ARTICLE 6.4 MECHANISM

A6.4-MEP012-A03

Draft Mechanism Methodology

Electricity generation from renewable sources connected to an electricity system

Version 01.0

Sectoral scope(s): 01

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Supervisory Body, at its tenth meeting, requested the Methodological Expert Panel (MEP) to prepare recommendations on products based on inputs including drafts, questions, and proposals provided by the secretariat, considering any inputs received from stakeholders.

2. In particular, the Supervisory Body requested the MEP to prepare a draft recommendation, including on further work on revision of Clean Development Mechanism (CDM) methodologies/tools, including the CDM methodologies of grid connected electricity generation from renewable sources.

2. Purpose

3. The purpose of this draft mechanism methodology is to define requirements for Article 6.4 activities that involve installation of a greenfield power plant that generates electricity from renewable sources and feeds all electricity generated into an electricity system.

3. Key issues and proposed solutions

4. The following sub-sections outline the key elements of the mechanism methodology, including a comparison of the elements with those in the approved CDM methodologies "ACM0002: Grid-connected electricity generation from renewable sources"[1] and from version 18.0 of the small-scale CDM methodology "AMS-I.D.: Grid connected renewable electricity generation".[2]

3.1. Applicability conditions

5. The proposed mechanism methodology is applicable to greenfield power plants that generate electricity from renewable sources connected to the electricity system, including run-of-river hydro, wind, solar and geothermal power plants. For Article 6.4 activities involving run-of-river hydropower plants, the mechanism methodology contains specific applicability conditions to ensure emissions from the reservoir are negligible.

Table 1. Comparison of applicability conditions between the CDM methodologies and the Article 6.4 mechanism methodology

CDM methodologies		Mechanism methodology
ACM0002	• Project type: retrofit, rehabilitation (or refurbishment), replacement or capacity addition to an existing power plant or construction and operation of	• Project type: a greenfield power plant that generates electricity from renewable sources and feeds all electricity generated

[1] See https://cdm.unfccc.int/methodologies/DB/XB1TX7TAZ6SLWM9B7BC67THHVD16JV.

[2] See https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK.

<table>
<tr><th colspan="2">CDM methodologies</th><th>Mechanism methodology</th></tr>
<tr><td></td><td>a new power plant/unit that uses renewable energy sources and supplies electricity to the grid;
• Energy sources: renewable sources except biomass.
• Specific conditions: power plants integrated battery energy storage system and hydropower plants can be applied under certain conditions.</td><td rowspan="2">into an electricity system. The power plant may include a battery energy storage system;
• Energy sources: hydro without construction of new reservoir, wind, solar, and geothermal;
• Specific conditions: hydropower plants can be applied under certain conditions. Conditions to avoide double counting and baseline equipment transfer are included.</td></tr>
<tr><td>AMS. I.D.</td><td>• Project type: construction and operation of a new power plant/unit or retrofit, rehabilitation (or refurbishment), replacement or capacity addition of an existing power plant that uses renewable energy sources and supplies electricity to the grid.
• Energy sources: renewable energy such as solar, hydro, tidal/wave, wind, geothermal and renewable biomass;
• Specific conditions: hydropower plants can be applied under certain conditions.</td></tr>
</table>

6. Some types of renewable power generation projects are not eligible under this version of the mechanism methodology because it does not include:

   (a) Provisions to determine the baseline emissions for activities involving retrofit, rehabilitation (or refurbishment), replacement or capacity addition;

   (b) Provisions to determine the carbon dioxide, methane and nitrous oxide emissions from reservoirs;

   (c) Provisions to determine the baseline and project emissions from biomass-fired power plants.

7. Moreover, wave and tidal power plants are not applicable under this mechanism methodology, given that the relevance of upstream emissions from the construction and operation of power plants would need to be further explored. The applicability conditions of the mechanism methodology may be expanded in future revisions of the mechanism methodology.

8. The mechanism methodology also specifies applicability conditions as required by the "Standard: Setting the baseline in mechanism methodologies" (A6.4-STAN-METH-004)[3] (hereinafter the "Baseline Standard") and the "Standard: Addressing leakage in mechanism methodologies" (A6.4-STAN-METH-005)[4] (hereinafter the "Leakage Standard"), including conditions to avoid:

[3] See https://unfccc.int/sites/default/files/resource/A6.4-STAN-METH-004.pdf.

[4] See https://unfccc.int/sites/default/files/resource/A6.4-STAN-METH-005.pdf.

(a) Leakage related to the use of pre-used equipment; and

(b) Different forms of double counting.

3.2. Project boundary

9. The project boundary includes the site of the project power plant and all power units connected physically to the electricity system that the Article 6.4 activity power plant is connected to.

10. The MEP has identified all potential emission sources that can be altered by an eligible Article 6.4 activity under this mechanism methodology. The justification on the exclusion of relevant emission sources is provided in Appendix 1 of the mechanism methodology.

11. Compared to the CDM methodologies, the mechanism methodology additionally accounts for:

    (a) Methane and nitrous oxide emissions from fossil fuel consumption by backup generators operated under the project; and

    (b) Shadowing effect for wind power plants.

3.3. Demonstration of additionality

12. To demonstrate additionality, the following analyses are required at the activity level: regulatory, lock-in risk, investment, and common practice. These analyses shall be conducted following the relevant methodological tools.

3.4. Baseline Emissions

3.4.1. Identification of the baseline scenario

13. An approach based on existing actual or historical emissions adjusted downwards is selected to determine the baseline scenario. The selection was made considering that:

    (a) Power plant construction is highly site-specific, depending on local natural resources; and

    (b) Emission intensity of each power generation technology is highly activity-specific, depending on the energy resources and technology employed.

14. The baseline scenario is determined at the mechanism methodology level as the electricity generation by existing power plants connected to the electricity system and by the addition of new generation sources.

3.4.2. Calculation of baseline emissions

15. The unadjusted baseline emissions are calculated using the "Methodological tool: Emissions from electricity generation and consumption" (A6.4-AMT-007) [5].

[5] See https://unfccc.int/sites/default/files/resource/A6.4-AMT-007-v01.0.pdf.

16. The downward adjustment is separately determined for the calendar year of the start date of the first crediting period and for the subsequent years, in accordance with the Baseline Standard. For the annual downward adjustment in subsequent years, a value of 1 per cent per year is used.

3.4.3. Comparison of the downward adjusted baseline and the conservative business-as-usual (BAU) baseline

17. The conservative BAU scenario is deemed to be the same as the baseline scenario. Therefore, the conservative BAU emissions will always be higher than the downward-adjusted baseline scenario, except for the calendar year of the start date of the first crediting period. For that year, a discount factor is applied to the adjusted baseline emissions to ensure they remain below the BAU baseline. Therefore, there is no need to calculate or compare the conservative BAU emissions in subsequent years.

3.5. Project emissions

18. The mechanism methodology includes the following sources of project emissions:

    (a) Carbon dioxide, methane and nitrous oxide emissions from fossil fuel consumption in backup generators;

    (b) Carbon dioxide emissions from electricity consumption (e.g., during times when a renewable power plant is not operating);

    (c) Carbon dioxide, methane and hydrocarbon/refrigerant emissions from the operation of geothermal power plants.

3.6. Leakage

19. Leakage emissions from the use of pre-used equipment are avoided through an applicability condition that requires equipment installed under the Article 6.4 activity to be newly produced and not previously used.

20. Leakage emissions related to competition for resource use, i.e., shadowing effects of a wind power plant, are calculated by subtracting the reduction in electricity generation by other wind power plants through shadowing effects.

21. All other potential leakage emissions sources are not considered in this version of the mechanism methodology. An analysis of unaccounted emission sources is included in Appendix 1.

3.7. Data and parameters

22. The data and parameters that are not monitored, and those that are monitored, are provided in sections 13 and 14 in the mechanism methodology.

3.8. Avoidance of double-counting

23. Consistent with the provisions in Appendix 1 to the Baseline Standard, the mechanism methodology contains provisions to avoid various forms of double-counting.

3.9. Alignment with NDCs, LT-LEDS, and long-term goals of the Paris Agreement

24. Activity participants shall provide the DOE with a confirmation from the DNA of the host Party that the DNA has undertaken an assessment of the activity's consistency with Decision 3/CMA.3 paragraph 40(c) and paragraph 27(a), as part of the host Party's approval.

4. Consideration of public comments

25. Not applicable (Document is published for a call for public input).

5. Impacts

26. Approval of this mechanism methodology will enable the development of Article 6.4 activities that install greenfield power plants that use renewable sources and feed the electricity into an electricity system.

6. Subsequent work and timelines

27. The MEP agreed to seek public input from stakeholders on the draft mechanism methodology. The MEP will consider stakeholders' input and recommend an updated draft of the mechanism methodology for consideration by the Supervisory Body.

28. The MEP is particularly interested to receive inputs on:

(a) Provisions for the application of the methodology to run-of-river hydropower projects and hydropower projects implemented in existing new or multiple reservoirs (refer to section 3 of the mechanism methodology);

(b) The options for the analysis of lock-in, including the thresholds for land-use and whether these thresholds should be established at the methodology or project level (refer to section 6.2 of the mechanism methodology);

(c) The common practice thresholds for Article 6.4 activities located in LDCs/SIDS and located in non-LDCs/SIDS (refer to section 6.4 of the mechanism methodology);

(d) The options for identifying comparable, similar and different activities for wind power projects (refer to section 6.4 of the mechanism methodology);

(e) The distance between the wind turbines installed under the Article 6.4 activity and any other wind power plants to account for the shadowing effect (refer to section 7.2.2 of the mechanism methodology); and

(f) The sources commonly used to report the shadowing effect (refer to section 13 of the mechanism methodology).

7. Recommendations to the Supervisory Body

29. Not applicable (Document is published for a call for public input).

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1. Introduction

1.1. Scope

1. The mechanism methodology applies to activities generating electricity from certain types of renewable sources connected to the electricity system such as hydro without construction of new reservoir, hydro constructed in an existing reservoir, wind, solar, and geothermal.

