ARTICLE 6.4 MECHANISM

A6.4-SB004-AA-A10-APPENDIX 1

Draft Methodology

Grid-connected electricity generation from renewable sources

Version 01.0

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1. Introduction

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

Table 1. Methodology key elements

Typical activity(ies)	Construction and operation of a new power plant/unit that uses renewable energy sources and supplies electricity to the grid
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 mechanism activities that include construction and operation of a greenfield power plant.

2.2. Applicability

Annex 4 to the SB03 meeting report i.e. “Information Note: Status of current work on the application of the requirements referred to in chapter V B (Methodologies) of the rules, modalities and procedure” (hereafter referred to as Requirements), captured the status of the work undertaken by the Supervisory Body related to the request of the CMA in decision 3/CMA.3, paragraph 6(d), to develop recommendations on the application of the requirements referred to in chapter V B (Methodologies) of the rules, modalities and procedures while stating it is not final, may not reflect all the views expressed and forms a basis for further work on this matter by the Supervisory Body. ‘Draft requirements’ in annex 4 above are included below:

Encouraging ambition over time

12. Paragraph 33 of the RMP states that ‘Mechanism methodologies shall encourage ambition over time’.

13. This requirement shall be implemented through the application of approaches to be elaborated in accordance with further guidance and procedures to be developed by the Supervisory Body, which are relevant and applicable to the implementation of other elements of para 33 of the RMP.

14. These approaches shall include approaches based on:

(a) increasing the stringency of the baselines over time.

(b) the implementation of replicable and scalable mitigation activities.

15. Developing Baseline Contraction Factors (BCFs) to periodically adjust the baseline downwards, is one way of implementing more stringent baselines over time. BCFs could be developed by the Supervisory Body at the request of the host Party or could be developed by host Party and approved by the Supervisory Body. A procedure [will][could] be established to guide the development of BCFs including the process for consultation with the host Parties.

16. Approaches to include progressively more efficient and less GHG intensive technologies in programmes, or activities which expand the user base of project technologies or greater penetration among potential end users, or expansion of geographical sectoral coverage, are potential ways of supporting replicability and scalability of mitigation activities.

> *17. The Supervisory Body shall develop further guidance on the applicability and/or procedures on the implementation of these approaches.*
>
> ***Contribution to equitable sharing of mitigation benefits***
>
> *34. Paragraph 33 of the RMP states that the 'Mechanism methodologies shall contribute to the equitable sharing of mitigation benefits between the participating Parties'.*
>
> *35. Mechanism methodologies may specify application of [an approach based on increasing the stringency of the baselines over time under paragraph 14 (a)] [approaches identified under paragraphs 14 to 17] so as to ensure that activity will contribute to equitable sharing of mitigation benefits.*
>
> *36. Mechanism methodologies shall require the activity participants to describe the measures taken to contribute to the delivery of mitigation benefits to the participating Parties in the project design documents.*
>
> *37. This requirement may also be operationalized through the DNAs, acknowledging that it is their full right to demand an equitable share of benefits as a pre-condition for the approval of activity(ies) and/or authorization of A6.4ERs to achieve their NDCs. Activity participants shall follow any guidance from the DNAs in this regard.*
>
> ***Alignment with the long-term temperature goals of the Paris Agreement***
>
> *41. Paragraph 33 of the RMP states that 'Mechanism methodologies shall align with the long-term temperature goal of the Paris Agreement.'*
>
> *42. Mechanism methodologies shall require demonstration that the activity is aligned with long-term temperature goals of the Paris Agreement.*
>
> *43. Mechanism methodologies may require the application of 'approaches' identified under paragraph 14 to 17 so as to ensure that activity aligns with the long-term temperature goal of the Paris Agreement.*
>
> *44. The Supervisory Body will develop further guidance on how this requirement will be demonstrated.*

3. Application of this methodology shall:

    (a) Encourage ambition over time;

    (b) Contribute to the equitable sharing of mitigation benefits between the participating Parties'; and

    (c) Require that activity aligns with the long-term temperature goal of the Paris Agreement.

4. The requirement in paragraph 3 above shall be met using approaches based on:

    (a) Increasing the stringency of the baselines over time;

    (b) The implementation of replicable and scalable mitigation activities.

5. With regard to paragraph 4(b) above, implementation of replicable and scalable mitigation activities should be demonstrated by referring to:

    (a) Plans for progressive deployment of more efficient and less GHG intensive technologies in programmes or activities, or

    (b) Activities that expand the user base of activity technologies or increase penetration of the activity technologies among potential end users over time, or

(c) Expansion of geographical sectoral coverage.

6. The methodology includes an option to apply Baseline Contraction Factors (BCFs) to periodically adjust the baseline downwards to implement more stringent baselines over time[1]. If the host Party has provided BCFs, those BCFs shall be applied when choosing this option. If the host Party has not provided BCFs and the Supervisory Body has published applicable values of BCFs, the BCFs published by the Supervisory Body shall be applied by the activity participant when using this option.

7. The activity participants shall describe in the activity design document the measures taken to contribute to the delivery of mitigation benefits to the participating Parties. In this regard the activity participant shall follow any guidance from the designated national authorities (DNA) of the host Party(ies).

