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Climate project methodology № 0019

# INCREASED ELECTRICITY GENERATION FROM EXISTING HYDROPOWER STATIONS THROUGH DECISION SUPPORT SYSTEM OPTIMIZATION

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# 1. Terms and definitions

1.1. The definitions and terms contained in Russian regulatory documents and national standards shall apply.

1.2. The climate project developer is encouraged to use the terms and definitions used in this methodology:

1.2.1. **Decision Support System (DSS) –** is an integrated set of computer programs (modules) that use forecasting methods, as well as optimization and modeling methods to optimize long-term and short-term benefits from the operation of the power system. Thus, DSS supports the adoption of complex decisions in complex situations and increases their effectiveness.

1.2.2. **Hydroelectric power plants (HPPs)** - are a complex of electromechanical devices and equipment necessary to convert potential hydroelectric energy into electrical energy.

1.2.3. **A hydraulic power unit** - is an aggregate consisting of a hydraulic turbine and a hydrogenerator.[1].

1.2.4. **Crediting period** – the period in which verified and certified GHG emission reductions or increases in net anthropogenic GHG removals by sinks attributable to a climate project activity, as applicable, can result in the issuance of carbon units. The time period that applies to a crediting period for a climate project activity, and whether the crediting period is renewable or fixed, is determined in accordance with Section 4. Project crediting period of this methodology.

1.2.5. **Project Design Document (PDD)** – is the principal document used by project developers to demonstrate and describe information about the proposed climate project for submission to the validation/verification authorities and the carbon carbon register

# 2. Scope and applicability

2.1. This methodology has been prepared on the basis of the existing methodology developed under the Clean Development Mechanism (AM0052) and includes its adaptation to the current Russian regulations and standards;

2.2. This methodology is applicable to existing grid-connected hydropower systems that may include multiple hydro generation units linked in a cascade, including both run of the river and reservoir-based units, where the project activity increases annual electricity generation through the introduction of a Decision Support System (DSS) that optimizes the operation of the existing hydropower facility/facilities;

2.3. In case of changes in the GHG regulatory legal framework of the Russian Federation, this methodology is subject to revision in order to take into account the relevant changes.

2.4. The methodology is applicable under the following conditions:

[1] In accordance with GOST R 55260.4.1-2013 "Technological part of hydroelectric power plants and pumped storage power plants"

2.4.1 Where the operation of hydropower systems is not currently optimized using a DSS, with optimization controls or modeling;

2.4.2 Where, at a minimum, three complete year of recorded data is available to establish the baseline relationship between water flow and power generation;

2.4.3 Where power generation units, covered under the project activity, have not undergone and will not undergo significant upgrades beyond basic maintenance that affect the generation capacity and/or expected operational efficiency levels during the crediting period;

2.4.4 Where no major changes to reservoir size (e.g., increase of dam height) or to other key physical system elements (e.g. canals, spillways) that would affect water flows within the project boundary, have been implemented during the baseline data period or will be implemented during the crediting period;

2.4.5 Where the project activity only includes the optimization of generation units that generated and supplied power to the electricity system during the year(s) for which historical data for the baseline was collected;

2.4.6 Where either no additional hydro power units are located downstream of the last hydropower unit within the project boundary or the first hydropower unit downstream the project boundary has the capacity to regulate at least 24 hours of maximum flow from upstream.[2]

2.5.The project site includes all of the hydropower generating units for which the DSS tool will be installed. The **spatial** extent of the project boundary includes the project site and all power plants connected physically to the electricity system to which the hydropower generating units in the project site is connected

2.5.For the baseline determination, project participants shall only account for $CO_2$ emissions from electricity generation in fossil fuel fired power plants that are displaced due to the project activity. The grid emission factor will be calculated according to «Appendix 2». Summary of emissions sources and GHGs are listed in Table 1.