1.2. Entry into force and validity

2. This mechanism methodology enters into force on DD Month YYYY.

3. This mechanism methodology remains valid for five years, until DD/MM/YYYY, unless an earlier date applies if the mechanism methodology is revised or withdrawn in accordance with the provisions of the "Procedure: Development, revision and clarification of methodologies and methodological tools" (A6.4-PROC-METH-001).[1]

1.3. Applicability of sectoral scopes

4. Designated operational entities validating and verifying Article 6.4 activities that use this mechanism methodology shall apply sectoral scope 1: Energy industries (renewable/ non-renewable sources).

2. Definitions

2.1. General terms

5. The following general terms are applicable to this mechanism methodology:

   (a) "Shall" is used to indicate requirements that must be followed;

   (b) "Should" is used to indicate that, among several options, one course of action is recommended as particularly suitable; and

   (c) "May" is used to indicate what is permitted.

2.2. Methodological terms and definitions

6. The following methodological terms and definitions are applied to this mechanism methodology:

   (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 the site of the project power plants during emergency;

   (b) **Binary geothermal power plant**: A geothermal technology that utilizes heat from a geothermal fluid through heat exchangers to vaporise an organic fluid with a low boiling point (e.g., butane or pentane in the Organic Rankine Cycle (ORC) or an ammonia-water mixture in the Kalina cycle) and drive a turbine. Binary geothermal plants are categorised as a closed cycle technologies;

[1] See https://unfccc.int/sites/default/files/resource/A6.4-PROC-METH-001.pdf.

(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 technologies;

(d) **Flash steam geothermal power plant:** A geothermal technology that is designed for high-temperature, water-dominated reservoirs. 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;

(e) **Greenfield power plant:** A new power plant that is constructed and operated at a site where no power plant was operated prior to the implementation of the project activity;

(f) **Hydraulic residence time:** The ratio of reservoir volume to mean inflow, representing the average time water remains within the reservoir under steady-state conditions;

(g) **Installed power generation capacity (or installed 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) **Power density of a reservoir:** The ratio of the installed power generation capacity of a hydropower plant to the surface area of its associated reservoir(s);

(i) **Power plant/unit:** 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;

(k) **Run-of-river hydro power plant:** A hydro power plant that draws the energy for electricity production mainly from the available flow of the river, such that the generation profile will, to varying degrees, be dictated by local river flow conditions;[2] and

(l) **Storage duration:** The equivalent time, expressed in hours, for which a hydropower plant can operate at rated turbine discharge using only its usable storage volume between maximum and minimum operating levels, assuming zero inflow.

7. Furthermore, the terms in the “Glossary: Article 6.4 mechanism terms” (A6.4-GLOS-GOV-001) and the definitions and terms in the methodological tools referred to in section 3 shall apply.

[2] This definition is informed by the discussion on page 451 of IPCC (2012).

3. Applicability

8. This mechanism methodology is applicable to Article 6.4 activities that install a greenfield power plant that generates electricity from renewable sources and feeds all electricity generated into an electricity system. The power plant may include a battery energy storage system (BESS).

9. The types of renewable energy power plants eligible under this mechanism methodology are hydro-power plants, wind power plants, solar photovoltaic power plants, solar thermal power plants, and geothermal power plants.

10. In the case of hydropower plants, one of the following two conditions (a) or (b) below shall apply:[3]

(a) The Article 6.4 activity involves the establishment of a run-of-river hydropower plant for which all of the following three conditions are satisfied:[4]

(i) The storage duration is not larger than [24][X] hours;

(ii) The hydraulic residence time is below [2][X] days; and

(iii) The implementation of the Article 6.4 activity does not involve the flooding of forests[5] or peatlands; or

(b) The Article 6.4 activity is implemented at a single or multiple existing reservoir(s) for which all of the following conditions are satisfied:

(i) The reservoirs have been established at least [X] years prior to the start date of the Article 6.4 activity;

(ii) The implementation of the Article 6.4 activity does not lead to a change in the volume of water in the existing reservoir;

(iii) The identification of the baseline scenario in section 7.2.1 finds that the reservoirs would continue to be in operation in the baseline scenario and not reduced in size; and

(iv) The power density of the reservoir is greater than [10][20] W/m^2.

[3] These conditions are introduced because this version of the methodology does not include provisions to estimate carbon dioxide, methane and nitrous oxide emissions from reservoirs. It is assumed that the fulfilment of these conditions ensures that such emissions are very small. Activity participants are encouraged to submit a proposed revision to this methodology to amend the methodology to cover reservoirs that do not satisfy these conditions.

[4] These factors were identified based on different studies. Storage duration is commonly used to distinguish run-of-river plants. Hydraulic residence time influences methane emissions because longer water retention promotes stratification, oxygen depletion and anaerobic decomposition. The available research also suggests that the amount of available biomass influences emissions. See, for example: World Bank. 2017. Greenhouse Gases from Reservoirs Caused by Biogeochemical Processes. World Bank, Washington, DC. https://documents1.worldbank.org/curated/en/739881515751628436/pdf/Greenhouse-gases-from-reservoirs-caused-by-biogeochemical-processes.pdf and
Tittel, J., Hüls, M. & Koschorreck, M. Terrestrial Vegetation Drives Methane Production in the Sediments of two German Reservoirs. Sci Rep 9, 15944 (2019). https://doi.org/10.1038/s41598-019-52288-1.

[5] Under this mechanism methodology, a forest shall meet the national definition of forests of the applicable host country.

Note: The MEP would like to seek public inputs on the above provisions on hydropower plants.

11. The Article 6.4 project power plant may be equipped with a backup generator as long as the following conditions are fulfilled:

    (a) The annual electricity generation of the backup generator does not exceed 1 per cent of the total electricity generation from the greenfield power plant installed under the Article 6.4 activity; and

    (b) The operation of the back-up generator is restricted solely to emergency situations or system contingency events necessary to maintain the continuity and safety of the renewable generation system.

12. A6.4ERs issued based on this mechanism methodology represent emission reductions.

13. This version of the mechanism methodology is applicable to Article 6.4 activities implemented at the project level. The mechanism methodology may be amended in the future to also cover activities implemented at other scales (e.g., programmes of activities, policies, sectoral approaches, etc).

14. Furthermore, the mechanism methodology is only applicable under the following conditions:

    (a) The renewable electricity generated by the Article 6.4 activity is not claimed, credited, or utilized under any certification scheme or other crediting mechanism.[6] Such claiming, crediting or utilization may occur under, but is not limited to, the issuance of energy attribute certificates (e.g., renewable energy certificates) with respect to the renewable electricity generated under the Article 6.4 activity; and

    (b) The activity participants have not entered into any agreements to supply the electricity through the electricity system to specific consumers; and

    (c) The equipment installed under the Article 6.4 activity has previously not been used in any other plant but is newly produced.[7]

15. This mechanism methodology is only applicable on a standalone basis and shall not be applied in combination with other mechanism methodologies, unless one or more of the other methodologies specifies how the interaction with this mechanism methodology is taken into account.

16. The mechanism methodology is not applicable to:

    (a) Activities that involve switching from fossil fuels to renewable energy sources at the site of the activity; and

    (b) Activities that involve any co-firing of biomass or fossil energy resources.

17. The above provisions shall be demonstrated as follows:

[6] This condition is introduced to avoid double counting due to overlap with other frameworks or environmental markets as per section 8.3 in Appendix 1 of version 01.0 of the “Standard: Setting the baseline in mechanism methodologies” (A6.4-STAN-METH-004).

[7] This condition is introduced to avoid any leakage from baseline equipment transfer, consistent with paragraph 14(a) of version 01.0 of the “Standard: Addressing leakage in mechanism methodologies” (A6.4-STAN-METH-005).

(a) The provisions in paragraphs 9, 10, 11, 13, 15 and 16 shall be demonstrated in the Project Design Document (PDD) and be assessed at the initial validation;

(b) The provisions in paragraphs 10, 11, 14 and 16 shall be demonstrated in each monitoring report and be assessed at each verification.

18. The applicability conditions included in the methodological tools referred to in paragraph 20 also apply.

4. Normative references

19. The mechanism methodology is based on elements from version 22.0 of the Clean Development Mechanism (CDM) methodology "ACM0002: Grid-connected electricity generation from renewable sources"[8] and from version 18.0 of the small-scale CDM methodology "AMS-I.D.: Grid connected renewable electricity generation".[9]

20. The following normative documents are indispensable for the application of this mechanism methodology. When applying this mechanism methodology, a valid version of the documents listed below shall be used:

(a) "Methodological tool: Common practice analysis" (A6.4-AMT-001);[10]

(b) "Methodological tool: Investment analysis" (A6.4-AMT-002);[11]

(c) "Methodological tool: Emissions from electricity generation and consumption" (A6.4-AMT-007);[12]

(d) "Methodological tool: Analysis of lock-in risk".[13]

21. The following documents provide supporting information that may assist in the application of this mechanism methodology:

(a) Intergovernmental Panel on Climate Change (2012). IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. IPCC, Geneva, Switzerland.[14]

[8] See https://cdm.unfccc.int/methodologies/DB/XB1TX7TAZ6SLWM9B7BC67THHVD16JV.

[9] See https://cdm.unfccc.int/methodologies/DB/W3TINZ7KKWCK7L8WTXFQQOFQQH4SBK.

[10] See https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-64-pacm/mechanism-process/methodologies/a64-amt-001.

[11] See https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-64-pacm/mechanism-process/methodologies/a64-amt-002.

[12] See https://unfccc.int/process-and-meetings/the-paris-agreement/article-6/article-64-pacm/mechanism-process/methodologies/a64-amt-007-emissions-from-electricity-generation-and-consumption.

[13] The options for the analysis of lock-in risk were proposed based on a version of the methodological tool recommended by the MEP at its 12th meeting to the Supervisory Body. Any changes made by the Supervisory Body to the recommended methodological tool will be reflected in a future revision of this mechanism methodology.

[14] See https://archive.ipcc.ch/pdf/special-reports/srren/SRREN_Full_Report.pdf.

(b) Intergovernmental Panel on Climate Change (2006). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2: Energy. IPCC, Geneva, Switzerland.[15]

(c) Intergovernmental Panel on Climate Change (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 1: General Guidance and Reporting. IPCC, Geneva, Switzerland.[16]

5. Project boundary

22. The project boundary shall include the site of the Article 6.4 project power plant and all power units connected physically to the electricity system[17] that the Article 6.4 activity power plant is connected to.