Rationale for changes

There was support at SB03 for grouping some elements of RMP requirements when providing options for meeting those requirements. Paragraph 3 lists three such requirements from the RMP and paragraph 4 provides two broad options to meet those requirements. Paragraph 5 details the options for showing ‘replicable and scalable activities. Paragraph 6 elaborates the process for increasing baseline stringency over time. Irrespective of the provisions in paragraphs 4 to 6, the baseline approaches under this methodology result in more accurate and conservative estimation of emission reductions as compared to methods now prevalent (e.g. as applied under the clean development mechanism (CDM)). For example:

- The approach under CDM allowed estimation of grid emission factors ex ante and leaving it fixed through the crediting period. This methodology requires ex-post update of emission factors periodically in all cases.
- As indicated in nationally determined contributions (NDCs) and national communications, many countries are setting targets and making rapid progress deploying renewables leading to decarbonization of electricity grids. Therefore, higher weight to recently built or prospective plants will lead to more conservative and accurate estimates of grid emission factors. In estimating emissions this methodology gives weight to recently built and prospective plants over other plants that typically cater to grid baseload and are run on fossil fuels.
- CDM approaches allowed exclusion of CDM registered renewable energy plants/units from the calculation of grid emission factors (e.g. in the calculation of build margin). This methodology requires that all plants on the grid including renewable energy plants that were registered under carbon market mechanisms be considered in calculations of grid emission factor.
- In rare cases where the operating margin (OM) value is less than the build margin (BM) value, the OM value is considered as combined margin (CM) emission factor of that particular grid.

“Tool to calculate the emission factor for an electricity system” includes further details regarding calculation of grid emission factor including weights of OM and BM.

[1] Activity participants may propose alternative approaches for consideration by the Supervisory Body.

Draft Requirements

Being real, transparent, conservative, credible

20. Paragraph 33 of the RMP states that the 'Mechanism methodologies shall be real, transparent, conservative, credible'.

21. Mechanism methodologies shall ensure that the results of Article 6.4 activities developed using them, represent actual tonnes of greenhouse gas emissions reduced or removed and shall provide credible methods for estimating emission reductions. Such estimation should be based on up-to-date scientific information and reliable data gathered through robust monitoring methods, excluding extraneous cofactors affecting emission reductions.

22. Mechanism methodologies shall require transparent descriptions of the source of the data used, and disclosure of data sources unless they are confidential, the assumptions made, the references used and the underlying steps deriving the estimates of the results of Article 6.4 activities, where necessary, including equations.

23. Mechanism methodologies shall result in conservative emission reduction estimates, from the measures applied or the options chosen, or assumptions made and shall not overestimate the emission reductions from Article 6.4 activities. Where relevant, the mechanism methodologies shall require the accounting of uncertainty associated with modelled and surveyed data.

8. The emission reductions achieved using this methodology shall be real, transparent, conservative and credible representing actual tonnes of greenhouse gas emissions (GHG) reduced. This requirement shall be met by:

(a) Basing the estimation of emission reductions on up-to-date scientific information that is clearly and consistently referenced using a standard citation method;

(b) Including transparent descriptions of the source of the data used, the assumptions made;

(c) Including all the underlying steps followed in deriving the estimates of the results, where necessary, including equations; and

(d) Ensuring emission reductions are not overestimated, for instance, where applicable, by requiring the accounting of uncertainty associated with modelled and surveyed data.

Rationale for changes

The above paragraphs are self-explanatory.

Draft Requirements

Contributing to the equitable share of mitigation benefits between participating Parties

38. Paragraph 33 of the RMP states that 'mechanism methodologies shall, in respect of each participating Party, contribute to reducing emission levels in the host Party, and align with its NDC, if applicable, its long-term low GHG emission development strategy, if it has submitted one and the long-term goals of the Paris Agreement'

39. Mechanism methodologies shall require demonstration that the activity aligns with the latest NDC of the host Party (if applicable) or [encourages] [enables] increasing ambition in the NDCs, and aligns with the LT-LEDs (if it has submitted one) [and the long-term goals of the Paris Agreement].

40. The Supervisory Body will develop further guidance on how this requirement will be demonstrated.

9. Activity participants shall demonstrate, to each participating Party, that the activity contributes to reducing emission levels in the host Party, and align with the host Party's NDC, the host Party's long-term low GHG emission development strategy, if it has submitted one and the long-term goals of the Paris Agreement. In this regard, the host Party's communications, including in relation to participation requirements under the Article 6.4 Mechanism may be referenced.

Rationale for changes

The above paragraphs are self-explanatory.

10. This methodology is applicable to construction and operation of grid-connected greenfield renewable energy power generation activities.[2]

11. The methodology is applicable to the mechanism activity that may include one of the following types of renewable energy power plant/unit: 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.

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

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

(b) The mechanism 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 mechanism 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 mechanism activity is an integrated hydro power plant 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:

[2] Capacity addition, retrofit, and integration of battery energy storage will be included in a future revision of this methodology. Activity participants are encouraged to make a submission in this regard.

(i) The power density calculated using the total installed capacity of the integrated hydro power plant, 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 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 hydropower plant.

13. In the case of integrated hydro power plants, activity 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 plant; 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 the mechanism 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 mechanism activity.

14. The methodology is not applicable to:

(a) Mechanism activities that involve switching from fossil fuels to renewable energy sources at the site of the activity, since the baseline may be the continued use of fossil fuels at the site subject to requirements of identification of baseline scenario as detailed under section 4.2; and

(b) Biomass fired power plants/units.

3. Definitions

15. 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 grid failure or tripping of generator units, to meet electricity demand of the equipment at power plants/units site during emergency;

(b) **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;

(c) **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;

(d) **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 activity;

(e) **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;

(f) **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 activity;

(g) **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;

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

(i) **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;

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

16. In addition, the definitions in the “Tool to calculate the emission factor for an electricity system” (hereinafter referred to as grid tool) apply.

4. Baseline methodology

4.1. Activity boundary

17. The spatial extent of the activity boundary includes the activity power plant/unit and all power plants/units connected physically to the electricity system that the mechanism activity power plant is connected to.

