Project Boundary

16. The project boundary is comprised of:

(a) The vehicles of the project;

(b) The geographic boundaries where the project activity vehicles are operated;

(c) The providers of the charging service to the project activity vehicles, including the charging equipment and stations of the project activities vehicle, electric supply sources (e.g. a grid and/or renewable energy generation source connected by a dedicated line to the charging stations) and other ancillary facilities.

4.2. Additionality

17. For the specific case of this methodology, additionality is demonstrated using the option provided below.

(a) Demonstrate that the project activity would otherwise not be implemented due to the existence of one or more barrier(s) listed in BM-T-001. The barrier(s) can be demonstrated for buyers/users and/or charging service providers of the electric vehicles even if the manufacturer or retailer of the electric vehicles is implementing the project.

4.3. Baseline

18. The baseline scenario in case of operation of electric vehicles is the operation of the comparable vehicles (the comparability of baseline and project vehicles to be demonstrated as per indicators in paragraph 11 above) that would have been used to provide the same transportation service.

4.4. Baseline emissions

19. Baseline emissions should be calculated using one of the two approaches described below:

20. Approach 1: Using distance travelled by project vehicles

21. The baseline emissions are calculated based on the unit of service provided by the project vehicles (travelled distance) times the emission factor for the baseline vehicle to provide the same unit of service as per the equation below:

$$BE_y = \sum_i EF_{BL,km,i} \times DD_{i,y} \times N_{i,y} \times 10^{-6} \qquad \text{Equation (1)}$$

Where:

BE_y	=	Total baseline emissions in year *y* (t CO_2)
$EF_{BL,km,i}$	=	Emission factor for baseline vehicle category *i* (g CO_2/km)
$DD_{i,y}$	=	Annual average distance travelled by project vehicle category *i* in the year *y* (km)
$N_{i,y}$	=	Number of operational project vehicles in category *i* in year *y*

22. Approach 2: Using the electricity used to charge the vehicles

23. The baseline emissions are calculated as per the equation below by transforming the electricity charged to the vehicles at the charging stations/points into travelled distance and the emission factor for fossil fuels used by the baseline vehicles to travel the same distance.

$$BE_y = \sum_i EF_{BL,km,i} \times \frac{EC_{PJ,i,y}}{SEC_{PJ,km,i,y}} \times 10^{-6}$$ Equation (2)

Where:

BE_y	=	Total baseline emissions in year *y* (t CO_2)
$EC_{PJ,i,y}$	=	The electricity consumed for charging project vehicles category i at the charging stations/points in year y (kWh)
$EF_{BL,km,i}$	=	Emission factor for baseline vehicle category *i* (g CO_2/km)
$SEC_{PJ,km,i,y}$	=	Specific electricity consumption per km per project vehicle category i in year y (kWh/km)

24. The Emission factor for baseline vehicle category ($EF_{BL,km,i}$) shall be determined as follows*:*

$$EF_{BL,km,i} = SFC_i \times NCV_{BL,i} \times EF_{BL,i} \times IR^t$$ Equation (3)

Where:

SFC_i	=	Specific fuel consumption of baseline vehicle category *i* (g/km)
$NCV_{BL,i}$	=	Net calorific value of fossil fuel consumed by baseline vehicle category *I* (J/g)
$EF_{BL,i}$	=	Emission factor of fossil fuel consumed by baseline vehicle category *i* (g CO_2/J)
IR^t	=	Technology improvement factor for baseline vehicle in year *t.* The improvement rate is applied to each calendar year. The default value of the technology improvement factor for all baseline vehicle categories is 0.99
T	=	Year counter for the annual improvement (dependent on age of data per vehicle category)

25. The specific fuel consumption of baseline vehicle category *i* (SFC_i) shall be determined using one of the following options:

4.4.1. Option (1): Sample measurement

26. Measure the actual fuel consumption rate of a representative sample of vehicles, for each vehicle category identified for highway driving. Vehicle categories shall be determined conservatively and be based on the fuel type used, the vehicle category, engine model year, power rating, passengers/load capacity auxiliary equipment (e.g. with and without air conditioners) and other relevant factors to distinguish vehicles with different fuel consumption rates. Sample vehicles shall be randomly chosen in accordance with the latest version of the Detailed Procedure for Offset Mechanism under CCTS using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The lower bound of 95 per cent confidence interval shall be used as the Specific Fuel Consumption.

4.4.2. Option (2): Top 20 per cent of the comparable vehicles used for public/private transportation

27. The specific fuel consumption for comparable vehicles is estimated by using the specific fuel consumption for highway driving obtained from manufacturer's specification of the top 20 per cent of vehicles operated/used for public/private transportation in the project region.

