CLEAN DEVELOPMENT MECHANISM

CDM-MP89-A01

Draft Large-scale Consolidated Methodology

ACM0002: Grid-connected electricity generation from renewable sources

Version 22.0

Sectoral scope(s): 01

DRAFT

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The recommended draft revision of “ACM0002: Grid-connected electricity generation from renewable sources” (hereinafter referred to as methodology) is based on the request for revision “AM_REV_0261: Revision to ACM0002 to include battery energy storage systems (BESS) to greenfield and existing renewable power generation power plants”.

2. Purpose

2. The purpose of this revision is to expand the scope of the methodology to cover the following project activities:

   (a) Installation of a Greenfield power plant with BESS; and

   (b) Capacity addition or retrofit to (an) existing solar photovoltaic or wind-based renewable energy generation project(s) with BESS.

3. Key issues and proposed solutions

3. The proposed revision includes:

   (a) Changes in the applicability conditions of the methodology to include installation of BESS together with the installation of a Greenfield power plant and capacity addition or a retrofit to (an) existing solar photovoltaic and wind-based renewable energy generation project(s) with BESS, and subsequent update to the identification of the baseline scenarios of the respective project activities;

   (b) A requirement for project participants to consider higher / favourable tariff while demonstrating additionality following the investment analysis;

   (c) A definition of BESS;

   (d) An approach to calculate project emissions due to use of electricity or fossil fuels to charge the BESS.

4. The draft revision of the methodology is applicable to all types of renewable energy technologies if the BESS is installed with a Greenfield power plant. However, in case of capacity addition or a retrofit to an existing renewable energy-based power plant, the methodology is only applicable to solar photovoltaic or wind-based renewable energy generation projects with BESS. This is because in the case of other renewable energy technologies it would be difficult to attribute the increased electricity generation to the installation of BESS, for example, in case of hydro or geothermal project the increased electricity generation may also be attributed to additional water resources or steam available post retrofit or capacity addition.

5. Further, the draft revision of the methodology is not applicable to concentrated solar power (CSP) projects as in that case, an apportioning approach to calculate the project emissions due to fossil fuel consumption attributed to the increased electricity generation from BESS

needs to be provided which could be a project specific issue. Therefore, the Methodologies Panel (hereinafter referred to as MP) suggested that in case a stakeholder would like to expand the scope of the methodology to cover CSP projects they should submit a request for revision to the methodology.

3.1. Comments by EB115

6. The Executive Board of the clean development mechanism (hereinafter referred to as the Board) provided the following comments at its one hundred and fifteenth meeting (EB 115) and requested the MP to further work on the draft revised methodology.

7. The Board highlighted that the description of potential scenarios under which BESS integration with the renewable energy plant is applicable is not clear. In response to this, the MP included a new paragraph (refer to paragraph 5 of the draft methodology) indicating the different potential scenarios for integration of BESS to the renewable energy projects. The MP has also included a table (refer to Table 2 of the draft methodology) to facilitate a better undertanding of various possible combinations of renewable energy technologies and the mode of BESS applicable for integration.

8. Further, the Board observed that the approach used to calculate project emissions due to use of grid electricity to charge the BESS should be a conservative one from TOOL05, to ensure conservative estimate of project emissions. The MP noted the concern from the Board and would like to highlight that the application of draft methodology (refer as per paragraph 6 (d) and paragraph 43), requires the project participant to charge the BESS using the electricity from the associatetd renewable energy plant. However, exceptionally, charging using electricity from the grid would be eligible under certain emergency conditions such as deep discharge of the battery.

9. Furthermore, the MP proposed a restriction on use of grid electricity for charging. The MP agreed to include a requirement (refer paragraph 6 (d)) that amount of grid electricity used to charge project BESS shall not be more than 2 per cent of the electricity generateted by the project renewable energy plant during a monitoring period. In cases where the project BESS consumes more than 2 per cent of the electricity for charging from grid, the project participant shall not be entitled for issuance of the certified emission reductions for the concerned monitoring period.

