PROPOSED NEW BASELINE AND MONITORING METHODOLOGY OR METHODOLOGICAL TOOL FORM
(Version 01.0)

INFORMATION TO BE COMPLETED BY THE SECRETARIAT AND METHODOLOGIES EXPERT PANEL	
Type of standard	New baseline and monitoring methodology
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[1] Format for footnotes.

SECTION A. Summary and applicability of the baseline and monitoring methodology or methodological tool

A.1. Title, submission date and version

Title of the Methodology: Pumped Hydro Storage and Supply of Electricity to the Grid

Submission Date: 12th May 2025

Version: 1.0

A.2. If this methodology or methodological tool is based on a previous submission or an approved Article 6.4 mechanism methodology or methodological tool, please state the reference numbers here. Explain briefly the main differences and their rationale.

This methodology is **not** derived from any previous submissions or approved methodologies to Article 6.4 mechanism.

A.3. Summary description of the methodology or methodological tool, including major baseline and monitoring methodological steps

This methodology applies to projects that store electrical energy as potential energy at time in the day, convert it back into electricity, and supply it to the grid at later time in the same day. The electricity generation, energy storage, and end-use may occur at the same location or at different locations, but all components are connected to the grid.

Only emission reductions attributable to the **"storage element"** have been considered to contribute to the mitigation activity emission reductions.

When energy storage technology such as pumped hydro are coupled with renewable electricity supply sources, the resulting dispatchable energy system displaces the higher carbon intensive electricity supplies to the grid.

The baseline alternative is supplying the generated renewable electricity to the grid directly, without storage at a time when GHG intensity of the grid is very low i.e., during the period when renewable energy plants (wind, solar, hydroelectric plants), connected to the grid, are in operation predominantly. The project activity- storage system- stores that electricity during this period and delivers the electricity when the electricity grid is dominated by non-renewable generation and the emission intensity or factor is thus higher.

This methodology is designed to assess emission reductions due to 'time translation' in the power generation and supply.

The methodology employs real-time dispatch analysis to estimate the emission coefficient of the electricity grid in an hour or smaller period.

SECTION B. Proposed new baseline and monitoring methodology or methodological tool

B.1. Summary description and scope of the methodology or methodological tool

SECTORAL SCOPE
1. Energy Industries (renewable / non-renewable)
2. Energy Distribution
3. Energy Demand
4. Manufacturing Industries

5. Chemical Industries
6. Construction
7. Transport
8. Mining/mineral Production
9. Metal Production
10. Fugitive emissions from fuels (solid, oil and gas)
11. Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride
12. Solvent Use
13. Waste handling and disposal
14. Afforestation and reforestation
15. Agriculture
16. Carbon capture and storage of CO2 in geological formation
17. Other activities involving removals

This methodology provides a standardized approach to quantifying greenhouse gas (GHG) emission reductions from grid-connected energy storage systems that enable time-shifted delivery of renewable electricity.

The methodology supports projects where renewable electricity is stored during periods of low specific grid emissions (tCO_2e/MWh) and later dispatched during high-demand periods, displacing more carbon-intensive electricity generation.

Mitigation Activity:

Storage and Supply of renewable energy connected to the electricity grid displacing high-emission electricity generation connected to the grid during peak demand periods.

Applicable Sectoral Scopes:

Scope	Sectoral Area	Justification
4	Energy industries (renewable / non-renewable sources)	The methodology involves the storage and dispatch of electricity within the grid, impacting overall grid emission intensity through load shifting and peak shaving.

B.2. Applicability conditions

The methodology is applicable under the following conditions:

1. The system stores potential energy in the form of water in a reservoir (stored component) which is subsequently converted back into electricity and supplied to the grid (which may be the same grid or a different one).
2. The generator, storage system owner/operator, and end-user of electricity may be the same entity or separate entities.
3. The energy stored and subsequently supplied must be predominantly sourced from renewable generation sources. This methodology does not apply if non-renewable electricity accounts for 25[2]% or more of the total energy stored and delivered.
4. The methodology is applicable only where greenhouse gas (GHG) intensity data of the connected electricity grid is publicly available at hourly or finer time intervals for each day of the year, or where reliable annual average GHG intensity data is publicly released by the grid authority. In cases where such data is monitored in real time but released by the grid authority later (e.g., monthly or annually), the methodology remains applicable, if project verification is conducted only after the official release of the data, using the most recent publicly available figures for the relevant monitoring period.

[2] Alternatively, the limit on % of non-renewable electricity may gradually decrease to reach 2% as the share of RE power in grid reaches 30%.

5. The renewable energy plant supplying electricity to PHSP must have been operational for less than two years, to ensure that the project does not divert existing renewable energy and thereby avoids associated emissions.
6. For pumped hydro storage plants (PHSP), one of the following conditions must be satisfied:
   - The project is implemented as a greenfield project involving multiple reservoirs, **with no alteration in the volume** of any reservoir; **or**
   - The project involves the construction of new single or multiple reservoirs, and the **power density** calculated using Equation (7) is **greater than 4 W/m²**.

B.3. Sources and references

This consolidated baseline and monitoring methodology is based on [elements from] the following [approved baseline and monitoring methodologies and] proposed new methodologies:

1. A6.4-MEP005-A01 - Draft Standard: Setting the baseline in mechanism methodologies (v.03.0)
2. A6.4-MEP005-A02 - Draft Standard: Addressing leakage in mechanism methodologies (v.02.0)

B.4. Definitions

Backup generator: A generator that is used in the event of an emergency, such as power supply outage due to either main generator failure, captive failure or tripping of generator units, to meet electricity demand of the equipment at power plants/units' site during emergency.

Banking: A facility by which electrical energy remaining unutilized by the "Exclusive" or "Non- Exclusive" Consumer or "Captive Consumer" out of the energy injected by the power producer into the transmission and/or distribution system, which is allowed to be utilized for wheeling to "Exclusive" or "Non-Exclusive" Consumers of the Company or captive consumer for later use, as per the terms and conditions set forth in the power purchase/consumption agreement.

Banking cycle: the period from 00:00 hrs from the first day of a calendar month to 24:00 hrs of last day of the same calendar month.

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

Greenfield power plant: A new renewable energy power plant that is constructed and operated at a site where no renewable energy power plant was operated prior to the implementation of the project activity.

Grid: A facility that receives electricity generated from the project activity renewable energy power plant with an aim to meet its entire or partial electricity demand.

Pumped Hydro Storage (PHS): A pumped hydro storage (PHS) is a type of hydroelectric energy storage system that utilizes two water reservoirs at different elevations to store and release energy. It works by pumping water from a lower reservoir to an upper reservoir when electricity is abundant and less needed and then releasing water from the upper reservoir to generate electricity during peak demand periods.