*Table 1. Emission sources included in or excluded from the project boundary*

| Source | | Gas | Included | Justification/Explanation |
|---|---|---|---|---|
| **Базовая линия** | | $CO_2$ | Yes | $CO_2$ is emitted when fossil fuels are burned to generate electricity. The project activity would displace those fossil fuels with enhanced hydropower output |
| | | $CH_4$ | No | - |
| | | $N_2O$ | No | - |
| **Проектный сценарий** | | $CO_2$ | No | In terms of project emissions, the project is enhancing the use of existing hydropower capacity to generate additional hydropower. No fossil fuel emissions will be used to generate this additional electricity and thus there will be no project emissions |

[2] Twenty four hour (24 hrs) capacity in cubic meters ($m^3$) = Maximum observed annual flow ($m^3/s$) *24 hr*3600 s/hr * 0.5. Note that factor 0.5 reflects that the storage must be 50% of the flow volume to re-regulate the inflow to the average daily value.

| Source | | Gas | Included | Justification/Explanation |
|---|---|---|---|---|
| | | $CH_4$ | No | - |
| | | $N_2O$ | No | - |

# 3. Baseline methodology

3.1 The baseline[3] is set conservatively[4] for a business-as-usual activity, taking into account all existing policies and measures, but not considering additional project activities (Business-as-usual model). The project developer may use one of the following approaches to determine the baseline with justification for the appropriateness of the choices[5]. The project developer may use one of the following approaches to determine the baseline with justification for the appropriateness of the choices:

3.1.1. best available technologies that represent an economically feasible and environmentally sound course of action.

3.1.2. an ambitious benchmark approach where the baseline is set at least at the average emission level of the 20% best performing comparable activities providing similar outputs and services in a defined scope in similar social, economic, environmental and technological circumstances;

3.1.3. an approach based on existing actual or historical emissions, adjusted downwards by at least 5%, unless otherwise specified in the project methodology.

3.2. This methodology details the calculation of baseline emissions for Approach 3.1.3 (current or historical emissions). For an approach based on current or historical emissions, the project developer should use paragraphs 3.5-3.16 of this methodology to calculate baseline emissions.

3.3. The following six steps are used to estimate baseline emissions. If generating units within the project site, where DSS is implemented, do not share a connected water source, the estimation of the baseline emissions will be sum of the baseline emissions estimated using Steps 1 through 6 for each water course separately

3.4. A Data Book shall be prepared prior to the implementation of the Decision Support System containing all functional relationships for each generating unit, including the flow-generation functions

3.5. **Step 1:** Collect data for estimating the baseline flow-output relationship. The flow-output relationship is developed from baseline data collected for each generating unit and spillway within the project boundary, as described in the steps below. All data available within the most recent three calendar years must be collected and applied to the methodology below. In cases where less than three full years is used, the DOE must verify the unavailability of data. A minimum of one calendar year's data must be used, as required by the applicability conditions.

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[3] Greenhouse gas baseline, GHG baseline - quantitative reference(s) of GHG emissions and/or GHG removals that would have occurred in the absence of a GHG project and provides the baseline scenario for comparison with project GHG emissions and/or GHG removals (ISO 14064-2:2019 Greenhouse gases - Part 2)

[4] Calculation of the baseline is considered conservative if the final estimate of emission reductions resulting from project activities will not be overestimated. If there is any doubt, the project developer should better understate the baseline projection.

[5] https://unfccc.int/sites/default/files/resource/cma2021_10a01E.pdf, стр. 34, B – methodologies.

3.6. **Step 2:** Estimate weekly baseline flow for each week (generating units and spill). The weekly flow ($Q_x$) is sum of the flow through generating unit(s) and the spillway(s), estimated on an hourly basis, as follows:

$$Q_x = \sum_{hpu=1}^{N} \sum_{h=1}^{168} Q_{hpu,h} + \sum_{SW=1}^{M} \sum_{h=1}^{168} Q_{SW,h} \quad (1)$$

Where:

$Q_x$ – Flow during week 'x' for each generation site ($m^3$/week);

$Q_{hpu,h}$ – Flow through generation unit '*hpu*' during hour '*h*' in week '*x*' estimated using relationship provided in equation 2 ($m^3$/hour);

$Q_{SW,h}$ – Flow over the spillway «*SW*» for hour «*h*» during week «*x*», estimated using equation 3, (м$^3$/час);

N – Total number of hydro power generation units 'hpu' within the project site on the same water course (number);

M – Total number of spillways within the project site on the same water course (number).