23. The greenhouse gases (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 project boundary

	Source	GHG	Included?	Controlled / Related to / Affected by?	Justification / Explanation
BASELINE	CO_2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the activity	CO_2	Yes	Affected by	The major source of emissions in the baseline
		CH_4	No	Affected by	Excluded for simplification and conservativeness
		N_2O	No	Affected by	Excluded for simplification and conservativeness
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	Controlled	Main emission source
		CH_4	Yes	Controlled	Main emission source
		N_2O	No	Controlled	Excluded for simplification
	For binary geothermal power plants, fugitive emissions of CH_4 and CO_2 from non-condensable gases contained in geothermal steam	CO_2	Yes	Controlled	Main emission source
		CH_4	Yes	Controlled	Main emission source
		N_2O	No	Controlled	Excluded for simplification

[15] See https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html.

[16] See https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol1.html.

[17] Refer to the “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-007) for definition of an electricity system.

	Source	GHG	Included?	Controlled / Related to / Affected by?	Justification / Explanation
	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	Controlled	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	Controlled	Main emission source
		CH_4	Yes	Controlled	Minor emission source
		N_2O	Yes	Controlled	Minor emission source
LEAKAGE	Upstream emissions from construction of the activity	CO_2	No	Affected by	Excluded for simplification, refer to the appendix for the reasoning
		CH_4	No	Affected by	Excluded for simplification, refer to the appendix for the reasoning
		N_2O	No	Affected by	Excluded for simplification, refer to the appendix for the reasoning
	Shadowing effects of wind power plants	CO_2	Yes	Affected by	Accounted for when quantifying the amount of electricity generated
		CH_4	No	Affected by	Excluded for simplification
		N_2O	No	Affected by	Excluded for simplification
	Rebound effects	CO_2	No	Affected by	Excluded for simplification, refer to the appendix for the reasoning
		CH_4	No	Affected by	
		N_2O	No	Affected by	

6. Demonstration of additionality

24. To demonstrate additionality, activity participants shall apply:

(a) Regulatory analysis (see provisions in section 6.1);

(b) Analysis of lock-in risk (see provisions in section 6.2);

(c) Investment analysis (see provisions in section 6.3); and

(d) Common practice analysis (see provisions in section 6.4).

25. The proposed Article 6.4 activity shall only be considered additional if all four analyses are concluded positively.

6.1. Regulatory analysis

26. Activity participants shall review relevant legal requirements applicable to the host country and the proposed Article 6.4 activity and possible alternative scenarios to the Article 6.4 activity, and demonstrate and justify, for each relevant legal requirement, that either:

(a) The law or regulation refers to or formally integrates the mechanism as an instrument for implementation;[18] or

(b) That the emission reductions resulting from the Article 6.4 activity would not occur as a result of the legal requirement, by confirming that all of the following conditions are true:

(i) The Article 6.4 activity is not implemented at a site where legal requirements explicitly require the installation of renewable power plants;

(ii) The implementation of the Article 6.4 activity, or another form of renewable electricity generation, is not indirectly required due to any legal requirements, such as obligations for the activity participant to achieve certain greenhouse gas performances; and

(iii) The Article 6.4 activity does not participate in a support scheme or is subject to a penalty scheme that is designed to achieve a quantitative target or outcome, such as a competitive bidding processes for the installation of a certain capacity of renewable power plants.

27. If one or more of the legal requirements identified in paragraph 26 fail the requirements of that paragraph, then A6.4ERs cannot be claimed, except for any emission reductions in excess of those emission reductions that would be achieved as a result of the legal requirements.

28. Activity participants shall assess the requirements of paragraph 26 for each monitoring period. Crediting shall cease on the date when a new relevant legal requirement enters into force.

6.2. Assessment of lock-in risk

[Option 1: No lock-in analysis is required for any of the activities applicable under this mechanism methodology

29. No lock-in analysis is required to be conducted under this mechanism methodology.[19]]

[18] For example, if the regulations explicitly mention that utilizing the Article 6.4 and its generated revenues are to be used as incentives to achieve the emission reductions in a specific sector.

[19] Given the low GHG emission intensity of renewable power generation technologies, activities eligible under this methodology are deemed to have no lock-in risk.

[Option 2: Lock-in analysis only for geothermal power generation.

30. In case of geothermal power plants, activity participants shall conduct lock-in risk analysis using a valid version of the "Methodological tool: Analysis of lock-in risk".[20] In applying the tool, activity participants shall implement all of the following specifications:

    (a) **Technology to be assessed:** assess the lock-in risk for geothermal power plant;

    (b) **Lifetime:** consider the operational lifetime;

    (c) **Calculation of the greenhouse gas emissions intensity:**[21]

        (i) Calculate the emission intensity of the Article 6.4 activity by dividing the project emissions determined in section 8 by the activity's annual electricity generation;

        (ii) Use the emission factor of the electricity system, as determined in section 7.2.2 as the emission intensity for BAU;

        (iii) Take a value of zero for the emission intensity for the lowest-emissions intensity alternative.

    (d) **Assessment of resources:** not conduct this assessment.[22]

    (e) **Scale assessment:** not conduct a scale assessment.[23]]

[Option 3: Lock-in analysis only required for solar and hydropower plants, limited to the resource assessment with regard to land use

31. For solar photovoltaic power plants, solar thermal power plants and hydropower plants, the activity participant shall conduct the resource use efficiency assessment following step 3 of the "Methodological tool: Analysis of lock-in risk", applying a threshold of [XX].[24]]

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[20] Data from Fridriksson et al. (2017) indicates an emission intensity range of 4 - 740 g/kWh for geothermal electricity generation. This suggests that some geothermal power plants have a high emissions intensity and thus carry a lock-in risk. Therefore, a lock-in risk analysis is required for geothermal power generation projects. See Fridriksson, T., Mateos, A., Audinet, P. and Orucu, Y. (2017). *Greenhouse Gases from Geothermal Power Production*. ESMAP Technical Report 09/16. World Bank, Washington, DC.

[21] The methodology specifies how the emissions intensity of the technology, the BAU emissions and the lowest emission intensity for the proposed Article 6.4 activity is calculated, therefore the determination of comparable technologies and applicable geographical area are not relevant.

[22] For renewable power plants, a resource important for mitigating climate change or achieving other policy objectives is land use. However, for a geothermal power plant, land is used primarily for the construction of wells, pipelines, and the plant itself, all of which are focused in a limited area. Therefore, an assessment of possible inefficient use of resources is not required.

[23] [Given the overall electricity demand and the installed capacity of individual renewable power plants, the scale assessment is not required.]

[24] Compared to other renewable power plant types eligible under the methodology, solar photovoltaic power plants, solar thermal power plants, and hydro power plants typically involve more extensive land use per kilowatt hour of electricity generation. For photovoltaic power plants, land may be used for the installation of photovoltaic modules. For solar thermal power plants, land may be used for the heat collection field and associated thermal storage facilities. For hydro power plants, land may be used from the flooding land areas. Therefore, the assessment of land resources is required for these power generation types within the methodology.

[Option 4: A combination of Option 2 and 3, i.e., assessment of lock in analysis for (a) geothermal power plants and (b) solar and hydropower plants, with the resource assessment limited to land use only.]

Note: The MEP would like to seek public inputs on:

a) The most appropriate option for analysis of lock-in; and

b) The provisions for options 3 and 4 on how to determine the threshold for land-use, including whether this threshold should be set at the mechanism methodology level or at the project level.

6.3. Investment analysis

32. Activity participants shall use a valid version of the "Methodological tool: Investment analysis" (A6.4-AMT-002) to conduct the investment analysis. In applying the tool, activity participants shall implement all of the following specifications:

(a) **Identification of alternative scenarios:** Identify realistic and credible alternative scenarios to the proposed Article 6.4 activity, which shall include, but are not limited to, the following:

(i) Implementation of the proposed Article 6.4 activity without registering it under the Article 6.4 mechanism;

(ii) Electricity generation by existing and/or new grid-connected power plants instead of the Article 6.4 activity; and

(iii) Electricity generation by greenfield power plants of any type other than the Article 6.4 activity.

(b) **Analysis method:** use the investment comparison analysis or, if the only alternative to the proposed Article 6.4 activity is the continuation of the current situation prior to the implementation of the Article 6.4 activity, use the benchmark analysis;

(c) **Financial indicator:** use the net present value (NPV) as financial indicator where the investment comparison analysis is applied and choose an appropriate indicator where the benchmark analysis is applied, such as internal rate of return (IRR) or NPV;

(d) **Implementation entity:** assume that the Article 6.4 activity could be implemented by either the activity participants or other entities, unless activity participants can demonstrate that in the specific context of the proposed Article 6.4 activity that it can only be implemented by the activity participants and not by any other entities; and

(e) **Sensitivity analysis:** In conducting the sensitivity analysis, apply a variation of at least +/- 10 per cent to the input values which constitute more than 20 per cent of the total costs or total revenues.

6.4. Common practice analysis

33. Activity participants shall use a valid version of the "Methodological tool: Common practice analysis" (A6.4-AMT-001) to conduct the common practice analysis. In applying the tool, activity participant shall implement all of the following specifications:

(a) **Approach for common practice analysis:** Approach A (which is based on the identification of existing "comparable activities" and differentiation between "similar" and "different" activities) shall be used;

(b) **Indicator of common practice:** The installed power generation capacity, expressed in MW, shall be used;

(c) **Stock-based or time-bound approach:** A time-bound approach shall be used (i.e. considering all comparable activities implemented within the reference period). The reference period shall be defined as the most recent [3][5] years prior to the earlier of (i) the start of operation of the Article 6.4 activity and (ii) the submission of the project design document (PDD) for validation;

(d) **Applicable geographical area:** The host country shall be used. Where the applicable geographical must be widened in accordance with Step 4 of the tool, the widening shall be conducted as follows:

(i) For Article 6.4 activities implemented in a least developed country (LDC) or small island developing state (SIDS): The applicable geographical area shall consist of all LDCs and SIDS;

(ii) For Article 6.4 activities implemented in countries other than LDCs or SIDS: The applicable geographical area shall correspond to the relevant [continent][regional group under the UNFCCC];

(iii) Where the widening based on sub-paragraphs (i) and (ii) above is not sufficient, the applicable geographical area shall be global (i.e., including all countries).