Installed power generation capacity (or installed capacity or nameplate capacity): The installed power generation capacity of a power unit is the capacity, expressed in Watts or one of its multiples, for which the power unit has been designed to operate at nominal conditions. The installed power generation capacity of a power plant is the sum of the installed power generation capacities of its power units.

NLDC/SLDC: National or State Load Dispatch Centre's.

The main functions assigned to NLDC/SLDC are:

I. Supervision Over the Regional Load Despatch Centres. (RLDC)

II. Scheduling and dispatch of electricity over the inter-regional links in accordance with grid standards specified by the authority and grid code specified by Central Commission in coordination with Regional Load Despatch Centres.

III. Coordination with Regional Load Despatch Centres for achieving maximum economy and efficiency in the operation of National Grid.

IV. Monitoring of operations and grid security of the National Grid.

V. Coordination for restoration of synchronous operation of national grid with Regional Load Despatch Centres.

VI. Coordination for trans-national exchange of power.

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

Reservoir: A reservoir is a water body created in valleys to store water generally made by the construction of a dam.

Open loop: With either an upper or lower reservoir that is continuously connected to a naturally flowing water source such as a river. At least one of the reservoirs connected to a source of natural inflow (Natural Lake, river, river-fed reservoir, the sea)

Wheeling: is an electricity transmission service that enables the instantaneous delivery of renewable energy, to a grid without any time lapse between the generation and consumption of electricity, under a power purchase agreement. This includes other similar arrangements such as open access mechanism, if the conditions related to time lapse between generation and consumption of the electricity are satisfied.

B.5. Baseline methodology

B.5.1. Activity boundary

The spatial extent of the activity boundary encompasses the energy storage system, the associated generation and/or pumping facility, as well as all renewable power plants physically connected to the grid electricity system to which the PACM project's storage and RE generation plants are linked. It also includes the grid that receives electricity from the project, either through wheeling arrangements or via a dedicated transmission and distribution line.

B.5.2. Baseline emissions or removals

Source	GHG[3]		Justification/Explanation
CO2 emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity	CO_2	☒ Included ☐ Not included	Major Emission Source
	CH_4	☐ Included ☒ Not included	Minor Emission Source
	N_2O	☐ Included ☒ Not included	Minor Emission Source
	-----	☐ Included ☒ Not included	Minor Emission Source

B.5.3. Activity emissions or removals

Source	GHG		Justification/Explanation
Utilization of electricity from grid or from fossil fuel	CO_2	☒ Included ☐ Not included	Major Emission Source
	CH_4	☐ Included	Minor Emission Source

[3] Refer to Appendix 1 of A6.4-STAN-AC-002 and A6.4-STAN-AC-004.

generators by PHS for pumped mode.		☒ Not included	
	N_2O	☐ Included ☒ Not included	Minor Emission Source
	-----	☐ Included ☒ Not included	Minor Emission Source
For PHS, emissions of CH4 from the reservoir	CO_2	☐ Included ☒ Not included	Minor Emission Source
	CH_4	☒ Included ☐ Not included	CH_4 Emissions from the reservoir
	N_2O	☐ Included ☒ Not included	Minor Emission Source
	-----	☐ Included ☒ Not included	Minor Emission Source

B.5.4. 'Business-as-usual' (BAU) scenario

B.5.4.1. Identification of the BAU scenario

The BAU scenario identifies what would happen in the absence of the project, considering current and historical trends, technologies, and policies. This scenario should reflect the most likely alternative to the project, based on available data and assumptions.

The identification of the BAU scenario involves the following steps:

1. **Define the Project's Service or Output**:
   - Clearly describe the service or output provided by the project, such as electricity generation, demand-side management, or emission reductions from improved processes.
2. **Assess Current Practices and Trends**:
   - Review historical data, existing technology, and the typical operations in the relevant sector (e.g., power generation). Identify current emissions levels associated with those practices and technologies.
3. **Identify Plausible Alternatives**:
   - Evaluate alternative methods or technologies that would provide the same service without the project, considering:
     - **Technological alternatives** (e.g., continuation of fossil fuel-based generation).
     - **Market dynamics** (e.g., expected growth in demand, technology adoption).
     - **Fuel mix** (e.g., the share of fossil fuels versus renewables in the energy mix).
     - **Operational practices** (e.g., grid balancing, energy storage, or backup capacity).
4. **Select the Most Likely BAU Scenario**:
   - From the plausible alternatives, select the most realistic BAU scenario that represents what is most likely to happen in the absence of the project. The BAU scenario should use conservative assumptions that reflect realistic trends, avoiding overly optimistic scenarios.

Procedure for Business-as-Usual Estimation

The Business as Usual (BAU) scenario represents the grid emissions that would have occurred in the absence of the pumped hydro energy storage (PHES) project. Establishing this scenario is essential to demonstrate the additionality of the project, ensuring that the emission reductions achieved are not part of a baseline or expected development trajectory.

To estimate the BAU emissions, the following procedure is adopted:

1. **Define the Project Output:**

The PHS project provides electricity during peak demand periods by storing energy and displacing more carbon-intensive generation. In the absence of the project, this electricity would be supplied by the existing grid mix, primarily fossil fuel-based sources.

2. **Historical Dispatch Data Analysis:**

   A multi-year analysis (typically 3–5 years) of historical hourly dispatch data is conducted to assess how the grid has met demand in similar timeframes. This helps identify the marginal units (i.e., the units that respond to changes in demand) and their emission characteristics.

3. **Calculate Hourly Emission Trends:**

   The hourly emission factors are computed for each hour of each day across the selected historical period. This provides insight into the marginal emissions at different times, accounting for fluctuations in fuel mix, load demand, and renewable generation.

4. **Establish Projected Margin Emission Factors:**

   This historical hourly emission factors' trend is extrapolated to arrive at projected margin hourly emission factors. This projection reflects expected marginal emissions that would occur without the project, assuming current grid dynamics and trends continue.

5. **Apply Projected Margins to Project Output:**

   The estimated project electricity supply (on an hourly basis) is then multiplied by the corresponding projected margin emission factor to estimate the total BAU emissions. This ensures that the BAU scenario reflects hourly emissions likely to occur, if the present growth trends of RE generation assets, demand patterns, grid management rules and regulations continue.