3.7. **Step 2a:** Deduce flow through generating units. The hourly flow through each generating unit is determined using the records of measured power output for that hour and the characteristic specifications of the generating unit. A curve for each HPU known as a "Hill Diagram" will be constructed that accurately pinpoints its *power* versus *flow* and *head*. The form of the flow-generation curve for each generating unit is represented by a third order, polynomial equation that relates measured power output to measured head and flow, using equations 2-6:

$$EG_{hpu,h} = a + b \times Q_{hpu,h} + c \times Q_{hpu,h}^2 + d \times Q_{hpu,h}^3 \quad (2)$$

$$a = a_1 + a_2 \times H_{hpu} + a_3 \times H_{hpu}^{\ 2} \quad (3)$$

$$b = b_1 + b_2 \times H_{hpu} + b_3 \times H_{hpu}^{\ 2} \quad (4)$$

$$c = c_1 + c_2 \times H_{hpu} + c_3 \times H_{hpu}^{\ 2} \quad (5)$$

$$d = d_1 + d_2 \times H_{hpu} + d_3 \times H_{hpu}^{\ 2} \quad (6)$$

Где:

$EG_{hpu,h}$ –Observed power output of 'hpu' unit for hour 'h' during week 'x' (MWh);

a, b, c, d – Coefficients that are a function of head, calculated as per equations above

$Q_{hpu,h}$ – Flow through generation unit 'hpu' during hour 'h' ($m^3$/hour);

$a_i$, $b_i$, $c_i$, $d_i$– The power polynomial coefficients for each generating unit based on "*hill diagram"* information provided by the owner or manufacturer;

$H_{hpu}$ – Head acting on the generating unit hpu (headwater level less tail water level) for each hour 'h' (m).

3.8 **Step 2b: Calculate spillway flows.** Spillway flows are calculated with the application of a "rating equation" which relates the flow through the spillway gate opening to monitored parameters - the water level and the gate opening.[6] Rating equation provided by the owner

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[6] Design of Small Dams, US Bureau of the Interior, Bureau of Reclamation, Chapter IX, Spillways Water Resources Engineering, Linsley and Franzini, McGraw Hill.

and/or equipment manufacturer shall be used for estimating the spillway flows. For example, a typical equation for spillway overflow with a radial gate partially open is:

$$Q_{SW,h} = C_o \times L_e \times O \times (WL_h - E_{sill})^E \times 3600 \quad (7)$$

Where:

$Q_{SW,h}$ –Hourly spillway flow ($m^3$/hour);
$C_0$ – Known coefficient taken from manufacturer/owner data;
$L_e$ – Length of the gate measured as built (m);
O – Vertical opening (m);
$WL_h$ –Water level during hour ‘h’ (m);
$E_{sill}$ – Elevation of the sill measured as built (m);
E – Known coefficient taken from manufacturer/owner data.

3.8 Spillway flows will be calculated for each hour and aggregated weekly over the year. These values are used in Step 3.

3.9 **Step 3: Establish the flow-output (generation) relationship.** Tabulate weekly total flow (generation flow and spillway flow) estimated in the previous step along with recorded power generation during the corresponding week of the baseline period[7]. The data plot shall be visually inspected to ensure that the data is uniformly distributed over the range of weekly total flow recorded. Estimate the relationship between *total weekly flow* and *total weekly generation* for the baseline through regression analysis using polynomial equation form.

3.10 The estimated equation should be of the form:

$$EG_x = f(Q_x) = a + b_1 x Q_x + b_2 x Q_x^2 + \ldots + b_n x Q_x^n \quad (8)$$
$$EG_x = \sum_{hpu=1}^{N} \sum_{h=1}^{168} (EG_{hpu,h}) \quad (9)$$

Where:

$EG_x$ – Recorded value of power generation for week ‘x’ estimated as sum of recorded observation of power generation in each of the units ‘hpu’ for hour ‘h’ in the week ‘x’ (MWh);
$Q_x$ – Estimated value of flow in the week ‘x’, estimated as per Step 2 ($m^3$/week);
a, $b_1 \ldots b_n$ – coefficients of the estimated regression equation.

[7] The period before the implementation of the project activities. It is necessary to compare the data of one week. Weeks of the project period and the baseline period.

3.11 The estimated relationship should be monotonous in nature, i.e. the slope of the function should be non-negative at all points of the function.[8] The criteria for determining the degree of polynomial ‘n’ is as follows:

a) The value ‘n’ for which the adjusted $R^2$ of the equation is highest;

b) Estimates of parameters a, $b_1,\ldots,b_n$ are significant at the 5 per cent confidence level.