4. Impacts

10. This revision allows the renewable energy-based plants to store the electricity generated during low demand periods and supplying it to the grid during the time when there is a higher demand, thereby ensuring increase in the capacity factor of the renewable energy-based power plant.

5. Subsequent work and timelines

11. The draft revised methodology is recommended by the MP for consideration by the Board at its 116th meeting. No further work is envisaged.

6. Recommendations to the Board

12. The MP recommends that the Board adopt this draft revised methodology, to be made effective at the time of the Board’s approval.

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1. Introduction

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

Table 1. Methodology key elements

Typical projects	Retrofit, rehabilitation (or refurbishment), 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.
Type of GHG emissions mitigation action	Renewable energy: Displacement of electricity that would be provided to the grid by more-GHG-intensive means

2. Scope, applicability, and entry into force

2.1. Scope

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

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

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

3. Further, the methodology applies to project activities which integrate battery energy storage systems (BESS) to a Greenfield power plant or to an existing grid-connected solar photovoltaic or wind power plant.

2.2. Applicability

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

   (a) Install a Greenfield power plant;

   (b) Involve a capacity addition to (an) existing plant(s);

   (c) Involve a retrofit of (an) existing operating plants/units;

   (d) Involve a rehabilitation of (an) existing plant(s)/unit(s); or

   (e) Involve a replacement of (an) existing plant(s)/unit(s).

5. In case of BESS integration with the renewable energy power generation project activities following scenarios are applicable under this methodology:

   (a) Integrate BESS with a Greenfield power plant;

(b) Integrate a BESS together with capacity addition to (an) existing solar photovoltaic[1] or wind power plant(s)[2];

(c) Integrate a BESS to (an) existing solar photovoltaic or wind power plant(s)[3];

(d) Integrate a BESS together with retrofit of (an) existing solar photovoltaic[2] or wind power plant(s).

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

Renewable Energy Technology / Mode of installation of BESS	Solar Photovoltaic or Wind	Other Renewable technologies
Integrate BESS with a Greenfield power plant	Eligible	Eligbile
Integrate BESS with an existing plant(s)	Eligible	Not eligible
Integrate BESS with capacity addition to an existing plant(s)	Eligible	Not eligible

6. The methodology is applicable under the following conditions:

(a) The project activity may include renewable energy power plant/unit of one of the following types: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar 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, solar, wave or tidal power capacity addition projects) the existing plant/unit started commercial operation prior to the start of a minimum historical reference period of five years, used for the calculation of baseline emissions and defined in the baseline emission section, and 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) For project activity scenario under paragraph 5 (a) above, the integration of the BESS should have been conceptualised as a part of the renewable energy generation plant/unit;

(d) The BESS should be charged with electricity generated from the associated renewable energy power plant. However, in emergency cases[4], the BESS may be charged with electricity from the grid or using fossil fuel electricity generator. In such cases, the corresponding GHG emissions shall be accounted as project

[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 BESS.

[2] Wherein BESS and capacity addition are implemented together.

[3] Wherein BESS is implemented as a capacity addition activity.

[4] For example, in cases of the start of the project activity on day 1 or upon deep discharge of the battery.

emissions. 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. In cases, where the project BESS consumes more than 2 per cent of the electricity for charging the project participant shall not be entitled for issuance of the certified emission reductions for the concerned monitoring period.

7. In case of hydro power plants, one of the following conditions shall apply:[5]

(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, 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 shall be:

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.

8. In the case of integrated hydro power projects, project ~~proponent~~ 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 CDM 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

[5] Project participants wishing to undertake a hydroelectric project activity that results in a new reservoir or an increase in the volume of an existing reservoir, in particular where reservoirs have no significant vegetative biomass in the catchments area, may request a revision to the approved consolidated methodology.

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 CDM project activity.

9. 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.

10. 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”.