(e) **Consideration of scale of output or capacity of the technology, measure, or practice:** All capacity sizes of comparable activities shall be used;

(f) **Common practice threshold:** The common practice factor thresholds to be applied under this mechanism methodology shall be:

(i) [x] per cent for Article 6.4 activities located in non-LDCs/SIDS; and

(ii) [x] per cent for Article 6.4 activities located in LDCs/SIDS.

Note: The MEP would like to seek public inputs on the above thresholds.

(g) **Comparable, similar and different activities:**

(i) Comparable activities shall be all power plants connected to the electricity system;

(ii) Similar activities shall be specified as follows:

[Option 1:

a. For wind power plants: all other wind power plants;].

[Option 2:

b. For onshore wind power plants: all other onshore wind power plants;

c. For offshore wind power plants: all other offshore wind power plants].

End of options 1 and 2

d. For solar PV plants: all other solar PV power plants;

e. For solar thermal power plants: all other solar thermal power plants;

f. For geothermal power plants: all other geothermal power plants;

g. For run-of-river hydro power plants: all other hydro power plants.

Note: The MEP would like to seek public inputs on which option is the most appropriate for identifying comparable, similar and different activities for wind power projects.

7. Baseline emissions

7.1. Selection of the baseline approaches from paragraph 36 of the rules, modalities and procedures

34. The following approach from the RMPs as per decision 3/CMA.3 is used to determine the baseline in this mechanism methodology:[25]

☐ Best available technologies that represent an economically feasible and environmentally sound course of action, where appropriate.

☐ 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.

☒ An approach based on existing actual or historical emissions, adjusted downwards to ensure alignment with paragraph 33 of the RMP.

7.2. Application of the selected approach, prior to implementation of a downward adjustment

7.2.1. Procedure for the identification of the baseline scenario

35. The baseline scenario shall be deemed as electricity generation by existing power plants connected to the electricity system and by the addition of new generation sources.

36. Where an Article 6.4 activity installs a greenfield hydropower plant at an existing reservoir, the activity participant shall consider all possible alternatives with regard to the existing reservoir and justify that there are no feasible alternatives other than continuing to operate

[25] The approach is selected considering that the power plant construction is highly site-specific, depending on local natural resources and the emission intensity of each power generation technology is highly activity-specific, depending on the energy resources and technology employed.

the reservoir without reducing its size. The possible alternatives shall include, but not limited to:

(a) Installing a hydropower plant, i.e., implementation of the proposed Article 6.4 activity without registering it under the Article 6.4 mechanism;

(b) Decommissioning the reservoir within the crediting period;

(c) Retrofitting the reservoir to increase its size;

(d) Retrofitting the reservoir to reduce its size; and

(e) Operating the reservoir at its current size and using it for the same purpose as that prior to the implementation of the Article 6.4 activity.

7.2.2. Calculation of the unadjusted baseline emissions from electricity generation from the Article 6.4 activity

37. Activity participants shall use a valid version of the "Methodological tool: Emissions from electricity generation and consumption" (A6.4-AMT-007) to calculate the unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year *y* ($BE_{EG,y}$). In applying the methodological tool, activity participants shall implement all of the following specifications:

(a) **Electricity generation or consumption sources s:** The only source *s* to be considered for determining baseline emissions is the electricity generated by the Article 6.4 project power plant and fed into the electricity system;

(b) **Determination of the amount of electricity generated or consumed:** The electricity generation from the Article 6.4 activity ($EG_{PJ,y}$ or $EG_{PJ,h}$ in this mechanism methodology) corresponds to the general parameters $EG_{s,y}$ or $EG_{s,h}$ in the mechanism methodological tool;

(c) **Type of electricity generation sources:** For solar and wind power plants, the electricity generation shall be considered as intermittent, regardless of whether the plants are operated with an integrated BESS.[26] For geothermal power and hydropower plants, the electricity generation shall be considered as non-intermittent;

(d) **Applicable scenarios:** Scenario A in step 2 of the methodological tool shall apply;

(e) **Whether Case 1 or Case 2 applies:** Case 2 in step 4 of the methodological tool shall apply;

(f) **Consideration of uncertainty:** Baseline emissions prior to downward adjustment shall be determined without accounting for the uncertainty of the relevant parameters.

38. The electricity generation from the Article 6.4 activity ($EG_{PJ,y}$ or $EG_{PJ,h}$) shall be calculated based on the quantity of electricity generated by the Article 6.4 project power plant and fed into the electricity system in year *y* ($EG_{plant,y}$ or $EG_{plant,h}$) and, where applicable, by

[26] This requirement for BESS is a temporary provision, and the MEP may incorporate specific provisions in a future revision of the methodology. Activity participants are also invited to submit a revision to this mechanism methodology through the "Procedure: Development, revision and clarification of methodologies and methodological tools" (A6.4-PROC-METH-001).

subtracting (i) any reduction in electricity generation by other wind power plants through shadowing effects in year y ($EG_{shadowing,y}$ or $EG_{shadowing,h}$) and/or (ii) any renewable electricity generation that would occur in the baseline scenario due to legal requirements in year y ($EG_{legal,y}$ or $EG_{legal,h}$), as follows:

$$EG_{PJ,y} = EG_{plant,y} - EG_{shadowing,y} - EG_{legal,y}$$ Equation (1)

or

$$EG_{PJ,h} = EG_{plant,h} - EG_{shadowing,h} - EG_{legal,h}$$ Equation (2)

Where:

$EG_{PJ,y}$	=	Electricity generation from the Article 6.4 activity in year y (MWh)
$EG_{plant,y}$	=	Quantity of electricity generated by the Article 6.4 project power plant and fed into the electricity system in year y (MWh)
$EG_{shaddowing,y}$	=	Reduction in electricity generation by other wind power plants through shadowing effects in year y (MWh), where applicable
$EG_{legal,y}$	=	Renewable electricity generation that would occur in the baseline scenario due to legal requirements in year y (MWh), where applicable
$EG_{PJ,h}$	=	Electricity generation from the Article 6.4 activity in hour h (MWh)
$EG_{plant,h}$	=	Quantity of electricity generated by the Article 6.4 project power plant and fed into the electricity system in hour h (MWh)
$EG_{shaddowing,h}$	=	Reduction in electricity generation by other wind power plants through shadowing effects in hour h (MWh), where applicable
$EG_{legal,h}$	=	Renewable electricity generation that would occur in the baseline scenario due to legal requirements in hour h (MWh), where applicable

39. For wind power plants, any reduction in electricity generation by other wind power plants through shadowing effects ($EG_{shadowing,y}$ or $EG_{shadowing,h}$) does not need be account for if:

(a) The distance between the wind turbines installed under the Article 6.4 activity and any other wind power plants is greater than [x] kilometers; or

Note: The MEP would like to seek public inputs on the above distance.

(b) The shadowing effects affect other wind power plants that are registered as an Article 6.4 activity.

40. The unadjusted baseline emissions from electricity generation in year y ($BE_{EG,y}$) shall be calculated in accordance with Step 10 of the methodological tool, by multiplying the electricity generation from the Article 6.4 activity ($EG_{PJ,y}$ or $EG_{PJ,h}$) with the respective emission factor for the electricity system.

7.3. Application of the downward adjustment

41. The downward adjusted baseline emissions from electricity generation from the Article 6.4 activity are separately determined for the calendar year of the start date of the first crediting period (section 7.3.1) and subsequent calendar years (section 7.3.2).

7.3.1. Downward adjustment in the calendar year of the start date of the first crediting period

42. The steps below shall be followed to determine the downward adjusted baseline emissions from electricity generation from the Article 6.4 activity in the calendar year of the start date of the first crediting period ($BE_{EG,adj,y1}$).

7.3.1.1. Step 1. Determine the uncertainty of the unadjusted baseline emission from electricity generation ($UNC_{BE,EG,y1}$)

43. Activity participants shall determine the uncertainty of the unadjusted baseline emissions from electricity generation from the Article 6.4 activity for the calendar year of the start date of the first crediting period ($UNC_{BE,EG,y1}$). This term shall be determined at the lower bound of the 95 per cent confidence interval relative to the central estimate of the estimated unadjusted baseline emissions from electricity generation from the Article 6.4 activity in that year, following the relevant provisions in the “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-007).

44. In applying the tool, activity participants shall consider uncertainty in all parameters used to calculate baseline emissions, including the electricity generation and the emission factor for the electricity system. Activity participants shall document the uncertainties assigned to each parameter, specify assumptions made, and include any associated references for estimating the uncertainties of parameters in the PDD. This documentation and the derivation of the overall uncertainty through the error propagation or Monte Carlo simulation methods shall be provided together with the PDD (e.g., in a spreadsheet).

7.3.1.2. Step 2. Determine the downward adjusted baseline emissions based on uncertainty ($BE_{EG,adj,UNC,y1}$)

45. Activity participants shall determine the downward adjusted baseline emissions from electricity generation from the Article 6.4 activity based on uncertainty in the calendar year of the start date of the first crediting period ($BE_{EG,adj,UNC,y1}$) as follows:[27]

$$BE_{EG,adj,UNC,y1} = BE_{EG,y1} \times \left(1 - UNC_{BE,EG,y1}\right)$$ Equation (3)

Where:

$BE_{EG,adj,UNC,y1}$	=	Downward adjusted baseline emissions from electricity generation from the Article 6.4 activity based on uncertainty in year y_1 (t CO_2eq)
$BE_{EG,y1}$	=	Unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
$UNC_{BE,EG,y1}$	=	Uncertainty of the unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (fraction)
y_1	=	Calendar year of the start date of the first crediting period

46. The parameter $BE_{EG,y1}$ in equation (3) corresponds to the parameter $BE_{EG,s,y}$ in the “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-

[27] This approach draws on paragraph 64(b) of the Baseline Standard that allows for approaches other than the approach in paragraph 64(a) which determines the uncertainty of baseline emissions at the lower bound of the 95 per cent confidence interval relative to the central estimate of the ex-ante quantified unadjusted net baseline emissions.

007) and shall be determined for the calendar year of the start date of the first crediting period (*y1*) in accordance with step 10 of the methodological tool.