18. The GHGs and emission sources included in or excluded from the activity boundary are shown in Table 2.

Table 2. Emission sources included in or excluded from the activity 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 mechanism activity	CO_2	Yes	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
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

4.2. Identification of the baseline scenario and baseline-as-usual scenario

Draft Requirements

Being below business as usual

24. Paragraph 33 of the RMP states that the 'Mechanism methodologies shall be below 'business as usual''.

25. Mechanism methodologies shall require that the baseline selected following the approach described under section 2.15 shall be demonstrated as being below business-as-usual (BAU). For that purpose, the mechanism methodology shall require the identification of the BAU scenario(s) and provide an approach for the calculation of BAU emissions.

4.2.1. Business-as-usual scenario

19. This methodology requires that the activity participant identify below business-as-usual (BAU) scenario(s) from one of the baseline scenarios described in paragraph 22 below and provide an approach for the calculation of BAU emissions and achieve emission reductions that are below BAU.

20. The grid emission factor estimated according to the method described for operating margin (OM) in the grid tool may be used to estimate the BAU emissions.

Rationale for changes

The above paragraph is self-explanatory.

4.2.2. Suppressed demand scenario

Draft Requirements

Recognizing suppressed demand

30. Paragraph 33 of the RMP states that the 'Mechanism methodologies shall recognize suppressed demand'.

31. Supervisory Body will recognise suppressed demand, where applicable, by considering that the baseline scenario is not the historical condition, but rather a situation where the baseline equipment or measure cannot realistically provide the level of service required of the Article 6.4 activity and alternative technology that provides the level of service comparable to Article 6.4 activity is assumed/assessed.

32. In context where the baseline equipment or measure cannot realistically provide the level of service of the Article 6.4 activity, the Supervisory Body will recognize alternative technology that provides the level of service comparable to Article 6.4 activity to be the baseline scenario rather than a historical situation.

33. The Supervisory Body will assess if suppressed demand is a plausible situation for a given context on a case-by-case basis and, where relevant, it will recognize suppressed demand by including benchmarks and default factors in specific methodologies that may not be below BAU. Mechanism methodologies may include such factors where relevant for use by activity participant, however activity participants shall not directly estimate supressed demand while applying a methodology.

21. Activity participants may propose approaches to recognize suppressed demand, for consideration by the Supervisory Body.

Rationale for changes

The above paragraph is self-explanatory.

4.2.3. Identification of baseline scenario

Draft Requirements

Requirements on baselines

54. Paragraph 36 of the RMP states that

'Each mechanism methodology shall require the application of one of the approach(es) below to setting the baseline, while taking into account any guidance by the Supervisory Body, and with justification for the appropriateness of the choices, including information on how the proposed baseline approach is consistent with paragraphs 33 and 35 above and recognizing that a host Party may determine a more ambitious level at its discretion:

A performance-based approach, taking into account:

(i) Best available technologies that represent an economically feasible and environmentally sound course of action, where appropriate;

(ii) An ambitious benchmark approach where the baseline is set at least at the average emission level of the best performing comparable activities providing similar outputs and services in a defined scope in similar social, economic, environmental and technological circumstances;

(iii) An approach based on existing actual or historical emissions, adjusted downwards to ensure alignment with paragraph 33 above'.

55. Paragraph 27 of RMP states that 'A host Party may specify to the Supervisory Body, prior to participating in the mechanism: (a) Baseline approaches and other methodological requirements...'

56. Mechanism methodologies shall justify the appropriateness of the choice(s) made in the methodology for setting the baseline while taking into account guidance on the performance-based approach in the RMP. For the approach based on existing actual or historical emissions, the mechanism methodology may apply [approaches identified under paragraph 14 to 17 as an option] [BCF(s) identified under paragraph 15 as one option] to adjust the existing actual or historical emissions downwards to ensure alignment with paragraph 33 of the RMP.

57. Mechanism methodology should include provisions to progressively increase the stringency of the baselines applied in the methodology, as applicable.

58. A host Party may determine a more ambitious baseline requirement at its discretion.

59. The Supervisory Body may undertake further assessment and develop further guidance in relation to the baselines at a future meeting of the Supervisory Body.

22. This methodology requires use of a performance-based approach to identify the baseline scenario unless the host Party has determined a more ambitious baseline level, which would take precedence. The baseline scenario shall be determined using:

    (a) Best available technologies that represent an economically feasible and environmentally sound course of action, where appropriate;

    (b) An ambitious benchmark approach where the baseline is set at least at the average emission level of the best performing comparable activities providing similar outputs and services in a defined scope in similar social, economic, environmental and technological circumstances;

(c) An approach based on existing actual or historical emissions, adjusted downwards to ensure alignment with paragraph 33 of requirements referred to in chapter V.B (Methodologies) of the rules, modalities and procedures (RMP) of the Article 6.4 Mechanism.

23. Under this methodology, the baseline emission factor for the electricity generated by the Article 6.4 activity is calculated as the combined margin (CM) emission factor comprising the weighted average of the operating margin (OM) and build margin (BM) emission factors. The OM emission factor refers to the group of existing power plants whose current electricity generation would be affected by the proposed article 6.4 activity[3]. The BM emission factor refers to the group of prospective power plants whose construction and future operation would be affected by the proposed article 6.4 activity.

24. If the activity is the installation of a greenfield power plant, the baseline scenario is, electricity delivered to the grid by the mechanism 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 the grid tool.

[3] In principle, the OM consists of generation from the power plants with the highest variable operating costs in the economic merit order dispatch of the electricity system. Natural gas and oil-based power plants have the highest variable operating costs, followed by coal. Hydropower, co-generation plants and other sources of power including waste to energy and other renewables are typically “must run” or low cost and therefore contribute to the OM only under special circumstances.