11. In addition, the applicability conditions included in the tools referred to below apply.[6]

2.3. Entry into force

12. The date of entry into force is the date of the publication of the EB XX meeting report on DD Month YYYY.

2.4. Applicability of sectoral scopes

13. For validation and verification of CDM projects and programme of activities by a designated operational entity (DOE) using this methodology, application of sectoral scope 01 is mandatory.

3. Normative references

14. This consolidated baseline and monitoring methodology is based on elements from the following proposed new methodologies:

   (a) “NM0001-rev: Vale do Rosario Bagasse Cogeneration (VRBC)” project in Brazil whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Econergy International Corporation;

   (b) “NM0012-rev: Wigton Wind Farm” project in Jamaica whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Ecosecurities Ltd;

   (c) “NM0023: El Gallo Hydroelectric” project, Mexico whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Prototype Carbon Fund (approved by the CDM Executive Board on 14 April 2004);

[6] The condition in TOOL02 that all potential alternative scenarios to the proposed project activity must be available options to project participants; does not apply to this methodology, as this methodology only refers to some steps of this tool.

(d) “NM0024-rev: Colombia: Jepirachi Windpower” project whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Prototype Carbon Fund;

(e) “NM0030-rev: Haidergarh Bagasse Based Co-generation Power” project in India whose Baseline study, Monitoring and Verification Plan and Project Design Document was submitted by Haidergarh Chini Mills, a unit of Balrampur Chini Mills Limited;

(f) “NM0036: Zafarana Wind Power Plant” project in the Arab Republic of Egypt whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Mitsubishi Securities;

(g) “NM0043: Bayano Hydroelectric Expansion and Upgrade” project in Panama whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by Econergy International Corporation;

(h) “NM0055: Darajat Unit III Geothermal” project in Indonesia whose Baseline study, Monitoring and Verification Plan and Project Design Document were prepared by URS Corporation and Amoseas Indonesia Inc.

15. This methodology also refers to the latest approved versions of the following tools:[7]

(a) “TOOL01: Tool for the demonstration and assessment of additionality” (hereinafter referred to as TOOL01);

(b) “TOOL02: Combined tool to identify the baseline scenario and demonstrate additionality” (hereinafter referred to as TOOL02);

(c) “TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion” (hereinafter referred to as TOOL03);

(d) “TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation” (hereinafter referred to as TOOL05);

(e) “TOOL07: Tool to calculate the emission factor for an electricity system” (hereinafter referred to as TOOL07);

(f) “TOOL10: Tool to determine the remaining lifetime of equipment” (hereinafter referred to as TOOL07);

(g) “TOOL11: Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period” (hereinafter referred to as TOOL011);

(h) “TOOL32: Positive lists of technologies” (hereinafter referred to as TOOL32);

16. For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

[7] Available on the UNFCCC CDM website.

3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

17. "Existing actual or historical emissions, as applicable"; or

18. "Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

4. Definitions

19. The definitions contained in the Glossary of CDM terms shall apply.

20. 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 or 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)** – an electrochemical device which typically includes a battery system, a battery management system, an inverter or power conversion system, and an energy management system; whose purpose is to store electricity from an external electricity source such as electricity from a renewable energy power generation plant;

(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;

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

(k) **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;

(l) **Rehabilitation (or refurbishment)** - 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 or refurbishment 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;

(m) **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;

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

(o) **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.

21. In addition, the definitions in ~~latest approved version of~~ TOOL07 apply.

5. Baseline methodology

5.1. Project boundary

22. The spatial extent of the project boundary includes the project power plant/unit and all power plants/units connected physically to the electricity system[8] that the CDM project power plant is connected to.

23. The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table 2.

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
	CO_2 emissions from incremental electricity supply to the grid due to BESS installation to an existing solar photovoltaic or wind power plant	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

[8] Refer to ~~the latest approved version of~~ TOOL07 for definition of an electricity system.

Source		Gas	Included	Justification/explanation
	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

5.2. Identification of the baseline scenario

5.2.1. Baseline scenario for Greenfield power plant (paragraph 4(a) or 5(a))

24. If the project activity is the installation of a Greenfield power plant with or without BESS, 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, as reflected in the combined margin (CM) calculations described in TOOL07.