7.3.1.3. Step 3. Determine the minimum downward adjusted baseline emissions ($BE_{EG,ajd,min,y1}$)

47. The minimum downward adjusted baseline emissions from electricity generation from the Article 6.4 activity for the calendar year of the start date of the first crediting period ($BE_{EG,adj,min,y1}$) shall be determined as follows:

$$BE_{EG,adj,min,y1} = BE_{EG,y1} - \left(BE_{EG,y1} - PE_{y1}\right) \times 0.1$$ Equation (4)

Where:

$BE_{EG,adj,min,y1}$	=	Minimum downward adjusted baseline emissions from the electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
$BE_{EG,y1}$	=	Unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
PE_{y1}	=	Project emissions in year y_1 (t CO_2eq), calculated as per section 8
0.1	=	Default discount factor to determine the minimum downward adjusted baseline provided in the “Standard: Setting the baseline in mechanism methodologies” (A6.4-STAN-METH-004)[28]
y_1	=	Calendar year of the start date of the first crediting period

7.3.1.4. Step 4. Compare $BE_{EG,adj,UNC,y1}$ and $BE_{EG,adj,min,y1}$

48. To determine the downward adjusted baseline emissions from the electricity generation from the Article 6.4 activity in the calendar year of the start date of the first crediting period ($BE_{EG,adj,y1}$), activity participants shall use the lower of the two values determined in Steps 2 and 3 above, as follows:

$$BE_{EG,adj,y1} = min\left(BE_{EG,adj,min,y1}\ ;\ BE_{EG,adj,UNC,y1}\right)$$ Equation (5)

Where:

$BE_{EG,adj,y1}$	=	Downward adjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
$BE_{EG,adj,min,y1}$	=	Minimum downward adjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
$BE_{EG,adj,UNC,y1}$	=	Downward adjusted baseline emissions from electricity generation from the Article 6.4 activity based on uncertainty in year y_1 (t CO_2eq)
y_1	=	Calendar year of the start date of the first crediting period

7.3.1.5. Step 5. Determine the initial downward adjustment (DA_{y1})

49. In the following section on downward adjusted baselines in subsequent years, the initial downward adjustment is an input parameter. It shall be determined as the higher value between the minimum downward adjustment, represented by the term ($BE_{EG,y1}$ – PE_{y1}) x

[28] See https://unfccc.int/sites/default/files/resource/A6.4-STAN-METH-004.pdf.

0.1 in equation (5), and the downward adjustment based on the uncertainty, represented by the term ($BE_{EG,y1}$ x $UNC_{BE,EG,y1}$) in equation (5), as follows:

$$DA_{y1} = max\begin{pmatrix} (BE_{EG,y1} - PE_{y_1}) \times 0.1 \\ or \\ BE_{EG,y1} \times UNC_{BE,EG,y1} \end{pmatrix} \times \frac{d_{y1}}{d_{PJ,y1}}$$ Equation (6)

Where:

DA_{y1}	=	Initial downward adjustment (t CO_2eq)
$BE_{EG,y1}$	=	Unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
PE_{y_1}	=	Project emissions in year y_1 (t CO_2eq), calculated as per section 8
$UNC_{BE,EG,y1}$	=	Uncertainty of the unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year y_1 (fraction)
y_1	=	Calendar year of the start date of the first crediting period
0.1	=	Default discount factor to determine the minimum downward adjusted baseline provided in the "Standard: Setting the baseline in mechanism methodologies" (A6.4-STAN-METH-004)
$d_{PJ,y1}$	=	Number of days from the start date of the first crediting period until the end of that year
d_{y1}	=	Number of days in the calendar year of the start date of the first crediting period (365 or 366 days)

7.3.2. Downward adjustment in subsequent years

50. The starting point for increasing the downward adjustment over time shall be the downward adjusted baseline values in the calendar year of the start date of the first crediting period, as determined in section 7.3.1.

51. The annual increase in the downward adjustment shall be applied starting on 1 January of a calendar year. The first increase shall be applied in the calendar year following the calendar year of the start date of the first crediting period. A pro-rata approach may be used to apply this minimum value to periods other than a full calendar year.[29]

52. The downward adjusted baseline emissions in subsequent years shall be determined based on an increase in the downward adjustment by 1 per cent per calendar year as informed as

[29] The pro-rata approach is illustrated through the following numerical example. Suppose that the first crediting period of an Article 6.4 activity starts on 1 October 2025, and the initial downward adjustment is determined to be 50 tCO_2eq per year. Then, the annual increase in the downward adjustment is determined to be 5 tCO_2 per year, resulting in a total downward adjustment is 55 tCO_2eq per year in the second year and 60 tCO_2 per year in the third year. In this example, following a pro-rata approach means that a downward adjustment of 50 tCO_2eq per year shall be pro-rated before being applied in the calendar year of the start date of the first crediting period, i.e., for the period from 1 October 2025 to 31 December 2025. This corresponds to an absolute value of 12.60 tCO_2eq for that period, calculated as 92 days divided by 365 days multiplied by 50 tCO_2eq. For the calendar year 2026 (i.e., the period from 1 January 2026 to 31 December 2026), a downward adjustment of 51.26 tCO_2eq shall be applied, calculated as the sum of (i) 273 days divided by 365 days multiplied by 50 tCO_2eq 50 and (i) 92 days divided by 365 days multiplied by 55 tCO_2eq. Starting from 2027, the annual downward adjustment is increased by 5 tCO_2eq on 1 January of each year, resulting in a value of 56.26 tCO_2eq for 2027, 61.26 tCO_2eq for 2028, and so forth).

per paragraph 71 of the “Standard: Setting the baseline in mechanism methodologies” (A6.4-STAN-METH-004), as follows:

$$BE_{EG,adj,y} = BE_{EG,y} - \left[DA_{y1} + \left(BE_{EG,y1} \times 0.01 \times (y - y1)\right)\right] \quad \text{Equation (7)}$$

Where:

$BE_{EG,adj,y}$	=	Downward adjusted baseline emissions from electricity generation from the Article 6.4 activity in year *y* (t CO_2eq)
$BE_{EG,y}$	=	Unadjusted baseline emissions from electricity generation from the Article 6.4 activity in year *y* (t CO_2eq)
DA_{y1}	=	Initial downward adjustment (t CO_2eq)
$BE_{EG,y1}$	=	Unadjusted baseline emissions from the electricity generation from the Article 6.4 activity in year y_1 (t CO_2eq)
y	=	Calendar years of the crediting period after the calendar year of the start date of the crediting period
0.01	=	Annual increase in the downward adjustment
$y1$	=	Calendar year of the start date of the crediting period

53. The parameter $BE_{EG,y}$ in the equation above refers to the parameter $BE_{EG,s,y}$ of the methodological tool “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-007) and shall be determined as per the provisions of this methodological tool.

7.4. Determination of a conservative ‘Business-as-usual’ (BAU) baseline and comparison of the downward adjusted baseline and the conservative business-as-usual baseline

54. The conservative business-as-usual (BAU) scenario for Article 6.4 activities eligible under this mechanism methodology is deemed to be the same as the baseline scenario, i.e., that the electricity delivered by the Article 6.4 activity to the electricity system would otherwise be generated by the operation of existing grid-connected power plants and by the addition of new generation sources.[30]

55. Since the conservative BAU scenario and the baseline scenario are the same, the conservative BAU emissions will always be higher than the downward adjusted baseline emissions, except for the calendar year of the start date of the first crediting period. Therefore, for that year the crediting baseline determined in equation (5) shall be multiplied with a factor of 0.99 to ensure it is lower than the conservative BAU. Activity participants do not need to calculate or compare the conservative BAU emissions in subsequent years.

[30] Conservativeness is ensured because the “Methodological tool: Emissions from Electricity Generation and Consumption” (A6.4-AMT-007) determines the emission factor for an electricity system reflecting the dynamic trends in the electricity system to which the Article 6.4 activity is connected.

8. Project emissions

56. Project emissions shall be calculated as follows:

$$PE_y = PE_{FC,y} + PE_{EC,y} + PE_{GP,y} \quad \text{Equation (8)}$$

Where:

PE_y = Project emissions in year *y* (t CO_2eq)

$PE_{FC,y}$ = Project emissions from fossil fuel consumption in year *y* (t CO_2eq), where applicable

$PE_{EC,y}$ = Project emissions from electricity consumption in year *y* (t CO_2eq), where applicable

$PE_{GP,y}$ = Project emissions from the operation of dry, flash steam or binary geothermal power plants in year *y* (t CO_2eq), where applicable

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

57. This emission source shall include any fossil fuel consumption occurring during the operation of the Article 6.4 project power plant. This may, for example, include emissions from the operation of backup generators or emissions arising from maintenance of the Article 6.4 project power plant (e.g. emissions from fossil fuels used in ships or helicopters to maintain offshore wind power plants). Fossil fuel consumption associated with the construction or decommissioning of the Article 6.4 project power plant do not need to be considered. Emissions from the construction of the Article 6.4 project power plant shall not be included.

58. Activity participants shall describe the relevant emissions sources in the PDD and justify that all relevant emissions sources from fossil fuel consumption were considered.