B.5.4.2. Calculation of the BAU emissions or removals

The BAU scenario represents the emissions that would have occurred in the absence of the pumped hydro storage project. This is a critical component to determine if the project is additional (i.e., it results in emission reductions that would not have happened otherwise). For a PACM project, the BAU scenario typically involves the following elements:

In this context, the BAU emissions are calculated by considering the emissions produced by the energy mix used to meet the grid demand.

$$\mathbf{BAU_y} = \sum_{d=1}^{365} \sum_{h=1}^{24} ((EG_{h,d,y}^{Delivered} * y_{\mathrm{h,d,y}}) - (EG_{h,d,y}^{Received} * x_{\mathrm{h,d,y}})) * EF_{PM,h,d,y} \quad \text{Equation (1)}$$

Where,

BAU_y = BAU emissions for year y, based on historical trends and projections of grid-connected power plants t *CO2*

$EG_{h,d,y}^{Delivered}$ = Electricity delivered to grid at hour h, day d, in year y (MWh)

$EG_{h,d,y}^{Received}$ = Electricity used for pumping at hour h, day d, in year y (MWh)

$EF_{PM,h,d,y}$ = Projected Margin grid emission factor at hour h, day d, in year y (tCO_2/MWh)

$x_{h,d,y}$ = Fraction of received electricity that is renewable at hour h, day d, in year y ($0 \le x \le 1$)

$y_{h,d,y}$ = Fraction of delivered electricity that is renewable at hour h, day d, in year y ($0 \le y \le 1$)

Steps to Calculate Projected Margin Emission Factor ($EF_{PM,h,d,y}$):

The **Projected Margin Emission Factor (EFPM)** represents the anticipated marginal emission intensity of the electricity grid for a given hour and day, based on historical dispatch patterns. It is calculated by analyzing historical emission factors on an hourly basis over a period of 3 to 5 years. This approach captures both **intra-day (hourly)** and **seasonal (daily/monthly)** variations in grid emissions.
This methodology assumes that recent historical trends in marginal emission intensity are indicative of future performance, allowing for a forward-looking estimate of grid emissions that better aligns with actual operational conditions.

$$EF_{PM,h,d,y} = EF_{h,d,N} + \left(\frac{1}{N-1}\right)\sum_{y=2}^{N}(EF_{h,d,y} - EF_{h,d,y-1})$$ Equation (2)

$EF_{h,d,y}$ = Historical emission factor for hour h, day d, and year y (t CO2/MWh)
$EF_{h,d,N}$= Emission factor for the latest historical year for hour h, day d, year y (in tCO_2/MWh)
N = Number of historic years (typically 3 to 5 years)

B.5.5. Baseline scenario

B.5.5.1. Baseline approach from paragraph 36 of the RMPs

(a) Choose one or more option(s)

☐ 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.

(b) Justify the choice(s)

The baseline approach for this methodology is based on actual greenhouse gas (GHG) emissions from grid operations during the monitoring period, without the influence of the proposed project. It assumes that the electricity supplied to the grid by the project would otherwise have been generated by existing grid-connected power plants and the addition of new generation sources. These emissions are adjusted downward, if necessary, to comply with paragraph 33 of the RMP. The emission factor is calculated on an hourly basis using the dispatch data analysis method, ensuring the baseline reflects the real-time behaviour of the grid.

B.5.5.2. Identification of the baseline scenario

Step 1: Collect Real-Time Data for the Project Period

- Gather real-time or periodic data for electricity generated and dispatched during each hour of the operational period. This should include:
  - **Hourly electricity generation** from the project (in MWh) or any contributing sources.
  - **Hourly emissions** data (in tons of CO2 or other gases) for each generating source in the grid.

Step 2: Identify the Contribution of Different Generation Sources

- Identify the generation sources that contribute to meeting the grid demand during each hour. This can include **renewable sources** (e.g., Hydro, wind, solar), **fossil fuel-based plants** (e.g., coal, gas), and others.
- For each hour, determine the contribution of each source in terms of **electricity generation** (MWh) and **emissions** (tons of CO2 or other gases).

Step 3: Calculate Hourly Emission Factor (EF) for Each Hour

- For each hour h, calculate the **emission factor** (EF_h)

Step 4: Monitor Hourly Emissions and Adjust as Needed

- Continue to calculate the emission factor for each hour in real-time or at regular intervals, based on the generation mix for each hour.
- Ensure that the emissions are being tracked accurately, and **adjustments** may be required if the energy mix changes significantly over time.

Step 5: Calculate the Emission Factor at an hour "h" on a day "d" in year "y"

- Calculate the Emission Factor at a specific hour of the day for the entire monitoring period. This will reflect the marginal emissions associated with electricity generation during that specific time, accounting for fluctuations in the energy mix.

Step 6: Monitor Emissions Over the Project Monitoring Period

- To track the real-time emissions continuously or periodically during the project period.

B.5.5.3. Calculation of baseline emissions or removals

In the baseline scenario, the electricity generated by the project activity related to renewable sources is directly supplied to the electricity grid (instead of storing the same). Accordingly, the net baseline emissions at any hour of the day and year are as follows:

$$\mathbf{BER_y} = \sum_{d=1}^{365} \sum_{h=1}^{24} ((\boldsymbol{EG^{Delivered}_{h,d,y}} * \boldsymbol{y}_{\mathbf{h,d,y}}) - (\boldsymbol{EG^{Received}_{h,d,y}} * (\boldsymbol{x}_{\mathbf{h,d,y}})) * \boldsymbol{EF_{DD,h,d,y}} \quad \text{Equation (3)}$$

$BER_{h,d,y}$ = Baseline Scenario emission reductions at an hour 'h' on a day 'd' in year 'y' (t CO2/hr)

$EG^{Delivered}_{h,d,y}$ = Electricity delivered to grid at hour h, day d in year y (MWh)

$EG^{Received}_{h,d,y}$ = Electricity used for pumping at hour h, day d, in year y (MWh)

$EF_{DD,h,d,y}$ = Dispatch Data Grid emission factor at hour h, day d, in year y (tCO_2/MWh)

$x_{\text{h,d,y}}$ = Fraction of received electricity for pumping that is renewable at hour h, day d, in year y ($0 \leq x \leq 1$)

$y_{\text{h,d,y}}$ = Fraction of delivered electricity that is renewable at hour h, day d, in year y ($0 \leq y \leq 1$)

B.5.5.4. Difference between BAU and baseline emissions or removals

As required by the A6 guidance notes, this section outlines the methodology for calculating the difference between Business-as-Usual (BAU) emissions and baseline emissions for energy storage systems such as Pumped Hydro Storage Plants (PHSPs). The calculation ensures alignment with Article 6.4 requirements, including consistency with national policies, NDCs, and long-term low-carbon growth paths.

Each year within the crediting period, the difference between Business-As-Usual (BAU) emissions and baseline emissions is calculated as:

$$\Delta \boldsymbol{E_y} = \boldsymbol{BAU_y} - \boldsymbol{BER_y} \quad \text{Equation (4)}$$

Where,

ΔE_y: Difference in emissions for year y (tCO_2e/yr)

B.5.5.5. Application of downward adjustment

In this methodology, the BaU and Baseline is not a number but a set of 7860 or more numbers i.e. emission intensity of the relevant grid at each hour (or a smaller duration) in a day during the 365 days. Accordingly, comparison of BAU and Baseline is not possible to determine downward adjustment. A conservative estimate of emission reductions can be arrived at by following the procedure below:

1. Compute the annual emission reductions attributable to the mitigation activity using BAU and Baseline emissions.
2. Chose lower amongst the two numbers representing a conservative value.