5.2.2. Baseline scenario for capacity addition to an existing (i) renewable energy power plant (paragraphs 4(b) or (ii) solar photovoltaic or wind power plant/unit (paragraph 5(b) or 5(c))

25. If the project activity is a capacity addition with or without BESS to an existing grid-connected renewable energy power plant/unit, 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, as reflected in the combined margin (CM) calculations described in TOOL07. 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.

5.2.3. Baseline scenario for retrofit or rehabilitation or replacement of an existing power plant (paragraph 4(c) or 4(d) or 4(e))

26. The following step-wise procedure to identify the baseline scenario shall be applied:

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

27. Apply Step 1 of TOOL02. The options considered should include:

(a) P1: The project activity not implemented as a CDM 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.

5.2.3.2. Step 2: Barrier analysis

28. Apply Step 2 of TOOL02.

5.2.3.3. Step 3: Investment analysis

29. If this option is used, apply the following:

(a) Apply an investment comparison analysis, as per Step 3 of TOOL02, 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 Step 2b of TOOL01, if more than one alternative is remaining after Step 2 and if the remaining alternatives include scenarios P1 and P2.

5.2.4. Baseline scenario for retrofit of an existing solar photovoltaic or wind power plant/unit (paragraph 5(d))

30. In this case, the project activity covers installation of a BESS to an existing power plant(s)/unit(s). This provides the possibility of shifting electricity supply to the grid using the same existing power generation capacity to periods in which the electricity can be transmitted and utilized immediately (i.e., avoiding oversupply conditions). This allows for a higher power plant load factor over the year, enabling more electricity supply to the grid from such renewable power plant as compared to the situation prior to the installation of BESS potentially displacing electricity generation based on fossil fuels. It is expected that this only applies to solar photovoltaic or wind power plants whose electricity generation is intermittent. 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.

5.3. Additionality

5.3.1. Simplified procedure to demonstrate additionality

31. For the simplified procedure to demonstrate additionality the project ~~proponent~~ participant shall refer to the methodological tool TOOL32.

5.3.2. Procedure to demonstrate additionality based on the TOOL01

32. The additionality of the project activity shall be demonstrated and assessed using the ~~latest version of the~~ TOOL01.

33. In case of integrated hydro power project, the following shall be considered for the purpose of investment analysis:

(a) Investment associated with the CDM project activity i.e. construction of a new reservoir and new power plants/units; and

(b) Revenue due to net electricity generation ($EG_{PJ,y}$) as determined using equation (~~10~~12).

34. In case of installation of Greenfield power plant or retrofit to an existing solar photovoltaic or wind power plant with BESS, where the project participants have the flexibility of generation and charging the BESS during off-peak period and generation or sale of power to the grid during peak period, thereby getting a favourable tariff, such favourable tariff shall be used in the investment analysis for demonstration of economic attractiveness of the project activity by e.g. applying a higher tariff to the amount of electricity supplied to the grid during peak time. In the absence of such estimation, the project participants shall demonstrate the load, generation and consumption pattern and justify as to why that is not the case for the project activity.

5.4. Project emissions

35. 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:

$$PE_y = PE_{FF,y} + PE_{GP,y} + PE_{HP,y} + PE_{BESS,y}$$ 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 in year *y* ($t\ CO_2e/yr$)
$PE_{BESS,y}$		Project emissions from charging of BESS using electricity from the grid or from fossil fuel electricity generators ($t\ CO_2e/yr$).

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

36. 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 ($PE_{FF,y}$).

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

38. $PE_{FF,y}$ shall be calculated as per ~~the latest version of~~ TOOL03.

5.4.2. Emissions from the operation of dry steam, flash steam[9] and binary[10] geothermal power plants due to non-condensable gases and/or working fluid ($PE_{GP,y}$)

39. For dry or flash steam geothermal project activities, project participants shall account emissions of CO_2 and CH_4 due to release of non-condensable gases from produced steam.[11] Non-condensable gases in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarbons, including 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.