59. This source of project emissions shall be calculated as follows:

$$PE_{FC,y} = \sum_i \left(FC_{i,y} \times COEF_{i,y}\right) \quad \text{Equation (9)}$$

Where:

$PE_{FC,y}$ = Project emissions from fossil fuel consumption due to the Article 6.4 activity in year *y* (t CO_2eq)

$FC_{i,y}$ = Quantity of fuel type *i* combusted during the year *y* (mass or volume unit)

$COEF_{i,y}$ = Emission coefficient of fuel type *i* in year *y* (t CO_2eq / mass or volume unit)

i = Fuel types combusted

60. The CO_2 emission coefficient ($COEF_{i,y}$) can be calculated using one of the following options, depending on the availability of data on the fossil fuel type *i*, as follows:

(a) Option A.1: Calculated based on the chemical composition of the fossil fuel type *i*, if $FC_{i,y}$ is measured in a mass unit:

$$COEF_{i,y} = w_{c,i,y} \times 44/12 \times 1.002$$ Equation (10)

Where:

$w_{c,i,y}$	=	Mass fraction of carbon in fuel type *i* in year *y* (t C/mass unit of the fuel)
44/12	=	Unit conversion factor (t CO2eq / tC)
1.002	=	Factor to account for emissions of N_2O and CH_4 from the combustion of the fossil fuel

(b) Option A.2: Calculated based on the chemical composition of the fossil fuel type *i*, if $FC_{i,y}$ is measured in a volume unit:

$$COEF_{i,y} = w_{c,i,y} \times \rho_{,i,y} \times 44/12 \times 1.002$$ Equation (11)

Where:

$w_{c,i,y}$	=	Mass fraction of carbon in fuel type *i* in year *y* (t C/mass unit of the fuel)
$\rho_{,i,y}$	=	Density of fuel type *i* in year *y* (mass unit/volume unit of the fuel)
44/12	=	Unit conversion factor (t CO2eq / tC)
1.002	=	Factor to account for emissions of N_2O and CH_4 from the combustion of the fossil fuel

(c) Option B: Calculated based on net calorific value and CO_2 emission factor of the fuel type *i*, as follows:

$$COEF_{i,y} = NCV_{i,y} \times EF_{CO2e,i,y} \times 1.002$$ Equation (12)

Where:

$NCV_{i,y}$	=	Net calorific value of the fuel type *i* in year *y* (GJ/mass or volume unit)
$EF_{CO2e,i,y}$	=	CO_2 emission factor of fuel type *i* in year *y* (t CO_2eq/GJ)
1.002	=	Factor to account for emissions of N_2O and CH_4 from the combustion of the fossil fuel

61. Activity participants shall use options A.1 or A.2, unless they can demonstrate that the necessary data are unavailable. If the necessary data are unavailable, activity participants may use option B.

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

62. Activity participants shall use a valid version of the "Methodological tool: Emissions from electricity generation and consumption" (A6.4-AMT-007) to calculate project emissions from

electricity consumption in year *y* ($PE_{EC,y}$). In applying the tool, activity participants shall implement all of the following specifications:

(a) **Electricity generation or consumption sources:** The only source *s* to be considered for determining project emissions from electricity consumption is the electricity consumed by the Article 6.4 project power plant from the electricity system;

(b) **Determination of the amount of electricity generated or consumed:** The quantity of electricity consumed by the Article 6.4 project power plant from the electricity system in year *y* corresponds to the general parameters $EC_{s,y}$ or $EC_{s,h}$ in the methodological tool;

(c) **Type of electricity consumption source s:** For solar and wind power plants, the electricity consumption shall be considered as electricity consumption source depending on intermittent generation, regardless of whether the plants are operated with an integrated BESS. For geothermal power and hydropower plants, the electricity consumption shall be considered as electricity consumption source not depending on intermittent generation;[31]

(d) **Applicable scenarios:** Scenario A in step 2 of the methodological tool shall apply;

(e) **Whether Case 1 or Case 2 applies:** Case 1 in step 4 of the methodological tool shall apply; and

(f) **Consideration of uncertainty:** The upper bound of the uncertainty interval of the emission factor shall be used, determined in accordance with the provisions in the methodological tool. Uncertainty in the quantity of electricity consumed does not need to be accounted for.

63. The project emissions from electricity consumption in year *y* ($PE_{EC,y}$) shall be calculated in accordance with step 10 of the methodological tool.

64. In case the electricity consumption is netted from the total electricity generation according to step 4 of the methodological tool, it shall not be included in project emissions.

8.3. Project emissions from the operation of geothermal power plants ($PE_{GP,y}$)

65. Project emissions from the operation of geothermal power plants in year *y* ($PE_{GP,y}$) shall include the following emission sources:

(a) For dry or flash steam geothermal power plants, activity participants shall account for emissions of CO_2 and CH_4 due to the release of non-condensable gases from produced steam ($PE_{dry\ or\ flash\ steam,y}$). Non-condensable gases in geothermal reservoirs usually consist mainly of CO_2 and H_2S. They also contain a small quantity of hydrocarbons, which are predominantly CH_4. In dry or flash steam geothermal power projects, non-condensable gases flow with the steam into the power plant and come in touch with the atmosphere during the heat exchange process. In such a process, non-condensable and other gases within the geothermal fluid are partially

[31] This requirement for BESS is a temporary provision, and the MEP may incorporate specific provisions in a future revision of the methodology. Activity participants are also invited to submit a revision to this mechanism methodology through the "Procedure: Development, revision and clarification of methodologies and methodological tools" (A6.4-PROC-METH-001).

released to the atmosphere. A small proportion of the CO_2 is converted into 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 mechanism methodology assumes that all non-condensable gases entering the power plant in dry or flash steam geothermal technologies are discharged to the 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 considered negligible (see appendix 1).

(b) For binary geothermal power plants, the underground fluid is re-injected back into 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. Therefore, activity participants shall account for emissions from physical leakage of non-condensable gases ($PE_{steam,y}$). In addition, activity participants shall account for emissions from physical leakage of the working fluid contained in heat exchangers ($PE_{working\ fluid,y}$).

66. Accordingly, $PE_{GP,y}$ shall be calculated as follows:

(a) For dry or flash steam geothermal power plants:

$$PE_{GP,y} = PE_{dry\ or\ flash\ steam,y} \qquad \text{Equation (13)}$$

Where:

$PE_{GP,y}$	=	Project emissions from the operation of the project geothermal power plant in year y (t CO_2eq)
$PE_{dry\ or\ flash\ steam,y}$	=	Project emissions from the release of non-condensable gases in a dry steam or flash steam project geothermal power plant in year y (t CO_2eq)

(a) For binary geothermal power plants:

$$PE_{GP,y} = PE_{steam,y} + PE_{working\ fluid,y} \qquad \text{Equation (14)}$$

Where:

$PE_{GP,y}$	=	Project emissions from the operation of the project geothermal power plant in year y (t CO_2eq)
$PE_{steam,y}$	=	Project emissions from physical leakage of non-condensable gases in a binary project geothermal power plant in year y (t CO_2eq)
$PE_{working\ fluid,y}$	=	Project emissions from physical leakage of working fluid contained in heat exchangers in a binary project geothermal power plant due to in year y (t CO_2eq)

67. Project emissions from the release of non-condensable gases in a dry steam or flash steam project geothermal power plant in year y ($PE_{dry\ or\ flash\ steam,y}$) shall be calculated as follows:

$$PE_{dry\ or\ flash\ steam,y} = \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \times M_{steam,y} \qquad \text{Equation (15)}$$

Where:

$PE_{dry\ or\ flash\ steam,y}$	=	Project emissions from the release of non-condensable gases in a dry steam or flash steam project geothermal power plant in year *y* (t CO_2eq)
$w_{steam,CO2,y}$	=	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_2eq / t CH_4)
$M_{steam,y}$	=	Quantity of steam produced in year *y* (t steam)

68. Project emissions from physical leakage of non-condensable gases in a binary project geothermal power plant in year *y* ($PE_{steam,y}$) shall be calculated as follows:

$$PE_{steam,y} = \left(M_{Inflow,y} - M_{outflow,y}\right) \times \left(w_{steam,CO2,y} + w_{steam,CH4,y} \times GWP_{CH4}\right) \quad \text{Equation (16)}$$

Where:

$PE_{steam,y}$	=	Project emissions from physical leakage of non-condensable gases in a binary project geothermal power plant in year *y* (t CO_2eq)
$M_{Inflow,y}$	=	Quantity of steam entering the geothermal plant in year *y* (t steam)
$M_{outflow,y}$	=	Quantity of steam leaving the geothermal plant in year *y* (t steam)
$w_{steam,CO2,y}$	=	Average mass fraction of CO_2 in the produced steam in year *y* (t CO_2/t steam)
$w_{steam,CH4,y}$	=	Average mass fraction of CH_4 in the produced steam in year *y* (t CH_4/t steam)
GWP_{CH4}	=	Global warming potential of CH_4 (t CO_2eq / t CH_4)

69. Project emissions from physical leakage of working fluid contained in heat exchangers in a binary project geothermal power plant due to in year *y* ($PE_{working\ fluid,y}$) shall be calculated as follows:

$$PE_{working\ fluid,y} = M_{working\ fluid,y} \times GWP_{working\ fluid} \quad \text{Equation (17)}$$

Where:

$PE_{working\ fluid,y}$	=	Project emissions from physical leakage of working fluid contained in heat exchangers in a binary project geothermal power plant due to in year *y* (t CO_2eq)
$M_{working\ fluid,y}$	=	Quantity of working fluid leaked/reinjected in year *y* (t working fluid)
$GWP_{working\ fluid}$	=	Global Warming Potential for the working fluid used in the binary geothermal power plant (t CO_2eq / t working fluid)

9. Leakage emissions

70. No other sources of leakage emissions in this mechanism methodology other than shadowing effects from wind power plants are considered in this methodology (see Appendix 1 for more information). The shadowing effects of wind power plants are, for

simplicity, accounted for in determining the electricity generation from the Article 6.4 activity ($EG_{PJ,y}$ or $EG_{PJ,h}$) in section 7.2.2, and are thus not accounted for in this section.

Note: The provisions for determining of leakage may be changed based on the result of the ongoing analysis of the MEP of the relevance of different emission sources (see appendix 1) and public inputs received.

10. Emission reductions

71. Emission reductions shall be determined as follows:

$$ER_y = BE_{EG,adj,y} - PE_y \quad \text{Equation (18)}$$

Where:

ER_y	=	Emission reductions in year *y* (t CO_2eq)
$BE_{EG,adj,y}$	=	Downward adjusted baseline emissions from electricity generation from the Article 6.4 activity in year *y* (t CO_2eq)
PE_y	=	Project emissions in year *y* (t CO_2eq)
y	=	Calendar years of the crediting period

72. Note that this mechanisms methodology addresses uncertainty in the determination of individual parameters or through conservative assumptions. It is therefore not necessary to determine on overall uncertainty of the aggregated emission reductions.