4.4.3. Option (3): Using operational data of the vehicles under baseline operational conditions

28. When a specific baseline vehicle can be identified, that is a vehicle used in the same area and with similar operating conditions and this vehicle will not be replaced over the life of the project, the following options apply:

    (a) Specific fuel consumption (SFC_i) is determined from the average operational data of the vehicle(s) under baseline operating conditions, using at least one year of operational data, if that data is available, Otherwise

    (b) SFC_i should be obtained from manufacturer's specifications, if it can be demonstrated that the value is conservative given the operating conditions of the baseline vehicles (e.g. values for specific fuel consumption under standard testing conditions provided by the manufacturers). This may be the case when the project activity introduces new vehicles, and the baseline vehicle is also new and provides a similar service.

29. In project activities where baseline vehicles include non-standard vehicles such as jeepneys or tricycles, which are assembled locally, and for which manufacturers´ data is not available, the specific fuel consumption may be determined using one of the following two options:

    (a) Measure the actual fuel consumption and corresponding distance travelled of a sample of baseline vehicles operating in comparable traffic situations with a similar age or newer, a similar or smaller engine size, a similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rates. Sample vehicles shall be randomly chosen in accordance with the latest version of the “” Detailed Procedure for Offset Mechanism under CCTS using a 90 per cent confidence interval and a

10 per cent precision to determine the sample size. The lower bound of 95 per cent confidence interval shall be used as the specific fuel consumption;

(b) Use a specific fuel consumption value from peer-reviewed literature source or report authored by a nationally/internationally recognized independent third party or a research institute under the following two conditions to ensure conservative value:

(i) The specific fuel consumption value was derived from measurements taken under highway driving conditions or similar non-urban traffic conditions;

(ii) The specific fuel consumption value for baseline vehicles was derived with characteristics leading to similar or lower emissions as compared to the baseline vehicles, for example use specific fuel consumption values for vehicles of a similar age or newer, a similar or smaller engine size, a similar or lower passenger/goods load capacity, and a similar weight or lighter and other relevant factors to distinguish vehicles with different fuel consumption rate.

4.4.4. Option (4): Using data from a control group of vehicles

30. If no specific baseline vehicle can be identified or appropriate operational data is not available, then specific fuel consumption should be obtained through a statistically significant control group or existing statistics that are regularly updated. Such a control group or the source of data must shall have similar or conservative characteristics with respect to vehicle age (equal or newer), traffic conditions (equal or better), and air conditioning. The choice of such control group will be, in order of preference:

(a) Fleet of the same company operating simultaneously with the project activity;

(b) Fleet of company with similar operations operating simultaneously with the project activity.

(c) Host country statistics;

(d) IPCC or other international data.

31. Under this option specific fuel consumption is monitored throughout the project crediting period thus gradual efficiency improvements of the fleet or gradual deterioration of driving conditions would automatically be incorporated into the project efficiency levels.

4.4.5. Option (5): Existing statistics

32. If none of the above options apply due to lack of data, other public available existing statistics could be used as industry default values, such as host country statistics (released by transportation department or other authorities), IPCC or other international data.

4.5. Project Emissions

33. Project emissions include the electricity and fossil fuel consumption associated with the operation of project vehicles and shall be calculated as follows:

34. Approach 1: Using distance travelled by project vehicles

$$PE_y = \sum_i EF_{PJ,km,i,y} \times DD_{i,y} \times N_{i,y}$$ Equation (4)

Where:

PE_y	=	Total project emissions in year *y* (t CO_2)
$EF_{PJ,km,i,y}$	=	Emission factor per kilometre travelled by the project vehicle type *i* (t CO_2/km)
$N_{i,y}$	=	Number of operational project vehicles in category *i* in year *y*
$DD_{i,y}$	=	Annual average distance travelled by the project vehicle category *i* in the year *y* (km)

35. Approach 2: Using the electricity used to charge the vehicles

$$PE_y = \sum_i EF_{PJ,km,i,y} \times \frac{EC_{PJ,i,y}}{SEC_{PJ,km,i,y}}$$ Equation (5)

Where:

$EC_{PJ,i,y}$y	=	Electricity consumed by the project vehicles of type i in year y (kWh)
$SEC_{PJ,km,i,y}$	=	Specific electricity consumption by project vehicle category *i* per km in year *y* in urban conditions (kWh/km)
i		Vehicle types of project activities

36. The emission factor of the project vehicles shall be established as follows:

$$EF_{PJ,km,i,y} = \sum_i SEC_{PJ,km,i,y} \times EF_{elect,y} / (1 - TDL_y) \times 10^{-3} + \sum_i SFC_{PJ,km,i,y} \times$$ Equation (6)

Where:

$SEC_{PJ,km,i,y}$	=	Specific electricity consumption by project vehicle category *i* per km in year *y* in urban conditions (kWh/km)
$EF_{elect,y}$	=	CO_2 emission factor of electricity consumed by project vehicle category *i* in year *y* (kg CO_2/kWh)
$SFC_{PJ,km,i,y}$	=	Specific fossil fuel[2] consumption by project vehicle category *i* per km in year *y* in urban conditions (g/km*)*

2 For electric vehicle the values is 0.00.

$EF_{PJ,i}$	=	CO_2 emission factor of fossil fuel consumed by project vehicle category *i* in year *y* (g CO_2/J)
$NCV_{PJ,i}$	=	Net calorific value of the fossil fuel consumed by project vehicle category *i* in year *y* (J/g)
TDL_y	=	Average technical transmission and distribution losses for providing electricity in the year *y*

4.6. Leakage

37. No leakage calculation is required.

4.7. Emission reductions

38. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (7)}$$

Where:

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

5. Methodology: Monitoring Component

39. Relevant parameters shall be monitored and recorded during the crediting period as indicated in the section below by the non-obligated entity.