Rationale for changes

Electrification is a key element in the strategy to achieve the long-term temperature goal of the Paris Agreement. The Intergovernmental Panel on Climate Change (IPCC) clearly highlights the relevance of electrification in Assessment Report 6 of the Working Group III (see extract immediately below):

"Net-zero energy systems will rely more heavily on increased use of electricity (electrification) in end uses. The literature on net zero energy systems almost universally calls for increased electrification. At least 30% of the global final energy needs are expected to be served by electricity, with some estimates suggesting upwards of 80% of total energy use being electrified. Increased electrification is especially valuable in net zero energy systems in tandem with decarbonized electricity generation or net-negative emissions electricity generation storage".

Furthermore, inclusion of more renewable energy sources in the national energy mix is the most frequently cited mitigation measure in the NDCs[4].

The OM and the BM calculations serve to account for the operation of the activity power plant that affects the operation of installed power plants (OM) and the displacement of power plants that would have been installed (BM). In the context of a required rapid increase in the installed grid capacity with clean energy sources, sole use of historic data of plant operation would not provide an accurate and reliable picture. Thus, the option to use the historical data to determine OM and BM that remains fixed through the crediting period, which is allowed under the CDM, has been excluded i.e. a requirement to undertake ex-post calculation periodically is introduced. Further, it is proposed to adopt alternative weights for the OM and BM for a closer alignment with the above requirements i.e. renewable energy measures in NDCs and expected increase in the growth rate of the installed capacity should be considered for a decreasing weight for the OM with a corresponding increase in the weight of BM.

This approach corresponds to the ambitious benchmark approach of the RMP where the baseline is set at least at the average emission level of the best performing comparable activities providing similar outputs and services in a defined scope in similar social, economic, environmental and technological circumstances.

It also specified that if the value of OM is lower than the value of BM, the value of OM will be adopted as CM, in view of a few exceptional situations where BM could be higher than OM.

Further, the methodology requires actual and recent information about the electricity generating units to calculate the BM, which to some extent factors in the best available technologies that are economically feasible and environmentally sound specified under the RMP.

To summarize:

The OM and BM emission factors are required to be calculated using ex-post approach for each respective year during the monitoring period. Therefore, ex ante option for OM calculation under paragraph 40 (a) and for BM calculation ex ante option under paragraph 69 (a) of the CDM grid tool has been removed;

For BM calculation, the activity participant shall require including activities registered under carbon market mechanisms (including future Article 6.4 Mechanism activities) to determine the set of plants that generate at least 20 per cent of the entire grid generation;

[4] Refer to NDC synthesis report available at https://unfccc.int/ndc-synthesis-report-2022.

Further, the weights of OM and BM used to calculate weighted average combined margin (CM) emission factor are changed as follows, considering that many factors including ongoing decarbonisation of the grid, dispatchability of a source on the grid, generation cost, the average capacity values of the source (e.g. wind is considered to have double the capacity factor as solar) would influence the weights;

(i) Wind and solar power generation project activities, for a monitoring year:

i. During the first crediting period w_{OM} = 0.50 and w_{BM} = 0.50 (owing to their intermittent and non-dispatchable nature);

ii. During the second crediting period w_{OM} = 0.40 and w_{BM} = 0.60; and

iii. During the third crediting period w_{OM} = 0.30 and w_{BM} = 0.70;

(ii) All other projects for a monitoring year:

i. During the first crediting period w_{OM} = 0.40 and w_{BM} = 0.60;

ii. During the second crediting period w_{OM} = 0.20 and w_{BM} = 0.80; and

iii. During the third crediting period w_{OM} = 0.10 and w_{BM} = 0.90.

The secretariat pilot tested the proposed approach to calculate the grid emission factor for 5 different cases[5], where the data was obtained either from a CDM project or from a CDM standardized baseline and compared it with the grid emission factor calculated using approach currently prevailing under the CDM.

Comparison was done in two steps. In the first step, the per centage reduction in BM values owing to changed approach for BM under this methodology as compared to prevalent method under the CDM was calculated. This is reflected in Table 1. In the second step, the changes due to weights of OM and BM are further included and the combined impact in terms of per centage reduction of CM emission factor are included. This is reflected in Table 2 to 7.

Table 1. Comparison of BM values

Cases	BM calculated using prevalent CDM approach (excluding CDM registered projects)	BM calculated using proposed approach (including CDM registered projects)	Per centage reduction in BM values calculated using the proposed approach
1	0.318	0.288	9.5
2	0.342	0.340	0.6
3	0.344	0.344	0
4	0.066	0.066	0
5	0.211	0.211	0

Case 1 – “Project 10611: Expansion San Pedro Wind Farm” from Chile

Case 2 – “Project 8960: Maibarara Geothermal Power Project” from Philippines,

Case 3 – Standardized baseline submission for Armenia (accessible via https://cdm.unfccc.int/methodologies/standard_base/2015/sb169.html),

Case 4 – Standardized baseline submission for Kenya (accessible via https://cdm.unfccc.int/methodologies/standard_base/2015/sb145.html), and

[5] The cases were selected solely for the reasons of availability of data and for illustration purposes only. The analysis considers the latest available data i.e. during year 2018 - 2020, except in case 2 where the data is from year 2008 - 2010.

Case 5 – Standardized baseline submission for Belize (accessible via https://cdm.unfccc.int/methodologies/standard_base/2015/sb158.html)

The BM value calculated using the proposed approach is conservative, specifically:

i) In case 1: by 9.5 per cent since it has more renewable additions to the grid that were registered with the CDM during the data vintage years;
ii) In case 2: by about 1 per cent since it has recent additions of both renewable that were registered with CDM and fossil fuel-based plants during the data vintage;
iii) In case 3, 4 and 5: there is no difference observed. As detailed in CDM tool “Tool to calculate the emission factor for an electricity system”, CDM approach allows exclusion of CDM registered plants in a set of power units supplying 20 per cent of the entire grid’s supply. In these cases there were no recent power units that were registered with the CDM (or JI in case of Armenia) hence the power plants considered were identical under both the approaches.