Therefore:

$$\mathrm{BE_y} = \min\,(\mathbf{BAU_y}, \mathbf{BER_y}) \quad \text{Equation (5)}$$

B.6. Activity emissions or removals

Energy storage systems may generate activity emissions due to energy losses during charge and discharge cycles, as well as the use of non-renewable electricity for charging. In the case of pumped hydro storage projects, additional emissions may result from water evaporation from the reservoir.

Following project emissions are taken into consideration: $PE_{FF,y}$,$PE_{HP,y}$, $PE_{grid,y}$, $PE_{mw,y}$

Where,

$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year y (t CO_2e/yr).
$PE_{HP,y}$	=	Project emissions from water reservoirs of pumped hydro storage plants in year *y* (t CO_2e/yr).
$PE_{grid,y}$	=	Project emissions from electricity drawn from the grid to charge the storage system in year 'y' (tCO_2e/year).
$PE_{mw,y}$	=	Project emissions associated with pumping makeup water to the reservoir to compensate for evaporation losses.

Steps to estimate for activity emissions, are given below:

1. Emissions from fossil fuel consumption at project site ($PE_{FF,y}$)

$$PE_{FF,y} = \sum_f (Q_{f,y} * EF_{f,y} * NCV_f) \quad \text{Equation (6)}$$

Where:

$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year y (t CO_2e/yr)
$Q_{f,y}$	=	Quantity of fuel 'f' consumed during year 'y' (Gg/yr)
NCV_f	=	Net Calorific Value of fuel 'f' (TJ/Gg)
$EF_{f,y}$	=	Emission factor for fuel 'f'(t CO_2e/TJ)

2. Emissions from water reservoirs of pumped hydro storage projects ($PE_{HP,y}$)

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

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

Where:

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

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

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

a) For PHS, PD of the entire project is calculated as follows:

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

Where:

i	=	Individual power plants included in PHS
j	=	Individual reservoirs included in PHS

b) If the power density of the project activity using equation (16) is greater than 4 W/m^2 and less than or equal to 10 W/m^2:

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

Where:

$PE_{HP,y}$	=	Project emissions from water reservoirs (t CO_2e/hr)
EF_{Res}	=	Default emission factor for emissions from reservoirs of hydro power plants (kg CO2e/MWh)
TEG_y	=	Total electricity produced by the project activity, including the electricity supplied to the grid and the electricity supplied to internal loads, in year *y* (MWh)

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

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

3. Emissions from charging the storage using the power from the grid ($PE_{grid,y}$)

Under normal conditions, the charging of storage system is performed with the renewable electricity using the transmission infrastructure of the grid system. Pumped Hydro Storage plants may utilize grid electricity in addition to the electricity supplied by the renewable power plant ($EG_{grid,h,d,y}$). It uses the electricity drawn from the grid in delivering the grid balancing services to accommodate the addition of renewables to the grid. Pumped Hydro Storage (PHS) projects primarily function as enabling technologies that facilitate the integration of variable renewable energy sources, thereby enhancing grid stability and reducing overall system reliance on fossil fuel-based generation aligning with the broader intent of Article 6 to promote innovative, system-enhancing solutions that contribute to global decarbonization objectives. Accordingly, the activity emissions arising from the use of grid electricity by the project activity be computed.

In cases where PHS utilizes grid electricity, the corresponding project emissions **($PE_{grid,y}$)** shall be calculated.

During the monitoring periods where the PHS consumes more than 25 per cent of the electricity, the project participant shall not be entitled to issuance of the certified emission reductions for the concerned monitoring period.

Furthermore, the project participant(s) should compensate in full any negative emissions reductions which may arise from power consumption from the grid by the

$$\mathbf{PEgrid_{,y}} = \sum_{d=1}^{365} \sum_{h=1}^{24} ((EG_{h,d,y}^{Delivered} * (1 - y_{h,d,y})) - (EG_{h,d,y}^{Received} * (1 - x_{h,d,y}))) * EF_{DD,h} \quad \text{Equation (11)}$$

Where:

$PE_{grid,y}$ = Project emissions due to electricity used for charging the storage system from the electricity grid in year ‘y’(t CO_2e/yr)

$EG_{h,d,y}^{Delivered}$ = Electricity delivered to grid at hour *h*, day *d* (MWh)

$EG_{h,d,y}^{Received}$ = Electricity used for pumping at hour *h*, day *d* (MWh)

$EF_{DD,h,d,y}$ = Dispatch Data Grid emission factor at hour *h*, day *d* (tCO_2/MWh)

$x_{h,d,y}$ = Fraction of received electricity for pumping that is renewable ($0 \leq x \leq 1$)

$y_{h,d,y}$ = Fraction of delivered electricity that is renewable ($0 \leq y \leq 1$)

4. Emissions due to makeup water pumped to the reservoir due to evaporation $(PE_{mw,y})$

Consider the project emissions due to make up water only if non-RE power is being used in pumping to the reservoir. And is calculated as follows

$$PE_{mw,y} = V_{evap,y} * SEC_{pump} * EF_{DD,h,d,y} \quad \text{Equation (12)}$$

$PE_{mw,y}$	=	Project emissions due to makeup water pumped to the reservoir due to evaporation(tCO2/year)
$V_{evap,y}$	=	Volume of water lost through evaporation over the year (m3/year)
SEC_{pump}	=	Specific Energy Consumption for Pumping (MWh/m3)

Activity emissions are calculated as follows:

$$PE_y = PE_{FF,y} + PE_{HP,y} + PE_{grid,y} + PE_{mw,y} \quad \text{Equation (13)}$$

Where:

PE_y	=	Project emissions in year *y* (t CO_2e/yr)
$PE_{FF,y}$	=	Project emissions from fossil fuel consumption in year y (t CO_2e/yr).
$PE_{HP,y}$	=	Project emissions from water reservoirs of pumped hydro storage plants in year *y* (t CO_2e/yr).
$PE_{grid,y}$	=	Emissions from charging the storage using the power from the grid or from fossil fuel electricity generators
$PE_{mw,y}$	=	Project emissions due to makeup water pumped to the reservoir due to evaporation.

B.7. Leakage

B.7.1. Identifying and addressing leakages

The methodology identifies and assesses potential leakage emissions under the following four categories, aligned with A6.4 guidance:

1. Transfer of Baseline Equipment

If project implementation involves the relocation or repurposing of low-emission infrastructure (e.g., hydro turbines) from existing applications where they were displacing fossil-based energy, the resulting emissions increase at the original location shall be considered as leakage.

2. Competition for Resource Use

Where project activities lead to the diversion or constrained availability of shared resources—such as land/water for reservoir construction—resulting in indirect emissions or environmental impacts, these shall be accounted as leakage.

3. Diversion of Existing Production or Outputs

If renewable energy used to charge storage systems would otherwise displace fossil fuel generation in another context (e.g., grid exports), and is instead diverted to the project, then the increased fossil-based generation elsewhere shall be treated as leakage.