11. Avoidance of double counting

73. All activity participants shall demonstrate that the Article 6.4 activity will not result in double counting by:

(a) Providing evidence, in each monitoring report, that the outcomes from the Article 6.4 activity for which they intend to request issuance of A6.4ERs are not also claimed in other environmental markets or accounting framework (e.g., guarantees of origin for renewable energy generation, green hydrogen schemes, low-carbon fuel standards), except for outcomes not related to reducing greenhouse gases emissions (e.g., air contaminant reductions or social impacts); and

(b) Demonstrating that the reported GHG emission reductions for which they intend to request issuance of A6.4ERs do not overlap with mandatory domestic mitigation schemes (e.g., emissions trading systems), or that measures are in place to ensure that any relevant impacts of the activity (e.g., the GHG emission reductions achieved or the kilowatt-hours of renewable electricity produced) are not counted towards the achievement of targets or obligations under the mandatory domestic mitigation scheme (e.g., by cancelling allowances from the emissions trading system before issuing carbon credits) if the overlap exists, by:

(i) Declaring and providing evidence in each monitoring report that the Article 6.4 activity and the activities displaced in the baseline scenario do not fall within the scope of any mandatory domestic mitigation scheme; or

(ii) Where the Article 6.4 activity or the activities displaced in the baseline scenario fall within the scope of a mandatory domestic mitigation scheme, activity participants may provide evidence in each monitoring report that the mitigation outcomes of the Article 6.4 activity are not counted in the mandatory mitigation scheme to reduce the obligations by the entities covered by the scheme. For example, in the case of an emissions trading system covering electricity generation, a confirmation from the operator of the emissions trading system may be sought that a number of allowances equal to the A6.4ERs being requested for issuance for the electricity generation component were cancelled before the issuance of the A6.4ERs.

74. Notwithstanding paragraph 73 above, where the policy for establishing the framework or environmental market or for establishing the mandatory domestic mitigation scheme refers to or formally integrates the mechanism as an instrument for implementation, participation in such a framework or environmental market or domestic mitigation scheme does not result in double counting.

12. Demonstration of alignment with the policies, options and implementation plans with regard to the NDC and LT-LEDS of the host Party and the long-term temperature goal of the Paris Agreement and long-term goals of the Paris Agreement

75. Activity participants shall attach to the PDD presented to the DOE performing the validation a confirmation from the DNA of the host Party that the DNA has undertaken an assessment of the activity's consistency with Decision 3/CMA.3 paragraph 40(c) and paragraph 27(a), as part of the host Party's approval, to demonstrate that the activity does not constrain, but aligns with the policies, options and implementation plans of the host Party with regard to the nationally determined contribution (NDC) of the host Party, its long-term low greenhouse gas emission development strategies (LT-LEDS) if it has submitted one, and the long-term temperature goal of the Paris Agreement and long-term goals of the Paris Agreement.

13. Data and parameters not monitored

76. For parameters where the uncertainty was not provided, activity participants shall assume uncertainty based on expert judgement and justify the estimates.

Data / Parameter table 1.

Data/parameter	GWP_{CH4}
Description	Global warming potential of CH_4
Data unit	t CO_2eq / t CH_4
Equations referred	(15)
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	28
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Default value and uncertainty from IPCC Fifth Assessment Report (AR5). Shall be updated according to any future CMA decisions

Treatment of uncertainties	N/A
Additional comments	-

Data / Parameter table 2.

Data/parameter	$GWP_{working\ fluid}$
Description	Global Warming Potential for the working fluid used in the binary geothermal power plant
Data unit	t CO_2eq / t working fluid
Equations referred	(17)
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Value(s) applied	Default value depending on the type of working fluid
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	Default value and uncertainty from IPCC Fifth Assessment Report (AR5). Shall be updated according to any future CMA decisions
Treatment of uncertainties	N/A
Additional comments	-

Data / Parameter table 3.

Data/parameter	$EG_{shadowing,y}$, $EG_{shadowing,h}$
Description	$EG_{shadowing,y}$: Reduction in electricity generation by other wind power plants through shadowing effects in year *y* $EG_{shadowing,h}$: Reduction in electricity generation by other wind power plants through shadowing effects in hour *h*
Data unit	MWh
Equations referred	(1), (2)
Purpose of data	☒ Baseline emissions ☐ Project emissions ☐ Leakage emissions
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources
Choice of data or measurement methods and procedures	[The value shall be sourced from reports (e.g., Environmental Impact Assessment, feasibility reports) or technical studies undertaken at the project site.] *Note: The MEP would like to seek public inputs on the sources of shadowing effect for wind power plants*
Treatment of uncertainties	N/A

Additional comments	• If the shadowing effects are presented in electricity units, this value shall be discounted from the $EG_{PJ,y}$ • If the shadowing effects are presented in percentage, $EG_{PJ,y}$ or $EG_{PJ,h}$ shall be multiplied by (1 – percentage)

14. Data and parameters monitored

77. 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.

78. The parameters $EG_{plant,y}$ and $EG_{plant,h}$, required to determine the unadjusted baseline emissions from electricity generation in year *y* ($BE_{EG,y}$) shall be monitored as per the monitoring provisions of the parameters $EG_{s,y}$ and $EG_{s,h}$ from the “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-007).

79. The parameters $EC_{s,y}$ and $EC_{s,h}$ shall be monitored as per the provisions from the “Methodological tool: Emissions from electricity generation and consumption” (A6.4-AMT-007).

Data / Parameter table 4.

Data/parameter	$EG_{legal,y}$; $EG_{legal,h}$	
Description	$EG_{legal,y}$: Renewable electricity generation that would occur in the baseline scenario due to legal requirements in year *y* $EG_{legal,h}$: Renewable electricity generation that would occur in the baseline scenario due to legal requirements in hour *h*	
Data unit	MWh	
Equations referred	(1), (2)	
Purpose of data	☒ Baseline emissions ☐ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Regular review of the approval of legal requirements	
Measurement methods and procedures		
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	-
	Accuracy class	-
	Calibration requirements	-
	Location	-
QA/QC procedures	-	

Treatment of uncertainties	-
Additional comment	If the legal requirement is provided in percentage of generation, activity participants shall convert the percentage to absolute generation

Data / Parameter table 5.

Data/parameter	$w_{steam,CO2,y}$	
Description	Average mass fraction of carbon dioxide in the produced steam in year *y*	
Data unit	$t\ CO_2/t_{steam}$	
Equations referred	(15), (16)	
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	At least every three months and more frequently, if necessary	
Measurement methods and procedures	• 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 may be reported in terms of methane.	
Entity/person responsible for the measurement	Activity participants or Third-party laboratory	
Measuring instrument(s)	*Type of instrument*	As per the “ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis”
	Accuracy class	As per the “ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis”
	Calibration requirements	As per the “ASTM Standard Practice E1675 for Sampling 2-Phase Geothermal Fluid for Purposes of Chemical Analysis”
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	The monitoring of this parameter is applicable only to dry, flash steam and binary geothermal power projects	

Data / Parameter table 6.

Data/parameter	$w_{steam,CH4,y}$	
Description	Average mass fraction of methane in the produced steam in year *y*	
Data unit	t CH_4/t_{steam}	
Equations referred	(15), (16)	
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	As per the procedures outlined for $w_{steam,CO2,y}$	
Measurement methods and procedures	As per the procedures outlined for $w_{steam,CO2,y}$	
Entity/person responsible for the measurement	As per the procedures outlined for $w_{steam,CO2,y}$	
Measuring instrument(s)	*Type of instrument*	As per the procedures outlined for $w_{steam,CO2,y}$
	Accuracy class	As per the procedures outlined for $w_{steam,CO2,y}$
	Calibration requirements	As per the procedures outlined for $w_{steam,CO2,y}$
	Location	N/A
QA/QC procedures	-	
Treatment of uncertainties	As per the procedures outlined for $w_{steam,CO2,y}$	
Additional comment	As per the procedures outlined for $w_{steam,CO2,y}$	

Data / Parameter table 7.

Data/parameter	$M_{steam,y}$
Description	Quantity of steam produced in year *y*
Data unit	t_{steam} in year *y*
Equations referred	(15)
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions
Measurement and updating frequency	Continuously measured
Measurement methods and procedures	• 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, and the calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards
Entity/person responsible for the measurement	Activity participants

Measuring instrument(s)	*Type of instrument*	Venturi flow meter or other equipment with at least the same accuracy
	Accuracy class	According to the national, international, or meter supplier's instructions
	Calibration requirements	Calibration shall be conducted according to the national, international, or manufacturer's instructions
	Location	Main steam line
QA/QC procedures	The recorded data must be stored daily in a central database with backup	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	• The measurement results should be summarized transparently in regular production reports; • Applicable to dry or flash steam geothermal power projects	

Data / Parameter table 8.

Data/parameter	$M_{inflow,y}$	
Description	Quantity of steam entering the geothermal plant in year *y*	
Data unit	t_{steam} in year *y*	
Equations referred	(16)	
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuously measured	
Measurement methods and procedures	• 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, and the calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Venturi flow meter or other equipment with at least the same accuracy
	Accuracy class	According to the national, international, or meter supplier's instructions
	Calibration requirements	Calibration shall be conducted according to the national, international, or manufacturer's instructions
	Location	At the steam supply line to the geothermal power plant
QA/QC procedures	The recorded data must be stored daily in a central database with backup	

Treatment of uncertainties	Uncertainties are determined based on the measuring instruments
Additional comment	• The measurement results should be summarized transparently in regular production reports; • Applicable to dry or flash steam geothermal power projects

Data / Parameter table 9.

Data/parameter	$M_{outflow,y}$	
Description	Quantity of steam leaving the geothermal plant in year *y*	
Data unit	t_{steam} in year *y*	
Equations referred	(16)	
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Continuously measured	
Measurement methods and procedures	• The steam quantity leaving 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, and the calculation of steam quantities should be conducted on a continuous basis and should be based on national or international standards	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Venturi flow meter or other equipment with at least the same accuracy
	Accuracy class	According to the national, international, or meter supplier's instructions
	Calibration requirements	Calibration shall be conducted according to the national, international, or manufacturer's instructions
	Location	At the steam line coming out of the geothermal power plant
QA/QC procedures	The recorded data must be stored daily in a central database with backup	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	• The measurement results should be summarized transparently in regular production reports; • Applicable to dry or flash steam geothermal power projects	

Data / Parameter table 10.