Table 2 compares the per centage reduction in the CM grid emission factor owing to changes to weights of OM and BM during the first crediting period for wind and solar projects, and Table 3 and Table 4 contain the same comparison for second and third crediting periods, respectively. It is noted that the CM value calculated using the proposed weights is conservative in all cases.

Table 2. Comparison of CM value for wind and solar projects for the first crediting period

Cases	CM calculated using CDM weights (75:25)	CM calculated using proposed weights (50:50)	Per centage reduction in CM values
1	0.599	0.490	18.1
2	0.548	0.478	12.7
3	0.421	0.396	6.1
4	0.391	0.283	27.7
5	0.417	0.348	16.5

Table 3. Comparison of CM **value for wind and solar projects for the second crediting period**

Cases	CM calculated using CDM weights (75:25)	CM calculated using proposed weights (40:60)	Per centage reduction in CM values
1	0.599	0.450	24.9
2	0.548	0.450	17.8
3	0.421	0.385	8.5
4	0.391	0.240	38.8
5	0.417	0.321	23.1

Table 4. Comparison of CM value for wind **and solar projects for the third crediting period**

Cases	CM calculated using CDM weights (75:25)	CM calculated using proposed weights (30:70)	Per centage reduction in CM values
1	0.599	0.409	31.7
2	0.548	0.423	22.8
3	0.421	0.375	11.0
4	0.391	0.196	49.9
5	0.417	0.293	29.8

Table 5 compares the per centage reduction in the CM grid emission factor owing to changes to weights of OM and BM during the first crediting period for other projects such as geothermal and hydro, and Table 6 and Table 7 for second and third crediting periods, respectively. It is noted that CM value calculated using the proposed weights is conservative in all cases.

Table 5. Comparison of CM value **for other projects such as geothermal, hydro for the first crediting period**

Cases	CM calculated using CDM weights (50:50)	CM calculated using proposed weights (40:60)	Per centage reduction in CM values
1	0.505	0.450	11.0
2	0.479	0.450	6.0
3	0.396	0.385	2.6
4	0.283	0.240	15.3
5	0.348	0.321	7.9

Table 6. Comparison of CM value **for other projects such as geothermal, hydro for the second crediting period**

Cases	CM calculated using CDM weights (25:75)	CM calculated using proposed weights (20:80)	Per centage reduction in CM values
1	0.412	0.369	10.4
2	0.411	0.395	3.8
3	0.370	0.365	1.4
4	0.174	0.153	12.4
5	0.279	0.266	4.9

Table 7. Comparison of CM value for other projects such as geothermal, hydro for the third crediting period

Cases	CM calculated using CDM weights (25:75)	CM calculated using proposed weights (10:90)	Per centage reduction in CM values
1	0.412	0.328	20.2
2	0.411	0.367	10.5
3	0.370	0.354	4.2
4	0.174	0.109	37.3
5	0.279	0.238	14.8

4.3. Additionality

Draft Requirements

60. Paragraph 38 of the RMP states that 'Each mechanism methodology shall specify the approach to demonstrating the additionality of the activity. Additionality shall be demonstrated using a robust assessment that shows the activity would not have occurred in the absence of the incentives from the mechanism, taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation, and taking a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices incompatible with paragraph 33 above'.

61. Paragraph 39 of the RMP states that 'The Supervisory Body may apply simplified approaches for demonstration of additionality for any least developed country or small island developing State at the request of that Party, in accordance with requirements developed by the Supervisory Body'.

62. Additionality assessment shall require that the activity participants take a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices incompatible with the requirements discussed under sections 2.3 to 2.11 above.

63. Mechanisms methodology shall require that additionality demonstration of the article 6.4 activity is established by showing that:

(a) Without the incentive from the mechanism, the activity would not be feasible; and

(b) The activity represents mitigation that exceeds any mitigation that is required by law or regulation.

64. The Supervisory Body may approve a list of technologies that are considered additional and termed as positive list of technologies. Mechanism methodologies should require that the activity participant demonstrate that that the proposed article 6.4 activity is part of the positive list of technologies established by the Supervisory Body in order to use the positive list for the demonstration of additionality.

65. The Supervisory Body will consider the technologies for which necessary conditions exist with a high degree of certainty in accordance with the requirements in paragraph 63, where relevant on a regional basis, considering special circumstances of LDCs/SIDS, as the basis for developing the positive list.

66. The Supervisory Body will develop further guidance on the demonstration of additionality and the positive list of technologies at a future meeting of the Supervisory Body, including simplified approaches for demonstration of additionality for any LDCs/SIDS.

25. Additionality of the activity shall be demonstrated using a robust assessment that shows the activity would not have occurred in the absence of incentives from the mechanism, taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation.

26. The activity participants are required to take a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices incompatible with the requirements in paragraph 38 and 39 of the RMP.

27. If the Supervisory Body has established a positive list of technologies for additionality, the activity participant should demonstrate that the proposed Article 6.4 activity is part of that positive list and use that option to demonstrate additionality.

> **Rationale for changes**
>
> The mechanism methodologies should require the activity participant to demonstrate that the proposed article 6.4 activity is part of a positive list of technologies, if such list has been established by the Supervisory Body. The technologies may qualify to be on the positive list for which necessary conditions exist with a high degree of certainty, where relevant on a regional basis, considering special circumstances of LDCs/SIDS.