4. Environmental GHG Releases

Environmental emissions resulting from storage infrastructure construction, operation, or disposal that fall outside the direct project boundary but are causally linked to the project are considered leakage. This includes:

- Methane emissions from flooded biomass in new PSH reservoirs.

B.7.2. Estimation of emission leakages

$$LE_y = LE_{equip,y} + LE_{res,y} + LE_{div,y} + LE_{env,y} \quad \text{Equation (14)}$$

Where:

LE_y = Total leakage emission in a year y (tCO_2)

$LE_{equip,y}$ = Leakage from transferred baseline equipment in a year y (tCO_2)

$LE_{res,y}$= Leakage from resource competition in a year (tCO_2)

$LE_{div,y}$ = Leakage from diversion of production in a year (tCO_2)

$LE_{env,y}$= Leakage from indirect environmental emissions in a year (tCO_2)

Step 1.1: Transfer of Baseline Equipment *(Applicable to brownfield project activities)*

As stated in the applicability conditions, this methodology is limited to greenfield projects. Therefore, there is no transfer of baseline equipment, and leakage emissions associated with equipment transfer are considered zero.

Step 1.2: Competition for Resource Use

There is no competition for resource use, as the project is a greenfield activity and does not utilize resources that would otherwise be employed in alternative activities; therefore, leakage emissions from competing resource use are considered negligible.

Step 1.3: Diversion of Existing Production or Outputs

As the project is a greenfield development, there is no diversion of existing renewable electricity or fossil fuel-based generation from other uses. Therefore, no leakage is expected from the redirection of electricity for the operation of the PHS facility.

To mitigate any potential concerns, the project must source electricity from newly added renewable energy capacity or demonstrate surplus renewable electricity availability during off-peak hours. If electricity is sourced from the grid, the associated emissions will be included in activity emissions.

Step 1.4: Environmental GHG Release

Indirect GHG emissions from land-use change or project infrastructure may occur, especially for greenfield PHS projects that require large reservoirs or tunnels.

Examples include:

$$LE_{env,y} = ME_{veg} + LUC_{Emissions} \quad \text{Equation (15)}$$

1. **Methane released from submerged vegetation (ME_{veg})**

For greenfield projects where large reservoirs are built, **methane release** can be a significant source of indirect emissions. The emissions from submerged vegetation are typically related to the area of land flooded by the reservoir.

$$ME_{veg} = A_{flooded} * EF_{methane} * GWP \quad \text{Equation (16)}$$

ME_{veg} = Methane Emissions from Submerged Vegetation

$A_{flooded}$ = Area of land flooded by the reservoir (in hectares).

$EF_{methane}$ = Methane emission factor for the flooded land (tonCH_4/hectare/year).

GWP = Global Warming Potential of Methane

2. **Land Use Change (LUC) Emissions ($LUC_{Emissions}$)**

Leakage must be estimated based on:

- Site-specific land-use history
- Methane release potential from flooded zones, where applicable.

$$LUC_{Emissions} = A_i * EF_i * T * (1+R_i) \quad \text{Equation (17)}$$

A_i = Area of land use change type i (ha)

EF_i = Emission factor for land use type (e.g., tCO_2/ha/year)

T = Time period over which emissions are counted (i.e.: Crediting period) (years)

R_i = Risk or uncertainty adjustment factor for type *i*

B.8. Determination of emission reductions or net removals

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (18)}$$

Where:

ER_y	=	Net Emission Reduction's due to storage in year 'y' (t CO2e/yr)
PE_y	=	Project Emissions in year y (t CO2e/yr)
LE_y	=	Leakage Emissions in year y (t CO2e/yr)

B.9. Demonstration of additionality

STEP 1. Demonstration of prior consideration

The activity participants of a proposed A6.4 project shall demonstrate that the Article 6.4 mechanism benefits were considered necessary in the decision to implement the project by notifying the secretariat of the intention to seek registration of the proposed A6.4 project under the Article 6.4 mechanism through a dedicated interface on the UNFCCC website.

If the project has already started as per the definition of the "start date" of a project in the "Article 6.4 activity standard for projects", the activity participants shall submit such notification no later than 180 days after the start date of the project.

The prior consideration notification shall accompany a summary of the project information, which shall include, at minimum:

a) The project title.

b) The names of the activity participants.

c) The precise geographical location.

d) A brief description of the technologies or measures to be deployed.

e) The Article 6.4 mechanism methodology (hereinafter referred to as mechanism methodology) to be applied (if already known).

f) The actual or planned start date of the activity.

g) The type (fixed or renewable) planned start date and duration of the crediting period.

h) The approximate amount of GHG emission reductions or net GHG removals expected to be achieved by the project in each year of the crediting period.

STEP 2. Regulatory Analysis

The activity participant of the project or CP shall demonstrate that the mitigation activity is not a legal requirement. However, the activity participant shall ensure that all the rules and regulations related to the PACM project activity is mandatorily adhered to. The statutory documents (Environmental Impact Assessment, license to operate and other terms and conditions etc) shall be made available during the validation process.

The activity participant shall obtain the Host Party approval (through its DNA)

1. If the host Party approves the project, the approval shall include:

   a) Confirmation that, and information on how, the project fosters sustainable development in the host Party.

   b) Approval of any potential renewal of the crediting period, if the Party intends to allow the project to continue beyond the first crediting period, where the Party has specified that the crediting periods of A6.4 activities that it intends to host may be renewed pursuant to paragraph 27(b) of the RMPs;

   c) Explanation of how the project relates to the implementation of its NDC and how the expected GHG emission reductions or net GHG removals contribute to the host Party's NDC, and the purposes referred to in Article 6, paragraph 1.

   d) Authorization of the activity participants

STEP 3. Avoidance of locking-in the level of emissions

1. Definition of Lock-In Emissions Criteria

Lock-in risks are identified by assessing whether the project:

1. **Creates dependency on fossil fuels** (e.g., uses fossil-based grid electricity for pumping).
2. **Extends lifespan of high-emission infrastructure** (e.g., supports coal-based baseload indirectly).
3. **Adopts technologies with no decarbonization pathway** (e.g., design choices preventing RE integration).
4. **Triggers market/regulatory shifts favouring fossil fuels** (e.g., enables continued fossil dispatch capacity).