40. $PE_{GP,y}$ 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)

[9] 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.

[10] 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.

[11] 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 ~~proponents~~ participants are welcome to propose revisions to this methodology to account for these baseline emissions.

$w_{steam,CH4,y}$	=	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 valid for the relevant commitment period (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:

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

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)

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

Where:

$M_{inflow,y}$	=	Quantity of steam entering the geothermal plant in year *y* (t steam/yr)
$M_{outflow,y}$	=	Quantity of steam leaving the geothermal plant in year *y* (t steam/yr)
$w_{steam,CO2,y}$	=	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 valid for the relevant commitment period (t CO2e/t CH_4)

$$PE_{working\ fluid,y} = M_{working\ fluid,y} \times GWP_{working\ fluid}$$ 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

5.4.3. Emissions from water reservoirs of hydro power plants ($PE_{HP,y}$)

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

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

Where:

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

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

(a) For integrated hydro power project 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
j	=	Individual reservoirs included in integrated hydro power project

(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 (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)

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

43. Under normal conditions, BESS should be charged with the electric power generated by the associated renewable power plant. Exceptionally, the BESS may be charged using grid electricity or electricity from fossil fuel generators. In cases where BESS is charged using grid electricity, the corresponding project emissions ($PE_{BESS,y}$) shall be calculated according to the procedures described in TOOL05. In cases where electricity from fossil fuel generators is used to charge the BESS the corresponding project emissions ($PE_{BESS,y}$) should be calculated according to the procedure described in TOOL03.

5.5. Baseline emissions

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

$$BE_y = EG_{PJ,y} \times EF_{grid,CM,y}$$ 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 fed into the grid as a result of the implementation of the CDM project activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* calculated using ~~the latest version of~~ TOOL07 (t CO_2/MWh)

5.5.1. Calculation of quantity of net electricity generation ~~$EG_{PJ,y}$~~

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

5.5.1.1. Greenfield power plants (paragraph 4(a) or 5(a))

46. If the project activity is the installation of a Greenfield power plant with or without BESS, then:

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

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM 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)

5.5.1.2. Capacity addition to (i) wind, solar, wave or tidal plant (paragraphs 4(b)) or (ii) solar photovoltaic or wind power plant (paragraph 5(b) or 5(c))

47. In the case of wind, solar, wave or tidal power plants/units or solar, or wind power plants/units with BESS, it is assumed that the addition of new capacity does not significantly affect the electricity generated by existing plants/units.[12] In this case, the electricity fed into the grid by the added power plants/units shall be directly metered and used to determine $EG_{PJ,y}$.

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

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM 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)

5.5.1.3. Capacity addition to hydro or geothermal power plant (paragraphs 4(b))

48. In the case of hydro or geothermal power plants/units, the addition of new power plants/units 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 for hydro power plants and geothermal power plants. $EG_{facility,y}$ 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.

5.5.1.4. Retrofit or rehabilitation or replacement of an existing renewable energy power plant (paragraphs 4(c) or 4(d) or 4(e)) or retrofit of an existing solar or wind power plant/unit (paragraph 5 (d))

49. If the project activity is the retrofit or rehabilitation or replacement of an existing grid-connected renewable energy power plant, or retrofit of an existing solar or wind power plant/unit with BESS, 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.

50. The power generation from renewable energy power projects 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

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

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.[13]

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

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

and

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

Where:

$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the CDM 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

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

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

53. To determine $EG_{historical}$, project participants may choose between two historical periods. This allows some flexibility: 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.

[13] 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.

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

(a) The five last 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.

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

5.5.2. Calculation of $DATE_{BaselineRetrofit}$

56. 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 type equipment, which shall be determined and documented as per TOOL10.

57. 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.

5.6. Leakage

58. 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.