4.4. Activity emissions

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

$$AE_y = AE_{FF,y} + AE_{GP,y} + AE_{HP,y} \quad \text{Equation (1)}$$

Where:

AE_y	=	Activity emissions in year y (t CO_2e/yr)
$AE_{FF,y}$	=	Activity emissions from fossil fuel consumption in year y (t CO_2/yr)
$AE_{GP,y}$	=	Activity emissions from the operation of dry, flash steam or binary geothermal power plants in year y (t CO_2e/yr)
$AE_{HP,y}$	=	Activity emissions from water reservoirs of hydro power plants in year y (t CO_2e/yr)

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

29. For geothermal and solar thermal plants, which also use fossil fuels for electricity generation, CO_2 emissions from the combustion of fossil fuels shall be accounted for as activity emissions ($AE_{FF,y}$).

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

31. $AE_{FF,y}$ shall be calculated as per the CDM tool “Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion”.

4.4.2. Emissions from the operation of dry steam, flash steam[6] and binary[7] geothermal power plants due to non-condensable gases and/or working fluid ($AE_{GP,y}$)

32. For dry or flash steam geothermal activities, activity participants shall account emissions of CO_2 and CH_4 due to release of non-condensable gases from produced steam. Non-condensable gases in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They

[6] 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.

[7] 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.

also contain a small quantity of hydrocarbons, including predominantly CH_4. In dry or flash steam geothermal power plants, 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.

33. $AE_{GP,y}$ is calculated as follows:

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

Where:

$AE_{GP,y}$	=	Activity emissions from the operation of dry steam, flash steam and/or binary geothermal power plants in year *y* (t CO_2e/yr)
$PE_{dry\ or\ flash\ steam,y}$	=	Activity 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)
$AE_{binary,y}$	=	Activity 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)

34. Activity emissions from dry or flash steam geothermal power plants:

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

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 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)

35. Activity emissions from binary geothermal power plants:

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

Where:

$AE_{steam,y}$	=	Activity 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 activity participants are not required to account these activity emissions.

$AE_{working\ fluid,y}$	=	Activity 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)

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

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)

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

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 (***$AE_{HP,y}$***)

36. The power density (*PD*) of the 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 activity (W/m^2)
Cap_{PJ}	=	Installed capacity of the hydro power plant after the implementation of the activity (W)
Cap_{BL}	=	Installed capacity of the hydro power plant before the implementation of the 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 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 activity, when the reservoir is full (m^2). For new reservoirs, this value is zero

37. For hydro power plant activities that result in new single or multiple reservoirs and hydro power plant activities that result in the increase of single or multiple existing reservoirs,

activity participants shall account for CH_4 and CO_2 emissions from the reservoirs, estimated as follows:

38. For integrated hydro power plant PD of the entire activity is calculated as follows:

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

Where:

i	=	Individual power plants included in integrated hydro power plant
j	=	Individual reservoirs included in integrated hydro power plant

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

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

Where:

$AE_{HP,y}$	=	Activity 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 activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh)

40. If the power density of the activity is greater than 10 W/m^2:

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

4.5. Baseline emissions

41. Baseline emissions include only CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the activity. The methodology assumes that all activity 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:

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

Where:

BE_y	=	Baseline emissions in year *y* (t CO_2/yr)
$EG_{PJ,y}$	=	Quantity of net electricity generation that is produced and fed into the grid as a result of the implementation of the mechanism activity in year *y* (MWh/yr)
$EF_{grid,CM,y}$	=	Combined margin CO_2 emission factor for grid connected power generation in year *y* (t CO_2/MWh) calculated as per the requirements in the grid tool

4.5.1. Calculation of $EG_{PJ,y}$

42. The calculation of $EG_{PJ,y}$ for greenfield plants is described as follows:

4.5.1.1. Greenfield power plants

43. If the activity is the installation of a greenfield power plant, then:

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

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 mechanism activity in year *y* (MWh/yr)
$EG_{facility,y}$	=	Quantity of net electricity generation supplied by the activity plant/unit to the grid in year *y* (MWh/yr)

4.6. Leakage

Draft Requirements

Avoid leakage where applicable

26. Paragraph 33 of the RMP states that the 'Mechanism methodologies shall avoid leakage, where applicable'.

27. Leakage is the net change of anthropogenic emissions by sources of greenhouse gases (GHGs) which occurs outside the project boundary, and which is measurable and attributable to the Article 6.4 activity, as applicable.

28. Mechanism methodologies shall:

(a) Ensure that the potential sources of leakage in a typical activity covered by the mechanism methodology are identified, including, but not limited to, used equipment transferred outside of the project boundary and diversion of resources from other activities, or diversion of production or service provision;

(b) Include provisions to avoid or minimize all sources of leakage as far as possible;

(c) Quantify the leakage that cannot be avoided and deduct it from the emission reduction achieved by the Article 6.4 activities;

(d) Require the activity participant to follow any guidance from the designated national authority (DNA) of the host Party on leakage, where available.

29. For some classes of activities, monitoring at jurisdictional level may be necessary to quantify and account for leakage. In addition, further work will be required to assess the implications of activities implemented outside national borders and transboundary activities. Supervisory Body will develop further guidance in this regard at a future meeting of the Supervisory Body.

44. Activity participants applying this methodology shall avoid leakage, where applicable by:

(a) Identifying the potential sources of leakage such as baseline equipment transferred outside the activity boundary or used equipment deployed as activity technology, diversion of production or service provision;

(b) Describing provisions that will be implemented to avoid or minimize all sources of leakage;

(c) Applying approaches to quantify the leakage that cannot be avoided and deduct it from the emission reduction achieved by the Article 6.4 activities; and

(d) Following any guidance from the DNA of the host Party on leakage.

Rationale for changes

The above requirements are self-explanatory.

4.7. Emission reductions

45. Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \quad \text{Equation (13)}$$

Where:

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

4.8. Data and parameters not monitored

46. 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:	As per recent IPCC assessment report. For example, IPCC AR6 mentions the value as 25 t CO_2e/t CH_4
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	EF_{Res}
Data unit:	$kgCO_2e$/MWh
Description:	Default emission factor for emissions from reservoirs
Source of data:	Refer to Appendix
Value to be applied:	~~90~~ 100 $kgCO_2e$/MWh or use G-res Tool available at https://g-res.hydropower.org/
Any comment:	-

Data / Parameter table 3.