2. Process to Identify Lock-In Emissions Risks

Step 1: Project Component Analysis

Component	Lock-In Risk Assessment	Mitigation Strategy
Pumping Energy Source	Partial dependency on non-renewable energy for pumping operations.	Requirement that use of non-RE sources may be limited to 5% as the RE share in the grid is 30% or more
Generation Output	PHS project may indirectly support fossil-based peak demand if not properly timed.	Ensure dispatching of the energy from PHS during peak demand periods to displace fossil-fuelled Peaker plants, promoting RE integration instead.
Technology Selection for Storage and Generation	Use of outdated or less-efficient technologies that limit future performance and emissions reductions.	Implement advanced, efficient technologies.
Project Lifetime	Risk of technological obsolescence or degradation in system performance over time. Risk of reservoirs emitting methane	Design the system for future technological upgrades and improvements Management of reservoirs (continuous upgradation) to eliminate potential future methane emissions

Step 2: Comparison to Baseline (BAU)

1. **BAU Scenario**: Grid-reliant peak generation supported by fossil gas or diesel plants (30–40-year lifespan, direct emissions).
2. **Project Scenario**: PHS charged/stored with renewable energy, with a limited proportion (<25%) of grid electricity allowed, providing long-duration storage with no direct fossil emissions and strong alignment with renewable integration goals.

Step 3: Qualitative Checklist

Confirm the project meets all criteria for lock-in avoidance:

- Designed for full integration with national/international RE expansion.
- No support to fossil generators through grid capacity mechanisms.
- Alignment with national decarbonization goals and timelines (e.g., net-zero by 2070).

3. Addressing Edge Cases

Temporary Fossil Grid Exposure:

If pumping uses grid electricity during RE shortages:

- Cap fossil-based input to **<25% annually** (of total pumping energy).
- Include a **transition plan** toward 100% RE input by mid-crediting period.
- Quantify and transparently disclose any indirect fossil linkage via residual grid mix.

OPTION 1: FINANCIAL ADDITIONALITY AND COMMON PRACTICE ANALYSIS

STEP 4. Financial additionality

The activity participant shall demonstrate additionality based on the additionality standard A6.4-SBM015-A11 Demonstration of additionality in mechanism methodologies Version 1.0

Sub-step 4.1. Investment Analysis

Provide an assessment of whether the project is financially additional using investment analysis. The analysis should demonstrate that the proposed activity would not have occurred in the absence of incentives from the mechanism through an investment analysis (default approach) using the appropriate tool as stipulated by Art 6.4 SB.

Sub-step 4.2. Barrier Analysis

The Activity participant shall demonstrate the barriers (such as first-of-its-kind, geographical, political, availability of technology, suppress demand etc) to establish additionality using the appropriate tool as stipulated by Art 6.4 SB.

STEP 5. Common practice analysis

The activity participant shall demonstrate that such projects are not a common practice using the appropriate tool as stipulated by Art 6.4 SB.

OPTION 2: PERFORMANCE-BASED APPROACH

STEP 4. Performance-based approach

Not Applicable

B.10. Methodologies principles

B.10.1. Encouraging ambition over time

a) This mechanism methodology applies increasingly ambitious baselines over the crediting period, ensuring alignment with the host Party's long-term mitigation goals and decarbonization strategies. By integrating dynamic baseline adjustments, the methodology incentivizes improved performance over time and facilitates the deployment of low-carbon technologies.

b) The methodology facilitates the deployment of **technologies or measures not yet widely adopted** or available in certain regions, such as advanced energy storage systems/pumped hydro storage. This promotes **knowledge transfer**, supports **cost reduction pathways**, and helps **unlock investment** in scalable, replicable, and impactful low-carbon solutions that accelerate the transition to net-zero systems.

c) The methodology contains provisions to ensure the progressive inclusion of more efficient, less GHG-intensive technologies over time. This includes:

- A linearly decreasing emission factor to reflect grid decarbonization,
- Conservative adjustments when the calculated reductions exceed business-as-usual (BAU) emissions,
- Flexibility for host Parties to apply stricter emission factors or targets based on their ambition levels.

These features collectively support replication, scalability, broader geographic adoption, and greater penetration of climate mitigation solutions as project deployment expands. In all three approaches used to identify the baseline scenario, the host Party's ambition is explicitly embedded. The methodology ensures that the most conservative baseline is applied across the available options, and it quantifies the difference between BAU and baseline scenario emissions to prevent locking in high-emissions pathways.

B.10.2. Contributing to the equitable sharing of mitigation benefits between participating Parties

This methodology is designed to attribute mitigation outcomes solely to the storage of renewable energy. By enabling storage, the grid can accommodate a higher share of variable renewables, enhancing overall system flexibility. **Emission reductions resulting from renewable energy generation are retained by the host**

country, while only those attributable to the storage function are eligible for crediting. Furthermore, since pumped hydro storage (PHS) systems have a typical lifespan of over 50 years, only a portion—approximately one-fifth—of their lifetime emission reductions are credited and transferred. The remaining mitigation benefits are retained by the host country, supporting its Long-Term Low Emission Development Strategy (LT-LEDS).

B.10.3. Aligning with the NDC of each participating Party, if applicable, its LT-LEDS, if it has submitted one, the long-term temperature goal of the Paris Agreement and the long-term goals of the Paris Agreement

The project activity must align with the most recent Nationally Determined Contributions (NDCs) of each participating Party and contribute to the achievement of their Long-Term Low Emission Development Strategies (LT-LEDS), where submitted. In addition, the activity should be consistent with the long-term temperature goal of the Paris Agreement and the objective of achieving net-zero emissions by or around mid-century.

The activity participant is required to demonstrate:

- That the project contributes to the unconditional and/or conditional targets outlined in the host country's NDC.
- That it supports the long-term decarbonization pathway, including through infrastructure that does not result in emissions lock-in.
- That the activity delivers mitigation outcomes which are additional to those already embedded in existing policy commitments.
- That it enables or accelerates the integration of renewable energy, energy efficiency, or low-carbon technologies consistent with a net-zero future.
- This alignment must be substantiated with evidence such as national planning documents, RE targets, sectoral roadmaps, or official correspondence with the host Party.

B.10.4. Encouraging broad participation

This methodology is designed to be applicable across all geographies and project scales, thereby encouraging broad participation from Parties with varying capacities and contexts.

B.10.5. Including data sources, accounting for uncertainty and monitoring

This methodology provides clear guidance on data sources, approaches to uncertainty, and monitoring requirements to ensure robust and transparent emission reduction estimates.

B.10.6. Taking into account policies and measures and relevant circumstances

The methodology contains provisions to consider relevant circumstances, including national, regional, or local, social, economic, environmental and technological, based on robust data and verifiable information. The type of data and information that would be necessary to demonstrate eligibility conditions, set the baseline, and demonstrate additionality is specified in the methodology.

B.11. Reversals

Not applicable, as the methodology does not cover removal-type project activities.

B.12. Monitoring methodology

B.12.1. Data and parameters not monitored

Data/parameter	$EF_{h,d,y,N}$
Description	Emission factor for the latest historical year for hour h, day d, year y
Data unit	tCO_2/MWh

Equations referred	Equation 2
Purpose of data	☒ Baseline emissions / removals ☐ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	The emission factor is estimated from historical hourly grid dispatch and emissions data. The calculation involves marginal emission factors over a baseline period (typically 3–5 years).
Additional comments	The projected margin is used to represent expected marginal emissions from fossil-based generation displaced by the project. This value must be updated periodically (e.g., every crediting period) using the most recent 3–5 years of data.