5.7. Emission reductions

59. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (17)}$$

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)

5.7.1. Estimation of emissions reductions prior to validation

60. Project participants shall prepare as part of the CDM-PDD an estimate of likely emission reductions from the proposed project activity during the crediting period. This estimate should, in principle, employ the same methodology as selected above. Where the grid

emission factor ($EF_{CM,grid,y}$) is determined ex post during monitoring, project participants may use models or other tools to estimate the emission reductions prior to validation.

5.8. Changes required for methodology implementation in 2nd and 3rd crediting periods

61. Project participants shall refer to TOOL11.

5.9. Project activity under a programme of activities

62. In addition to the requirements set out in the CDM Project Standard for programme of activities regarding applicatiton of multiple methodologies ~~latest approved version of the "Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programme of activities"~~, the following shall be applied for the use of this methodology in a project activity under a programme of activities (PoAs).

63. The PoA may consist of one or several types of CPAs. CPAs are regarded to be of the same type if they are similar with regard to the demonstration of additionality, emission reduction calculations and monitoring. The coordinating/managing entity (CME) shall describe in the CDM-PoA-DD for each type of CPAs separately.

64. Eligibility criteria for CPA inclusion used for each type of CPAs. In case of combinations of renewable technologies in one CPA, the eligibility criteria shall be defined for each technology separately;

(a) Emission reduction calculations for each type of CPAs;

(b) Monitoring provisions for each type of CPAs.

65. The CME shall describe transparently and justify in the CDM-PoA-DD which CPAs are regarded to be of the same type. CPAs shall not be regarded to be of the same type if one of the following conditions is different:

(a) The project activity with regard to any of the following aspects:

(i) Renewable energy power generation technology;

a. Hydro-power plant/unit;

i. Hydropower plant/unit with reservoir;

ii. Hydropower plant/unit without reservoir;

b. Wind power plant/unit;

c. Geothermal power plant/unit;

d. Solar power plant/unit;

i. Photovoltaic;

ii. Heat concentration;

e. Wave power plant/unit;

f. Tidal power plant/unit;

g. Combination of any of the above;

(ii) Project activity type:

a. Greenfield;

b. Capacity addition;

c. Retrofit of existing operating plant/unit;

d. Rehabilitation of existing plant/unit;

e. Replacement of existing plant/unit;

(b) The legal and regulatory framework;

(i) Legal regulations;

(ii) Promotional policies.

66. When defining eligibility criteria for CPA inclusion for a distinct type of CPAs, the CME shall consider relevant technical and economic parameters, such as:

(a) Technical and economic parameters that are technology specific (e.g. ranges of load factors, sizes of installation, wind speed);

(b) Parameters reflecting the investment climate:

(i) Subsidies or other financial flows;

(ii) Tariffs;

(iii) Depreciation;

(iv) Power purchase agreements;

(v) Other parameters determining market circumstances;

(c) Ranges of costs (capital investment, operating and maintenance costs, etc.) and revenues (income from electricity sale, subsidies/fiscal incentives, official development assistance (ODA)).

67. When ~~Option (ii) in the latest approved version of the "Standard for demonstration of additionality, development of eligibility criteria and application of multiple methodologies for programmes of activities" is applied, that is related to~~ defining technical and economic criteria as ranges of values for each input parameter required for the inclusion of the CPA in the PoA-DD, the eligibility criteria related to costs, revenues and investment climate shall be updated every two years in order to correctly reflect the technical and market circumstances of a CPA implementation.

5.10. Data and parameters not monitored

68. 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:	***GWP_{CH4}***
Data unit:	t CO_2e/t CH_4
Description:	Global warming potential of methane valid for the relevant commitment period
Source of data:	IPCC
Value to be applied:	For the first commitment period: 21 t CO_2e/t CH_4 For the second commitment period: 25 t CO_2e/t CH_4
Any comment:	–

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:	**The percentage share of total installed capacity of the specific technology**
Data unit:	%
Description:	The percentage share of total installed capacity of the specific technology in the total installed grid connected power generation capacity in the host country
Source of data:	National statistics or other official data
Value to be applied:	–
Any comment:	–

Data / Parameter table 10.