3.12 **Step 4: Determine baseline power generation**. Use the flow-output relationship defined in Equation 4 to estimate baseline electricity output during each week of the project period ($EG_{Bl,x}$), and sum this for each week of the year *‘y’*.

$$EG_{BL,y} = \sum_{x=1}^{52} E\,G^{B1} \quad (10)$$

$$EG_{BL,x} = f({Q_x}^{Pr}) + 1x96xSE(f({Q_x}^{Pr})) \quad (11)$$

Где:

$EG^{B1}$ – Estimated electricity that would have been generated corresponding to flow $Q_x^{Pr}$ estimated in the week ‘x’ of project crediting period ‘y’ (MWh);

${Q_x}^{Pr}$ – Flow for week ‘x’ measured during the project year “y” ($m^3$/week);

$SE$ – Standard error of the estimate.

3.12 Note that due to the inclusion of the second term in Equation 7, there is only a 5 per cent chance that the estimated baseline output would be understated by the equation. Therefore, there would only be a 5 per cent chance that weekly energy generation gains would be overestimated.

3.13 To be conservative, the project developer will not seek to claim credit for any weekly project results, in which the flow (${Q_x}^{Pr}$) falls outside the recorded boundaries of the baseline data. This gives the project developer incentives to use as many years of baseline data as possible. It also allows the baseline to conservatively and accurately normalize data in changing climates and in different withdrawal regimes.

3.14 Exclusion of any outlier data points should be documented with a clear rationale (atypical circumstances such as blackouts, major equipment malfunction and repair) and validated and/or verified by the DOE. In the project year, the project developer will not be able to claim any emission reductions in weeks where major atypical circumstances occur.

3.15 **Step 5: Calculation of project electricity generation**. The total electricity generation for the project $EG_y$ in year *y* is calculated as follows:

$$EG_{Pr,y} = \sum_{x=1}^{52} \sum_{hpu=1}^{N} EG_{\mathrm{Pr},hpu,x} \quad (13)$$

Где:

$EG_{Pr,y}$ – Electricity generated during the project in year ‘y’ (MWh);

$EG_{Pr,hpy,y}$ – Total electricity generated by unit ‘hpu’ in week ‘x’ of year ‘y’ (MWh). It is assumed that there are 52 weeks on average in a year.

3.16 **Step 6: Baseline emissions.** Baseline emissions (BE) is calculated as follows%

$$BE = (EG_{Pr,y} - EG_{Bl,y}) \times EF_{grid,y} \quad (14)$$

[8] The function *EG =f(Q)* is **monotone** if, whenever $Q_x \leq Q_y$, then $EG_x \leq EG_y$.

Where:

$EF_{grid,y}$ – $CO_2$ emissions factor (see Appendix 2) ($tCO_2$/MWh)

## 4. Project crediting period

4.1 The starting date of project activities is not regulated.

4.2 A crediting period for emission reduction projects is a maximum of 5 years renewable a maximum of twice, or a maximum of 10 years with no option of renewal.

4.3 The crediting period begins no earlier than 5 years prior to applying for validation for projects validated until December 31, 2025, and no earlier than 2 years prior to applying for validation for projects validated after January 1, 2026.

4.4 The additionality and baseline shall be evaluated at the beginning of the crediting period and confirmed or reevaluated at the beginning of the next 5-year phase if the project is conducted 3 times 5 years each.

## 5. Additionality

5.1. Additionality shall be demonstrated using Tool #1 «Demonstration of the additionality of the project activity»;

5.2. The project developer needs to demonstrate the additionality of the project activity in the PDD. Paragraphs 5.3-5.4 provide explanatory information regarding this methodology and the Tool "«Demonstration of the additionality of the project activity»".

5.3. Project participants shall identify realistic and credible alternatives(s) to the project activity including the following possible alternatives:

*a)* *Alternative #1*: Status Quo. Continuation of the current water management practices;

*b)* *Alternative #2*: Changes to hydro system operation or facilities (other than the project), including dam height, turbine replacement, spillway dimensions, and other changes that would materially affect the flow-output relationship;

*c)* *Alternative #3*: The proposed project activity, not undertaken as a project activity

5.4 The alternatives proposed in this Section are only indicative. Project proponents should propose other possible alternatives that are reasonably foreseeable.