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

Data / Parameter table 4.

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 activity, when the reservoir is full (m^2). For new reservoirs, this value is zero
Source of data:	Activity site
Value to be applied:	Measured from topographical surveys, maps, satellite pictures, etc.
Any comment:	-

Data / Parameter table 5.

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:	-

5. Monitoring methodology

Draft Requirements

Including data sources and accounting for uncertainty

45. Paragraph 34 of the RMP states that 'Mechanism methodologies shall include relevant assumptions, parameters, data sources and key factors'.

46. The Supervisory Body should ensure that the mechanism methodologies are transparent, comprehensive and comprehensible and include relevant assumptions, parameters, data sources and key factors. Where relevant, requirements shall be expressed in terms of performance rather than specification of a product, and these requirements should be verifiable.

47. If it is necessary to invoke a requirement in a methodology that appears elsewhere in another methodology, this should be done by reference and not by repetition. If a test method or a procedure is, or is likely to be, applicable to two or more methodologies, a tool shall be prepared on the method itself, and each methodology shall refer to it to prevent potential deviations on account of repetitions.

47. This methodology includes relevant assumptions, parameters, data sources and key factors applicable to activities under this methodology. Where required, the activity participant shall transparently and clearly describe additional parameters and assumptions, data sources associated with the parameters, including a definition of uncertainty, and related adjustments where relevant.

Rationale for changes

The above requirements are self-explanatory.

48. 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.

49. In addition, the monitoring provisions in the CDM tool "Tool to calculate project or leakage

CO_2 emissions from fossil fuel combustion" shall be applied to calculate $AE_{FF,y}$.

5.1. Data and parameters monitored

Data / Parameter table 6.

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:	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 plants

Data / Parameter table 7.

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:	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 plants

Data / Parameter table 8.

Data / Parameter:	$M_{steam,y}$
Data unit:	t steam/year
Description:	Quantity of steam produced in year *y*
Source of data:	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 plants

Data / Parameter table 9.

Data / Parameter:	TEG_y
Data unit:	MWh/year
Description:	Total electricity produced by the activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y*
Source of data:	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 plant activities with a power density greater than 4 W/m^2 and less than or equal to 10 W/m^2

Data / Parameter table 10.

Data / Parameter:	Cap_{PJ}
Data unit:	W
Description:	Installed capacity of the hydro power plant after the implementation of the activity
Source of data:	Activity 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 11.

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 activity, when the reservoir is full
Source of data:	Activity 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 12.

Data / Parameter:	$M_{inflow,y}$
Data unit:	t steam/year
Description:	Quantity of steam entering the geothermal plant in year *y*
Source of data:	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 13.

Data / Parameter:	$M_{outflow,y}$
Data unit:	t steam/year
Description:	Quantity of steam leaving the geothermal plant in year *y*
Source of data:	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 14.

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:	Activity site
Measurement procedures (if any):	Measured via logbooks 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:	-

Data / Parameter table 15.

Data / Parameter:	$EG_{PJ,grid,y}$
Data unit:	MWh/yr
Description:	Quantity of electricity generated and supplied by the Article 6.4 activity power plant to the grid in year y
Source of data	Direct measurement or calculated based on measurements from more than one electricity meters
Measurement procedures (if any):	Use electricity meters installed at the grid interface for electricity export to grid and for supply to captive consumers use electricity meters installed at the entrance of the electricity consuming facility. In case of grid and net electricity generation: This parameter should be either monitored using bi-directional energy meter or calculated as difference between: (a) The quantity of electricity supplied by the Article 6.4 activity plant/unit to the grid; and (b) The quantity of electricity the Article 6.4 activity plant/unit from the grid. If it is calculated, then the following parameters shall be measured: (a) The quantity of electricity supplied by the Article 6.4 activity plant/unit to the grid; and (b) The quantity of electricity delivered to the Article 6.4 activity plant/unit from the grid
Monitoring frequency:	Continuous measurement and at least monthly recording
QA/QC procedures:	In cases where electricity meters are regulated (e.g. the electricity is supplied to the electric grid), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. The calibration of meters, including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier or requirements set by the grid operators. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier and/or as per the requirements set by the grid operators or national requirements. In cases where electricity meters are not regulated (e.g. the electricity is supplied to captive users), the electricity meter will be subject to regular maintenance and testing in accordance with the stipulation of the meter supplier or national requirements. The calibration of meters,

	including the frequency of calibration, should be done in accordance with national standards or requirements set by the meter supplier. The accuracy class of the meters should be in accordance with the stipulation of the meter supplier or national requirements. If these standards are not available, calibrate the meters every 3 years and use the meters with at least 0.5 accuracy class (e.g. meter with 0.2 accuracy class is more accurate and thus it is accepted). The electricity generation (gross or net) shall be cross-checked with records of electricity sale (e.g. sales receipt)
Any comment:	The Article 6.4 activity participants do not need to apply for post registration changes in the following situations and the change shall be described in the subsequent monitoring report and verification report: (a) Changing the type of meter during the monitoring period, for example from analogue to electrical or vice-versa as long as the meters comply with the accuracy class mentioned above; (b) Changing the accuracy class of meter from lower accuracy class to higher accuracy class; (c) Changing the calibration frequency of meter within the range stipulated in the national standards or requirements set by the meter supplier or requirements set by the grid operators; (d) Apportioning of the electricity generated and supplied by the Article 6.4 activity power plant based on a common monitoring meter after: (e) DOE has verified that the apportioning is done by a third party (example: the electricity supplier to the grid); (f) DOE has verified that the apportioning is cross-checked with the sales receipt; (g) The apportioning and method used is highlighted in the subsequent monitoring report and verification report; (h) Changing meter type from check meter to bi-directional meter. In case of missing data due to meter failure or other reasons, one of the following options to estimate electricity generation may be applied: (a) the conservative value as zero; (b) The lowest daily value among the daily monitored values from the current crediting period multiplied by the number of days with missing data; (c) The energy input to the equipment determined by the fossil fuel consumed, adjusted by efficiency. Efficiency of the equipment in this case shall be taken from the manufacturer's specifications. (d) For solar PV, installed capacity of the power plant adjusted by availability factor. The availability factor for the missing data period shall be conservatively assumed as 12 per cent. Estimation of electricity generation can only be applied if it is demonstrated that the power generating equipment is operational