Data/parameter	$M_{working\ fluid,y}$	
Description	Quantity of working fluid leaked/reinjected in year *y*	
Data unit	$t_{working\ fluid}$ in year *y*	
Equations referred	(17)	
Purpose of data	☐ Baseline emissions ☒ Project emissions ☐ Leakage emissions	
Measurement and updating frequency	Annually measured	
Measurement methods and procedures	Measured via log books and maintenance reports of the plant	
Entity/person responsible for the measurement	Activity participants	
Measuring instrument(s)	*Type of instrument*	Mass flow meter or other equipment with at least the same accuracy
	Accuracy class	According to the national, international, or meter supplier's instructions
	Calibration requirements	Calibration shall be conducted according to the national, international, or manufacturer's instructions
	Location	Heat exchanger or working fluid storage equipment
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	
Treatment of uncertainties	Uncertainties are determined based on the measuring instruments	
Additional comment	Applicable to binary geothermal power projects	

Appendix. Background information on the inclusion and exclusion of emission sources

Note: This Appendix will be further refined by the MEP. The MEP is seeking feedback on any missing elements or other considerations on this Appendix. As a result of the analysis, the consideration of emissions sources in the mechanism methodology may also be updated.

1. This Appendix provides additional background information and justification for why certain baseline, project and leakage emission sources are not quantified in this mechanism methodology. For this purpose, this appendix first identifies in section 1 all relevant emissions sources, consistent with the appendix 1 of the “Standard: Setting the baseline in mechanism methodologies”(A6.4-STAN-METH-004) and with the “Standard: Addressing leakage in mechanism methodologies” (A6.4-STAN-METH-005); then, it assesses in section 2 the relevance of the identified emission sources and explains how they have been addressed, and then draws an overall conclusions on why the proposed selection of emission sources ensures conservativeness.

1. Identification of relevant emission sources

2. The physical boundary of Article 6.4 activities applying this mechanism methodology is specified in section 5 of the mechanism methodology as the site of the project power plant and all power units connected physically to the electricity system.

3. The mechanism methodology accounts for the following emission sources:

   (a) Baseline emissions: CO_2 emissions from the combustion of fossil fuel in fossil fuel fired power plants connected to the electricity system. This source is related to the Article 6.4 activity since it is determined based on the emissions from the combustion of fossil fuel from power plants connected to the electricity system

   (b) Project emissions:

      (i) Emissions due to the combustion of fossil fuels in a backup generator. This source is controlled by the Article 6.4 activity since the quantity of fuel consumed is under the direct control of the activity participants;

      (ii) Emissions from non-condensable gases contained in geothermal steam of dry or flash steam geothermal power plants. This source is controlled by the Article 6.4 activity since the quantity of steam collected, is under the direct control of the activity participants;

      (iii) Fugitive emissions from non-condensable gases contained in geothermal steam of binary geothermal power plants. This source is controlled by the Article 6.4 activity since the quantity of steam entering and leaving the power plant is under the direct control of the activity participants;

      (iv) Fugitive emissions of working fluid contained in the heat exchangers of binary power plants. This source is controlled by the Article 6.4 activity since the quantity of working fluid used to operate the heat exchanger is under the direct control of the activity participants;

(c) Leakage emissions: shadowing effects of wind power plants. This source of emission is affected by the Article 6.4 activity since the construction of a wind power plant may result in shadowing effects on other wind power plants and reduce their electricity generation.

4. Several further emission sources were identified but are not accounted for in this version of the mechanism methodology:

(a) Baseline emissions:

(i) Non-CO_2 emissions from fossil fuel combustion of power plants in the electricity system;

(ii) Emissions from the operation of renewable power plants in the electricity system (e.g. biomass or geothermal power generation);

(iii) Upstream emissions from the construction of power plants in the electricity system. This source is affected by the Article 6.4 activity;

(iv) Upstream emissions from the production, processing and transportation of the fossil fuel used in power plants in the electricity system. This source is affected by the Article 6.4 activity;

(b) Project emissions: All emissions sources are accounted for;

(c) Leakage:

(i) Upstream emissions from the construction of the renewable power plant, including the emissions associated with the manufacturing of equipment and with the construction of the power plant. This source is affected by the Article 6.4 activity;

(ii) Baseline equipment transfer. This source of emission is affected by the Article 6.4 activity since emissions would occur due to the use of the equipment at a site not belonging to the project boundary that is out of the control of the activity participants;

(iii) Competition for resource use consumed by the project power plant – wind and water. This source of emission is affected by the Article 6.4 activity since the construction of the project power plant may impact downstream and upstream usage of water from a river and may affect the quality of the wind (i.e., the speed and turbulence of the air) used by downstream wind energy generators;

(iv) Diversion of existing production processes or outputs. This emission source is affected by the Article 6.4 activity since the construction of the project power plant results in displacing to another area a production activity existing in the same site of the project power plant prior to the construction of the project power plant;

(v) Increases in release of GHGs from the environment as a result of Article 6.4 activity. This emission source is affected by the Article 6.4 activity if construction of the project power plant results in deforestation;

(vi) Increase in the level of service as a result of the implementation of the Article 6.4 activity (rebound effect). This emission source is affected by the Article

6.4 activity if the electricity generated by the project power plant lowers electricity prices, leading to an increased use of electricity.

2. Addressing the unaccounted emission sources

5. The mechanism methodology addresses the unaccounted emission sources identified above as per the subsections below.

2.1. Upstream emissions from the construction and operation of power plant

6. The table below provides an overview of upstream emissions from power plants. It shows that upstream emissions for fossil fuel power plants are generally higher than emissions for renewable power generation power plants. Exclusion of this emissions source is therefore deemed to be conservative.

Note: The MEP will further review these numbers, including whether and how any land use is considered and, if necessary, further explore the impacts of land-use.

Table Comparison between the upstream emissions from the types of Article 6.4 projects eligible under this mechanism methodology and the upstream emissions from fossil fuel fired power plants[1]

Type of Article 6.4 project	Upstream emissions for the Article 6.4 project (g CO_2eq/kWh)	Upstream emissions for coal power plant (g CO_2eq/kWh)	Upstream emissions for natural gas power plant (g CO_2eq/kWh)
Wind onshore	12.15	163.68	78.12
Wind offshore	13.92		
Solar PV (poly-Si) ground mounted	36.08		
Solar PV (poly-Si) roof mounted	36.70		

[1] Adapted from United Nations Economic Commission for Europe (UNECE), *Life Cycle Assessment of Electricity Generation Options* (Geneva: United Nations, 2021). The report lists the sources of upstream emissions as follows:

(a) Upstream emissions from coal and natural gas power plants: energy carrier supply chain, from extraction to combustion (including methane leakage), infrastructure construction, operation, and dismantling (energy inputs and waste production) and connection to grid;

(b) Upstream emissions from concentrated solar power plants: infrastructure, site preparation and occupation, operation and maintenance, decommissioning (energy inputs and waste production) and connection to grid;

(c) Upstream emissions from photovoltaic power plants: infrastructure, site preparation and occupation, operation and maintenance, decommissioning (energy inputs and waste production) and connection to grid; and

(d) Upstream emissions from wind power plants: infrastructure, site preparation and occupation, operation and maintenance, decommissioning (energy inputs and waste production) and connection to grid.

Type of Article 6.4 project	Upstream emissions for the Article 6.4 project (g CO_2eq/kWh)	Upstream emissions for coal power plant (g CO_2eq/kWh)	Upstream emissions for natural gas power plant (g CO_2eq/kWh)
Solar PV (CIGS) – ground mounted	11.98		
Solar PV (CIGS) – roof mounted	11.40		
Concentrated solar – parabolic through	33.18		
Concentrated solar – central tower	14.76		
Hydro	10.47		
Geothermal – binary[2]	23 – 71		
Geothermal – dry or flash steam[2]	3.8 – 5.3		

2.1.1. Emissions from the combustion of fossil fuel in fossil fuel fired power plants connected to the electricity system.

7. This is the main baseline emission source and, therefore, was included in the calculation of emission reductions. For such types of power plants, the main GHG emitted from the combustion of fossil fuels is the CO_2, and the methodology does not consider emissions of CH_4 and N_2O since their concentrations in the exhaust gas are negligible.[3]

2.2. Leakage from the use of pre-used equipment

8. The mechanism methodology requires that the equipment installed under the Article 6.4 activity has previously not been used in any other plant but is newly produced, therefore this emission source was not included in the calculation of emission reductions.

2.3. Competition for water in case of hydro power plants

9. For hydropower plants implemented in an existing reservoir, the mechanism methodology requires activity participants to demonstrate for the baseline scenario that there are no feasible alternatives other than continuing to operate the existing reservoir without changing its size.

2.4. Increase in the level of service as a result of the implementation of the Article 6.4 activity (rebound effect)

[2] Adapted from Eberle, A; Heath, G; Nicholson, S; Carpenter, A. (2017) Systematic Review of Life Cycle Greenhouse Gas Emissions from Geothermal Electricity, U.S. National Renewable Energy Laboratory Technical Report NREL/TP-6A20-68474, https://docs.nlr.gov/docs/fy17osti/68474.pdf.

[3] The default CH_4 emission factor for the combustion of fossil fuels from the IPCC (2006) is in the range of 1-10 kg CH_4 / TJ (converted to 28-280 kg CO_2eq / TJ), whereas the N_2O emission factor from the same 2006 IPCC Guidelines is in the range of 0.6-2 kg N_2O / TJ (converted to 159-530 kg CO_2eq / TJ), which is significantly lower in scale when compared to the emissions of CO_2 (e.g., the CO_2 emission factor of natural gas is in the range of 54,300-58,300 kg CO_2eq / TJ).

10. Due to the low operating costs of some renewable power plants, the expansion of renewable power generation may displace power generation in those plants that have the highest marginal costs of electricity generation, which can lead to lower electricity prices (in some countries, this situation has led to an increasing number of hours where electricity prices are close to zero or negative.

11. The extent of such effects is likely to be highly variable and depend on the context and country (e.g., demand for electricity may increase anyways due to increased electrification of infrastructure). In some situation these effects could be significant. Nevertheless, this emission source is not considered here for simplicity, given that other conservative assumptions, in particular the neglection of upstream emissions from electricity generation in the baseline may outweigh this emission source.

12. This issue may be reconsidered, based on further data, in future revisions to this methodology.

3. Conclusions

13. The main unaccounted emission sources include upstream emission from the construction and operation of power plants, and potentially rebound effects. Given that upstream emissions from fossil fuel power plants are generally higher than those for renewable power plants, it is deemed that the selected approach is conservative.

Note: This conclusion may be updated in the light of further analysis. The MEP welcomes feedback on this conclusion and the analysis provided in this appendix.

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Document information

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