5.4. In order to demonstrate that the proposed project activity is not regarded as a “common practice”, a rationale must be provided for this. The project developer may interview electricity utilities, in the selected country or region, and the manufacturers of the DSS software/optimization technology to assess how common is the project activity. The project activity is not a common practice if:

5.4.1 The project type has not been implemented in the region;

5.4.2 Companies that provide the technology, used in the project activity, have minimal business in the country where the project is being implemented; and

5.4.3 Utility managers are unfamiliar with this type of project.

5.5 For the investment, barrier and common practice analyses, project participants should provide the following evidence:

5.5.1 Letters from the electricity utility implementing the proposed project activity indicating their unfamiliarity with the hydro-optimization technology;

5.5.2 Letters from one or more technology providers/developers that indicate average penetration rates in developed markets and whether similar projects have been developed in the country or region

5.5.3 Financial statements indicating the revenue losses and overall financial health of the electricity utility implementing the project activity;

5.5.4 Least-cost capacity expansion planning or feasibility studies, if available, that show that electricity utility implementing the proposed project activity has not considered the project activity as an option in these studies. This could include a list of priority investments for the utility. If the list does not include hydro-optimization but includes other projects, it shows that the enables bringing the proposed project forward;

5.5.5 Existing tariff rates or other information that show the income received from additional hydropower generation from implementing the project activity would not translate into additional income, thus making the investment not cost-effective (for the investment analysis);

## 6. Monitoring plan requirements

6.1 All data collected as part of monitoring of projects emissions should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent (100%) of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards. The list of parameters that need to be monitored is presented in the tables 2-13.

6.2 The following data for estimating the baseline relationship between power generation and flow shall be archived:

a) All the water courses and corresponding hydro power generating units, included within the project site;

b) Relevant parameters of each hydro power generation unit, reservoir dam and the spill way characteristic to verify the applicability conditions;

c) Hourly power generation of each hydro power generation unit within the project site;

d) Parameters for Rating equation to estimate flow over the spill ways;

e) Estimated parameters of power generation and flow relationship, as estimated in Step 3 of Baseline Section in Baseline methodology.

6.3 The following data for estimating the baseline relationship between power generation and flow index shall be archived:

a) Estimated flow for each hour of the crediting period;

b) (Projected estimate of baseline power generation corresponding to the project flow index;

c) Project power generation

6.4 In addition, various elements of the hydro system (changes to turbines, dams, etc.) need to be monitored to ensure continued adherence to applicability conditions.

6.5 Furthermore the project developer can apply the basic provisions of the CDM tool « Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation».

*Table 2. Data / Parameter monitored*

| **Data / Parameter:** | **$EF_{grid,y}$** |
|---|---|
| Data unit: | kgCO2/MWh |
| Description: | Baseline emission factor of the project activity power plant in year y |
| Source of data: | Calculation method. See Appendix 1. |
| Measurement procedures (if any): | - |
| Monitoring frequency: | Aggregated at least annually |
| Any comment: | - |

*Table 3. Data / Parameter monitored*

| **Data / Parameter:** | **Headwater level** |
|---|---|
| Data unit: | m |
| Description: | Headwater level |
| Source of data: | Operations data log at project site. Measured at head water entering generating unit |
| Measurement procedures (if any): | Hourly data records for each power generating unit in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | Hourly |
| QA/QC procedures: | The monitoring system used by the DSS will gather and archive this data. The data acquisition system used for the Decision Support Tool will provide highly accurate data. Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |
| Any comment: | - |

*Table 4. Data / Parameter monitored*

| **Data / Parameter:** | **Tail water level** |
|---|---|
| Data unit: | m |
| Description: | Tail water level |
| Source of data: | Operations data log at project site. Measured at tail water leaving generation units |
| Measurement procedures (if any): | Hourly data records for each power generating unit in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | Hourly |
| QA/QC procedures: | The monitoring system used by the DSS will gather and archive this data. The data acquisition system used for the Decision Support Tool will provide highly accurate data. Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |
| Any comment: | - |