	during the missing data period[8]. The missing data period shall not exceed seven consecutive days within three consecutive months except where end users of the subsystems or measures are households/communities/small and medium enterprises, 30 consecutive days within six consecutive months are allowed for article 6.4 activities

[8] This can be done through, for example, records in an automated monitoring system and photos displaying a time stamp.

Appendix. Emission factor for reservoirs

Issues related to emissions from reservoirs

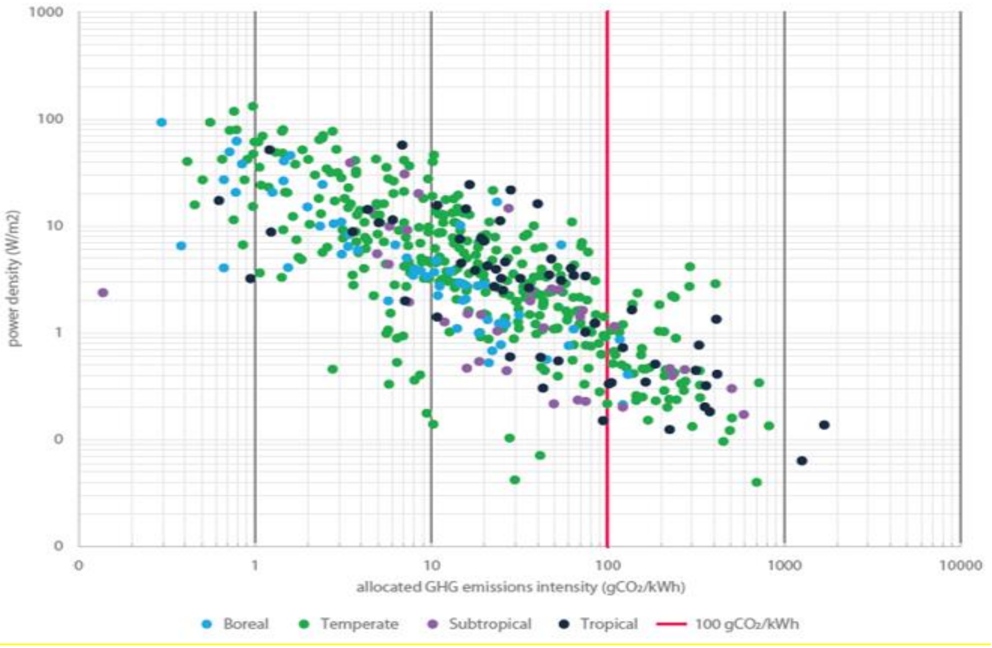
1. The International Hydropower Association's (IHA) study of nearly 500 reservoirs globally is by far the most comprehensive study[1] for estimation of the GHG emissions from hydropower plants.

2. The IHA study estimated the GHG footprint of 178 single purpose hydropower reservoirs and more than 300 multipurpose reservoirs. It found the global median GHG emission intensity of hydropower reservoirs to be 18.5 gCO2e/kWh.

3. Three-quarters of the reservoirs were estimated to have emissions less than 60 gCO2e/kWh. The study looked at reservoirs in boreal, temperate, subtropical and tropical climates in more than 50 countries in North and Central America, South America, Europe, Africa, South and Central Asia, East Asia and the Pacific.

4. The study concluded that the vast majority of hydropower reservoirs are producing low-carbon power, while some reservoirs in every climate category can potentially have high emissions exceeding 100 gCO2e/kWh (a threshold that is comparable to the ones in use in existing CDM methodologies and in other areas such as the Climate Bonds Initiative). Figure 1 shows the relationship between GHG emissions intensity and the power density of hydropower projects.

Figure 1. Relationship between GHG emissions intensity and the power density of projects



[1] Hydropower status report 2018 sector trends and insights.

5. The IHA study of single reservoir system cites depth and temperature as important predictors of carbon emissions and reflects spatial and seasonal variability. It reports that GHG emissions tend to decrease as reservoirs age and that reservoirs at higher latitudes emit less than reservoirs at lower latitudes.

6. As a conclusion, the Supervisory Body may consider applying a GHG emissions threshold of 100 kgCO_2e/MWh for emissions due to hydropower reservoirs.

7. Further, it shall be noted that the Chapter 7 of the IPCC 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Alternatively, recognizes that to make Tier 2 or Tier 3 estimates, the GHG Reservoir (G-res) Tool developed by IHA and UNESCO is the only easily available and widely applicable tool. The tool is developed to account for the potential biases in the estimation of GHG emissions from reservoirs. The tool uses empirical relationships between environmental drivers and emissions to estimate reservoir GHG fluxes.

8. Therefore, as an option to default value as mentioned under paragraph 6 above, the Supervisory Body may consider recommending use of the G-res Tool[2] available at https://g-res.hydropower.org/, to estimate the emissions due to hydropower reservoir. The G-res tool is a web-based tool to estimate and report net GHG emissions from a reservoir.

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[2] Refer to https://g-res.hydropower.org/about-tool/ to know more about this tool.