Data / Parameter table 1.

Data / Parameter:	$DD_{i,y}$
Data unit:	km
Description:	Annual average distance driven by project vehicle *i* in year *y* (km/yr)
Source of data:	Measurement

Measurement procedures (if any):	Measure the annual average distance driven by the project vehicles through: Option (A): monitoring of all vehicles or Option (B): representative sample survey of vehicles for each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the Detailed Procedure for Offset Mechanism under CCTS using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The lower bound of 95 per cent confidence interval shall be used as the annual distance travelled
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	TDL_y
Data unit:	percentage
Description:	Average technical transmission and distribution losses for providing electricity in the year *y*
Source of data:	
Measurement procedures (if any):	As per the procedures of BM-T-003
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$SEC_{PJ,km,i,y}$
Data unit:	kWh/km
Description:	Specific electricity consumption per km per project vehicle category *i* in year *y*
Source of data:	Measurement
Measurement procedures (if any):	Measure the specific electricity consumption through: Option (A): monitor electricity consumption of all project vehicles or Option (B): measure the amount of electricity consumed per km travelled for a representative sample of each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the Detailed Procedure for Offset Mechanism under CCTS using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The upper bound of 95 per cent confidence interval shall be used for the specific fuel/electricity consumed. Cross-checked against vehicle specifications (kWh/km) for urban conditions provided by the manufacturers and use the highest of the two values
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$SFC_{PJ,km,i,y}$
Data unit:	g/km
Description:	Specific fossil fuel consumption per km per project vehicle category *i* in year *y*
Source of data:	Measurement
Measurement procedures (if any):	Measure the specific fossil fuel consumption through: Option (A): monitor consumption of all project vehicles or Option (B): measure the amount of fossil fuels consumed per km travelled for a representative sample of each vehicle category. Sample vehicles shall be chosen in accordance with the latest version of the "Detailed Procedure for Offset Mechanism under CCTS using a 90 per cent confidence interval and +/- 10 per cent precision to determine the sample size. The upper bound of 95 per cent confidence interval shall be used for the specific fuel/electricity consumed. Cross-checked against vehicle specifications (g/km) for urban conditions provided by the manufacturers and use the highest of the two values
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$NCV_{BL,i}$, $NCV_{PJ,i}$
Data unit:	J/g
Description:	Net calorific value of fuel *i*
Source of data:	
Measurement procedures (if any):	Country specific data or IPCC default value
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	$EF_{BL,i}$, $EF_{PJ,i}$
Data unit:	g CO_2/J
Description:	CO_2 emission factor of fuel used by vehicles category *i*
Source of data:	
Measurement procedures (if any):	Country specific data or IPCC default value
Any comment:	-

Data / Parameter table 7.

Data / Parameter:	EF_{elect}
Data unit:	kg CO_2/kWh
Description:	CO_2 emission factor of electricity used by project vehicle
Source of data:	Measurement
Measurement procedures (if any):	As per procedures of BM-T-003
Any comment:	-

Data / Parameter table 8.

Data / Parameter:	$N_{i,y}$
Data unit:	-
Description:	Number of project vehicle in operation in year *y*
Source of data:	
Measurement procedures (if any):	Establish the number of the project vehicles in operation through: Option (A): based on annual sales records or official data on registered project vehicles cross-checked against the results from a representative sample survey vehicles to determine the percentage of vehicles in use or Option (B): based on annual sales records or official data for registered project vehicles, multiplied by the default factor 0.9^t, where *t* is year counter for the number of years since the vehicle was introduced (for example: if *n* vehicles are sold in year 1, in year 2 the number of vehicles still in operation are assumed to be equal to *n**0.9, and in year 3, $n*0.9^2$, etc.)
Any comment:	-

Data / Parameter table 9.

Data / parameter:	$EC_{PJ,i,y}$
Data unit:	kWh
Description:	Electricity consumed by the project vehicles of type *i* in year *y*
Source of data:	Electric charging records at the electricity charging station
Measurement procedures (if any):	
Any comment:	The electric charging records will be crosschecked by driver logs or invoices from electricity filling station

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Revision/Changes in the Document

Version	*Date*	*Description*
1.0	Month & Year	Section / Annexure Revision to _______________