*Table 5. Data / Parameter monitored*

| **Data / Parameter:** | **N** |
|---|---|
| Data unit: | Units |
| Description: | Total number of hydro power generation units ‘hpu’ within the project site on the same water course |
| Source of data: | Project site |
| Measurement procedures (if any): | Count the number of hydro power generation units within the project site on the same water course. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 6. Data / Parameter monitored*

| **Data / Parameter:** | **M** |
| --- | --- |
| Data unit: | Units |
| Description: | Total number of spillways within the project site on the same water course |
| Source of data: | Project site |
| Measurement procedures (if any): | Count the number of spillways within the project site on the same water course. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 7. Data / Parameter monitored*

| **Data / Parameter:** | **$a_i$, $b_i$, $c_i$ and $d_i$** |
| --- | --- |
| Data unit: | Units |
| Description: | The power polynomial coefficients for each generating unit based on “Hill Diagram” information provided by the owner or manufacturer. The “Hill Diagram” defines the three dimensional relationship between power output, head and flow |
| Source of data: | Manufacturer/owner |
| Measurement procedures (if any): | A ‘hill diagram’ will be included in the data book for every generating unit in the project boundary. This essentially provides information derived in equations 2 |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data. Hill Diagrams for a generating unit are stationary and do not change measurably within the life of the project. Any changes, however unlikely, would be in the direction of deterioration of the unit and would make the results of the project more conservative (i.e. yield lower generation in project years) |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 8. Data / Parameter monitored*

| **Data / Parameter:** | **$C_o$** |
| --- | --- |
| Data unit: | Units |
| Description: | Known coefficient taken from manufacturer/owner data |

| | |
|---|---|
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | The equation given by the owner will provide accurate data |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 9. Data / Parameter monitored*

| **Data / Parameter:** | $\mathbf{L_e}$ |
|---|---|
| Data unit: | m |
| Description: | Length of the gate measured as built |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | The equation given by the owner will provide accurate data |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 10. Data / Parameter monitored*

| **Data / Parameter:** | **O** |
|---|---|
| Data unit: | m |
| Description: | Vertical opening |
| Source of data: | Measured during operations at the project site |
| Measurement procedures (if any): | Hourly data records for each spillway in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | Hourly |
| QA/QC procedures: | These measurements are very simple to make and accurate. More importantly the measurements will be completely consistent between the baseline year and the project year. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |
| Any comment: | - |

*Table 11. Data / Parameter monitored*

| **Data / Parameter:** | **$E_{sill}$** |
|---|---|
| Data unit: | m |
| Description: | Elevation of the sill measured as built |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | The equation given by the owner will provide accurate data |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 12. Data / Parameter monitored*

| **Data / Parameter:** | **E** |
|---|---|
| Data unit: | Units |
| Description: | Known coefficient taken from manufacturer/owner data |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | The equation given by the owner will provide accurate data |
| Monitoring frequency: | This shall be checked yearly and compared with baseline data |
| QA/QC procedures: | - |
| Any comment: | - |

*Table 13. Data / Parameter monitored*

| **Data / Parameter:** | **$W_{Lh}$** |
|---|---|
| Data unit: | m |
| Description: | Water level in week ‘x’ |
| Source of data: | Operations data log at project site |
| Measurement procedures (if any): | Hourly data records for each spillway in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Monitoring frequency: | Hourly |

| | |
|---|---|
| QA/QC procedures: | Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |
| Any comment: | - |

6.2. Data and parameters that are not monitored should be calculated once and remain fixed throughout the crediting period. The list of not monitored parameters is presented in the tables 14-26. Data for all the variables mentioned below shall be based on 3 years of historic records prior to start of the project activity. It shall be ensured that the precipitation pattern in the watershed of the project area for the year does not represent either a DRY or WET year[9].

*Table 14. Data / Parameter monitored*

| **Data / Parameter:** | **M** |
|---|---|
| Data unit: | Units |
| Description: | Total number of spillways within the project site on the same water course, in the year before the implementation of the project activity |
| Source of data: | Project site |
| Measurement procedures (if any): | Count the number of spillways within the project site on the same water course in the year before the implementation of the project activity. The data shall be stored until two years after the end of the crediting period |
| Any comment: | - |

*Table 15. Data / Parameter monitored*

| **Data / Parameter:** | **N** |
|---|---|
| Data unit: | Units |
| Description: | Total number of hydro power generation units within the project site on the same water course, in the year previous to the implementation of the project activity |
| Source of data: | Project site |
| Measurement procedures (if any): | Count the number of hydro power generation units within the project site on the same water course in the year previous to the implementation of the project activity. The data shall be stored until two years after the end of the crediting period |

[9] This means that the average annual rainfall should be within one standard standard deviation for the normal average annual rainfall. Normal is defined as 30 year average of annual average rainfall.