Data / Parameter:	**The total installed capacity of the technology**
Data unit:	%
Description:	the total installed capacity of the technology in the host country
Source of data:	National statistics or other official data
Value to be applied:	–
Any comment:	–

Data / Parameter table 11.

Data / Parameter:	$GWP_{working\ fluid}$
Data unit:	–
Description:	Global Warming Potential of the Working Fluid
Source of data:	IPCC 2006
Value to be applied:	–
Any comment:	–

6. Monitoring methodology

69. 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.

70. In addition, the monitoring provisions in the tools referred to in this methodology apply. Accordingly, $EG_{facility,y}$, ~~and~~ $EG_{PJ\_Add,y}$ and $EG_{BESS,y}$ should be determined as per TOOL05, and $EF_{grid,CM,y}$ and $PE_{FF,y}$ should be determined as per TOOL07 and TOOL03 respectively. When applying the tool, requirement for the $EG_{PJ,grid,y}$ should apply to parameters $EG_{facility,y}$ and $EG_{PJ\_Add,y}$.

6.1. Data and parameters monitored

Data / Parameter table 12.

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 13.

Data / Parameter:	$w_{steam,CH4,y}$
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 $w_{steam,CO2,y}$
Monitoring frequency:	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 14.

Data / Parameter:	$M_{steam,y}$
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 15.

Data / Parameter:	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:	–
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 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. 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 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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Document information

Version	*Date*	*Description*
22.0	11 October 2022	MP 89, Annex 1 To be considered by the Board at EB 116. This version addresses the comments received from the Board at EB 115 meeting (EB115 meeting report, para.37).
21.0	13 July 2022	MP 88, Annex 4 To be considered by the Board at EB 115. Revision to include battery energy storage system to greenfield and capacity addition or retrofit of existing renewable energy power generation plants.
20.0	28 November 2019	EB 105, Annex 3 Revision to remove the positive list and introduce reference to TOOL32 (as the positive list was moved to TOOL32).
19.0	31 August 2018	EB 100, Annex 6 Revision to extend the validity of the positive list.
18.1	23 May 2018	Editorial revision to correct cross-reference of equation numbers in paragraph 41 (b).
18.0	26 April 2018	EB 99, Annex 1 Revision to extend the validity of the positive list.
17.0	13 May 2016	EB 89, Annex 1 Revision to include the provision for geothermal technologies with binary or closed loop heat exchange systems.
16.0	20 November 2014	EB 81, Annex 9

Version	*Date*	*Description*
		Revision to standardize the requirements on additionality in the methodology by including a positive list of technologies.
15.0	1 June 2014	EB 79, Annex 11 Revision to: • Expand the applicability of the methodology to cover projects involving construction of a new reservoir together with new power plant(s)/unit(s) for increased power generation in integrated hydro power projects; • Include the definition of “rehabilitation” and the procedure to calculate baseline emissions for rehabilitated plants; • Clarify how to account for project emissions due to the operation of a fossil-fuel-based backup generator; • Clarify monitoring requirements for reservoir area and installed capacity in case of hydro power plants and mass fraction of CO_2 and CH_4 in steam in geothermal plants; Include a reference to the methodological tools TOOL11 and TOOL10.
14.0	4 October 2013	EB 75, Annex 13 Revision to: • Remove requirements for specific case CPA-DDs and frequency of updating of eligibility criteria as these requirements are specified in the relevant standards Change the title from “ACM0002: Consolidated baseline methodology for grid-connected electricity generation from renewable sources” to “ACM0002: Grid-connected electricity generation from renewable sources”.
13.0.0	11 May 2012	EB 67, Annex 13 Revision to: • Provide more clarity on how the quantity of net electricity generation supplied by the project plant/unit to the grid shall be monitored; Introduce provisions for the use of this methodology in a project activity under a PoA.
12.2.0	25 November 2011	EB 65, Annex 16 The amendment incorporates applicability conditions on how the methodology shall be applied in cases where the project activity includes hydropower plant(s) with multiple reservoirs.
12.1.0	26 November 2010	EB 58, Annex 7 The revision includes a definition for reservoir.
12.0.0	17 September 2010	EB 56, Annex 5 The revision includes a definition for existing reservoir.
11	12 February 2010	EB 52, Annex 7