Data/parameter	N
Description	Number of historic years considered for the calculation of BAU
Data unit	tCO2/MWh
Equations referred	Equation 2
Purpose of data	☒ Baseline emissions / removals ☐ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Typically, 3–5 years.
Additional comments	This value must be updated periodically (e.g., every crediting period) using the most recent 3–5 years of data.

Data/parameter	$EF_{f,y}$
Description	CO_2 emission factor of the fossil fuel type used, indicating how much CO_2 is emitted per unit of energy content.
Data unit	tCO_2/TJ
Equations referred	Equation 6
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*

Choice of data or measurement methods and procedures	Default emission factors will be sourced from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, unless national-specific factors are available and more accurate.
Additional comments	No comments

Data/parameter	NCV_f
Description	Net calorific value of the fuel – energy content per unit of fuel
Data unit	TJ/tonne
Equations referred	Equation 6
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	Values will be taken from the IPCC Guidelines or national energy statistics. Preference is given to country-specific data from fuel suppliers or government energy agencies when available.
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Default emission factors will be sourced from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, unless national-specific factors are available and more accurate.
Additional comments	No comments

Data/parameter	Cap_{PJ}
Description	Installed capacity of the pumped hydro storage project after the implementation of the project activity
Data unit	Watt
Equations referred	Equation 7
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Determine the installed capacity based on manufacturer's specifications or recognized standards
Additional comments	No comments

Data/parameter	Cap_{BL}
Description	Installed capacity of the pumped hrdro storage project before the implementation of the project activity
Data unit	Watt

Equations referred	Equation 7 and 8
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Determine the installed capacity based on manufacturer's specifications or recognized standards
Additional comments	No comments

Data/parameter	A_{PJ}
Description	Area of the single or multiple reservoirs measured in the surface of the water, after the implementation of the project activity, when the reservoir is full
Data unit	m^2
Equations referred	Equation 7 and 8
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc
Additional comments	No comments

Data/parameter	A_{BL}
Description	Area of the single or multiple reservoirs measured in the surface of the water, before the implementation of the project activity, when the reservoir is full
Data unit	m^2
Equations referred	Equation 7
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, **IPCC**, commercial and scientific literature, etc.*

Choice of data or measurement methods and procedures	Measured from topographical surveys, maps, satellite pictures, etc
Additional comments	No comments

Data/parameter	EF_{Res}
Description	Default Emission factor for emissions from reservoirs
Data unit	$kgCO_2e/MWh$
Equations referred	Equation 9
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	90 $kgCO_2e/MWh$
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Decision at EB 23, CDM
Additional comments	*Not applicable*

Data/parameter	$A_{flooded}$
Description	Area of land flooded by the reservoir
Data unit	Hectares
Equations referred	Equation 16
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	The area flooded is estimated using topographic surveys or remote sensing (e.g., satellite imagery).
Additional comments	*Not applicable*

Data/parameter	GWP_{CH4}
Description	Global warming potential of methane valid for the relevant commitment period
Data unit	t CO2e/t CH4
Equations referred	Equation 16
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions

	Tick the applicable box(es).
Value(s) applied	28
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. ‘Other sources’ include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	IPCC Assessment Report 6
Additional comments	*Not applicable*

Data/parameter	A_i
Description	Area of land use change type
Data unit	%
Equations referred	Equation 17
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. ‘Other sources’ include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Land use classification is derived from official land cover maps, satellite-based land cover data, or field surveys.
Additional comments	*Not applicable*

Data/parameter	EF_i
Description	Emission factor for land use type
Data unit	tCO2/ha/year
Equations referred	Equation 17
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. ‘Other sources’ include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	IPCC
Additional comments	*Not applicable*

Data/parameter	T

Description	Time period over which emissions are counted (i.e.: Crediting period)
Data unit	Years
Equations referred	Equation 17
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	-
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	Based on the Project Crediting Period Choice
Additional comments	*Not applicable*

Data/parameter	R
Description	Risk or uncertainty adjustment factor
Data unit	%
Equations referred	Equation 17
Purpose of data	☐ Baseline emissions / removals ☐ Project emissions / removals ☒ Leakage emissions *Tick the applicable box(es).*
Value(s) applied	10%
Source of data	☐ Measured ☒ Other sources *Tick the applicable box. 'Other sources' include official statistics, expert judgment, proprietary data, IPCC, commercial and scientific literature, etc.*
Choice of data or measurement methods and procedures	The chosen adjustment factor is based on conservative estimation principles in line with IPCC and other GHG accounting best practices. This accounts for uncertainties in emission factors, activity data, or modelling approaches where high-quality measured data is not fully available. The value is consistent with buffers used in CDM and REDD+ methodologies.
Additional comments	*Not applicable*

B.12.2. Data and parameters monitored

Data/parameter	$EG_{h,d,y}^{Delivered}$
Description	Amount of electricity used for pumping at hour h, day d, in year y
Data unit	MWh/hr
Equations referred	Equation 1, Equation 3 and Equation 11
Purpose of data	☒ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Measurement methods and procedures	Measured using calibrated electricity meters installed at the grid interconnection point. Readings must be recorded continuously with at least hourly resolution.

Entity/person responsible for the measurement	Project proponent/plant operator (as applicable)	
Measuring instrument(s)	*Type of instrument*	Digital energy meter (grid-compliant)
	Accuracy class	Class 0.5s or better (as per IEC 62053-22 or equivalent)
	Calibration requirements	Calibrated annually or as per manufacturer/grid code
	Location	At the grid export metering point (typically at the substation or plant interconnection)
Measurement intervals	Continuous measurement, with automated hourly recording and data logging	
QA/QC procedures	Regular calibration and maintenance of meters; comparison with SCADA/utility data; backup logging system in case of data loss. Anomalies flagged and corrected in accordance with approved data handling protocol	
Additional comment	No comments	

Data/parameter	$EG_{h,d,y}^{Received}$	
Description	Amount of electricity used for pumping at hour h, day d, in year y	
Data unit	MWh/hr	
Equations referred	Equation 1, Equation 3 and Equation 11	
Purpose of data	☒ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*	
Measurement methods and procedures	Measured using calibrated electricity meters installed at the grid interconnection point. Readings must be recorded continuously with at least hourly resolution.	
Entity/person responsible for the measurement	Project proponent/plant operator (as applicable)	
Measuring instrument(s)	*Type of instrument*	Digital energy meter (grid-compliant)
	Accuracy class	Class 0.5s or better (as per IEC 62053-22 or equivalent)
	Calibration requirements	Calibrated annually or as per manufacturer/grid code
	Location	At the grid export metering point (typically at the substation or plant interconnection)
Measurement intervals	Continuous measurement, with automated hourly recording and data logging	
QA/QC procedures	Regular calibration and maintenance of meters; comparison with SCADA/utility data; backup logging system in case of data loss. Anomalies flagged and corrected in accordance with approved data handling protocol	
Additional comment	No comments	