Version	*Date*	*Description*
		The revision clarifies the applicability condition requesting availability of five years of historical data for capacity addition, retrofit and rehabilitation projects is not required for wind, solar, wave or tidal power capacity addition projects which directly meter the electricity generated by the added capacities.
10	28 May 2009	EB 47, Annex 7 The revision expands the applicability of the methodology to project activities that retrofit or replace renewable energy power generation units, to restore the installed power generation capacity to or above its original level. This revision includes the required provisions in the (i) definitions, (ii) baseline identification, and (iii) baseline emissions sections, in order to allow these types of project activities, as well as (iv) editorial changes in order to improve the overall clarity of the approved methodology.
09	13 February 2009	EB 45, Annex 10 Inclusion of project emissions for operation of solar power plant and backup power generation of all the renewable energy plants.
08	28 November 2008	EB 44, Annex 12 Incorporate changes in equation 9 of baseline emissions to account for the cases where the expansion of existing capacity of plant takes place as an additional energy generation unit is installed under CDM project activity.
07	30 November 2007	EB 36, Annex 11 • General editorial revision of the methodology to put it in the new format; • Inclusion of the TOOL07; • Inclusion of the TOOL03; • Inclusion of the definitions for power plant/unit, installed power generation capacity, electricity capacity addition, modification and retrofit, net electricity generation and grid/project electricity system; Editorial revisions of the applicability conditions to clarify: (a) That the methodology is applicable only to electricity capacity additions; (b) The requirements for hydro power plants in terms of reservoir and power density; (c) The minimum vintage of baseline data that has to be available; (d) That the methodology is not applicable to biomass power plants and to hydro power plants with power density less than 4W/m^2; • Inclusion of an equation to calculate the power density of hydro power plants;

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		Deletion of the parameters related to emissions associated with well testing in case of geothermal power plants, as those parameters were not necessary in the methodology.
06	12 May 2006	EB 24, Annex 7 • Revision of the applicability conditions to include hydro power plants with new reservoirs that have power density greater than 4 W/m^2 and inclusion of the equation to calculate the emissions from the reservoir in the emissions reductions section; • Revision of the baseline section to allow ex-ante calculation of the simple OM, simple-adjusted OM and average OM emission factors; • Inclusion of the clarification that 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; Inclusion of guidance and clarifications on the selection of alternative weights for the calculation of the combined margin.
05	24 February 2006	EB 23, Annex 9 Inclusion of guidances in the baseline section stating that power plant capacity additions registered as CDM project activities should be excluded from the calculation of emission factors and that if 20 per cent falls on partial capacity of a plant in the determination of the group of power plants used for the calculation of the build margin, that plant should be fully included in the calculation.
04	25 November 2005	EB 22, Annex 6 Inclusion of a procedure in the project boundary section on how to deal with cases where the application of the methodology does not result in a clear grid boundary.
03	30 September 2005	EB 21, Annex 8 Revision of the baseline section in order to include project activities that modify or retrofit an existing electricity generation facility and the corresponding procedure to determine the baseline scenario in this case ($EG_{baseline}$).
02	03 December 2004	EB 17, Meeting Report Inclusion of the following paragraph in the Baseline section as per request by the Board: “Which of the plausible alternatives scenarios, as listed in step 1 of the additionality text, is the most likely baseline scenario? Please provide thorough explanation to justify your choice, based on the factors (investment or other barriers) described in the additionality methodology. This methodology is applicable only if the most likely baseline scenario is electricity production from other sources feeding into the grid”.
01	03 September 2004	EB 15, Annex 2

Version	*Date*	*Description*
		Initial adoption.

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