Data/parameter	$y_{h,d,y}$
Description	Fraction of delivered electricity that is renewable at hour h, day d, in year y

Data unit	%	
Equations referred	Equation 1, Equation 3 and Equation 11	
Purpose of data	☒ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*	
Measurement methods and procedures		
Entity/person responsible for the measurement	Project proponent/plant operator (as applicable)	
Measuring instrument(s)	*Type of instrument*	Digital energy meter (grid-compliant)
	Accuracy class	
	Calibration requirements	Calibrated annually or as per manufacturer/grid code
	Location	At the grid export metering point (typically at the substation or plant interconnection)
Measurement intervals	Continuous measurement, with automated hourly recording and data logging	
QA/QC procedures	Regular calibration and maintenance of meters; comparison with SCADA/utility data; backup logging system in case of data loss. Anomalies flagged and corrected in accordance with approved data handling protocol	
Additional comment	No comments	

Data/parameter	$x_{\mathbf{h,d,y}}$	
Description	Fraction of received electricity that is renewable at hour h, day d, in year y	
Data unit	%	
Equations referred	Equation 1, Equation 3 and Equation 11	
Purpose of data	☒ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*	
Measurement methods and procedures		
Entity/person responsible for the measurement	Project proponent/plant operator (as applicable)	
Measuring instrument(s)	*Type of instrument*	Digital energy meter (grid-compliant)
	Accuracy class	
	Calibration requirements	
	Location	At the grid export metering point (typically at the substation or plant interconnection)
Measurement intervals	Continuous measurement, with automated hourly recording and data logging	

QA/QC procedures	Regular calibration and maintenance of meters; comparison with SCADA/utility data; backup logging system in case of data loss. Anomalies flagged and corrected in accordance with approved data handling protocol
Additional comment	No comments

Data/parameter	$EF_{DD,h,d,y}$	
Description	Dispatch Data Grid emission factor at hour h, day d, in year y	
Data unit	t CO2/hr	
Equations referred	Equation 3, Equation 11 and Equation 12	
Purpose of data	☒ Baseline emissions / removals ☐ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*	
Measurement methods and procedures	Emission factor is determined using actual hourly data on electricity generation and fuel-specific CO_2 emissions from grid-connected power plants that are on the margin at each hour. It reflects the emissions from real-time dispatch decisions.	
Entity/person responsible for the measurement	Grid operator or designated national/regional authority (e.g., system operator or energy regulator)	
Measuring instrument(s)	*Type of instrument*	Historical generation and emissions data from grid dispatch logs, emission monitoring systems, or national GHG inventory systems
	Accuracy class	Based on real-time monitored dispatch and emissions data; emission factors aligned with IPCC or country-specific sources
	Calibration requirements	-
	Location	Grid-wide, for the interconnected system where the project operates
Measurement intervals	Continuous measurement with hourly data recording and aggregation	
QA/QC procedures	-	
Additional comment	-	

Data/parameter	$Q_{f,y}$
Description	Quantity of fuel consumed during year
Data unit	Gg/yr
Equations referred	Equation 6
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*
Measurement methods and procedures	Fuel consumption data is collected from flow meters, fuel purchase records, or inventory balances. Data should be cross-checked with invoices or utility billing systems and adjusted for storage/stock changes if applicable.
Entity/person responsible for the measurement	Project proponent or facility operator

Measuring instrument(s)	*Type of instrument*	Mass flow meters, fuel tank level meters, or calibrated weighbridges, Data from vendor-certified fuel delivery logs can also be used with cross-verification.
	Accuracy class	Class 1.0 or better
	Calibration requirements	Annual calibration or per manufacturer requirements; documented calibration certificates must be retained
	Location	At fuel delivery, storage, or combustion point within the project boundary
Measurement intervals	Continuous or batch-wise (as per operational pattern); aggregated and reported annually	
QA/QC procedures	Cross-check fuel meter readings with procurement records and inventory reports. Periodic audit of measurement instruments. Documentation of all adjustments (e.g., for spillage, evaporation, or conversion factors)	
Additional comment	No additional comment	

Data/parameter	$V_{evap,y}$	
Description	Volume of water lost through evaporation over the year	
Data unit	m^3/year	
Equations referred	Equation 12	
Purpose of data	☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions *Tick the applicable box(es).*	
Measurement methods and procedures	Estimated using standard hydrological methods such as the water balance method, pan evaporation data	
Entity/person responsible for the measurement	Project proponent or facility operator or hydrological/meteorological authority of the plant	
Measuring instrument(s)	*Type of instrument*	Class A evaporation pans, weather station sensors, or satellite-based data
	Accuracy class	As per national hydrological standards or instrument specifications
	Calibration requirements	Not applicable
	Location	On-site near the reservoir (for pans/sensors) or remotely via satellite (for RS data)
Measurement intervals	Daily or monthly data, aggregated annually	
QA/QC procedures	-	
Additional comment	No additional comment	

Data/parameter	SEC_{pump}
Description	Specific Energy Consumption for Pumping
Data unit	MWh/m3
Equations referred	Equation 12

<table>
<tr><td>Purpose of data</td><td colspan="2">☐ Baseline emissions / removals ☒ Project emissions / removals ☐ Leakage emissions

Tick the applicable box(es).</td></tr>
<tr><td>Measurement methods and procedures</td><td colspan="2">Calculated as the ratio of total electricity consumed for pumping (in MWh) to the volume of water lifted (in m^3). Electricity import is measured using a bidirectional digital energy meter, and flow volume is measured using flow meters on the pump discharge line.</td></tr>
<tr><td>Entity/person responsible for the measurement</td><td colspan="2">Project proponent or facility operator;</td></tr>
<tr><td rowspan="4">Measuring instrument(s)</td><td>Type of instrument</td><td>Digital energy meter for electricity</td></tr>
<tr><td>Accuracy class</td><td>Class 0.5s or better</td></tr>
<tr><td>Calibration requirements</td><td>As per manufacturer or national standards. Calibration records must be maintained</td></tr>
<tr><td>Location</td><td>At the grid interconnection or pump motor control center</td></tr>
<tr><td>Measurement intervals</td><td colspan="2">Continuous measurement with hourly data logging</td></tr>
<tr><td>QA/QC procedures</td><td colspan="2">Cross-verification of energy data with SCADA logs and utility billing</td></tr>
<tr><td>Additional comment</td><td colspan="2">No additional comment</td></tr>
</table>

B.12.3. Monitoring for activities involving removals and emission reduction activities with reversal risks

Not applicable

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Document information

Version	*Date*	*Description*
01.0	18 December 2024	Initial publication of form template.

Decision Class: Regulatory
Document Type: Form
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