| | |
|---|---|
| Any comment: | - |

*Table 16. Data / Parameter monitored*

| **Data / Parameter:** | **$a_i$, $b_i$, $c_i$ and $d_i$** |
|---|---|
| Data unit: | Units |
| Description: | The power polynomial coefficients for each generating unit based on “hill diagram” information provided by the owner or manufacturer. The “hill diagram” is the one which defines the three dimensional relationship between power output, head and flow |
| Source of data: | Owner or manufacturer of the generating unit |
| Measurement procedures (if any): | The data shall be stored until two years after the end of the crediting period |
| Any comment: | - |

*Table 17. Data / Parameter monitored*

| **Data / Parameter:** | **H** |
|---|---|
| Data unit: | m |
| Description: | Head acting on the generating unit (headwater level less tail water level) |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | Hourly data records for each hydropower generating unit in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | The equation given by the owner will provide accurate data. More importantly, the equation will give consistent results between baseline measurements and project year measurements |

*Table 18. Data / Parameter monitored*

| **Data / Parameter:** | **$C_o$** |
|---|---|
| Data unit: | Units |
| Description: | Known coefficient taken from manufacturer/owner data |

| | |
|---|---|
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | Obtain the value before validation for each spillway in the project boundary. The data shall be stored until two years after the end of the crediting period |
| Any comment: | The equation given by the owner will provide accurate data. More importantly, the equation will give consistent results between baseline measurements and project year measurements |

*Table 19. Data / Parameter monitored*

| **Data / Parameter:** | **$L_e$** |
|---|---|
| Data unit: | m |
| Description: | Length of the gate measured as built |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | Obtain the value before validation for each spillway in the project boundary in order to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | The equation given by the owner will provide accurate data. More importantly, the equation will give consistent results between baseline measurements and project year measurements |

*Table 20. Data / Parameter monitored*

| **Data / Parameter:** | **O** |
|---|---|
| Data unit: | m |
| Description: | Vertical opening size of spillway |
| Source of data: | Measured during operations at the project site |
| Measurement procedures (if any): | Hourly data records for each spillway in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |

| | |
|---|---|
| Any comment: | These measurements are very simple to make and accurate. More importantly the measurements will be completely consistent between the baseline year and the project year. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |

*Table 21. Data / Parameter monitored*

| **Data / Parameter:** | **E** |
|---|---|
| Data unit: | Units |
| Description: | Known coefficient taken from manufacturer/owner data |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | Obtain the coefficient before validation for each spillway in the project boundary in order to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | The equation given by the owner will provide accurate data. More importantly, the equation will give consistent results between baseline measurements and project year measurements |

*Table 22. Data / Parameter monitored*

| **Data / Parameter:** | $\mathbf{E_{sill}}$ |
|---|---|
| Data unit: | m |
| Description: | Elevation of the sill measured as built |
| Source of data: | Manufacturer/owner data, design and or testing information for spillway |
| Measurement procedures (if any): | Obtain the coefficient before validation for each spillway in the project boundary in order to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | The equation given by the owner will provide accurate data. More importantly, the equation will give consistent results between baseline measurements and project year measurements |

*Table 23. Data / Parameter monitored*

| **Data / Parameter:** | **WLh** |
|---|---|
| Data unit: | m |
| Description: | Water level in week ‘x’ |
| Source of data: | Operations data log at project site |
| Measurement procedures (if any): | Hourly data records for each spillway in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |

*Table 24. Data / Parameter monitored*

| **Data / Parameter:** | **Глубина верхнего бьефа** |
|---|---|
| Data unit: | m |
| Description: | Headwater level |
| Source of data: | Operations data log at project site. Measured at head water entering generating unit |
| Measurement procedures (if any): | Hourly data records for each power generating unit in the project during the crediting period. The data shall be stored until two years after the end of the crediting period |
| Any comment: | Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |

*Table 25. Data / Parameter monitored*

| **Data / Parameter:** | **Глубина нижнего бьефа** |
|---|---|
| Data unit: | m |
| Description: | Tail water level |

| | |
|---|---|
| Source of data: | Operations data log at project site. Measured at tail water leaving generation units. |
| Measurement procedures (if any): | Hourly data records for each power generating unit in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | Meters shall be tested annually and calibrated as recommended by the manufacturer. Meters are typically accurate to plus or minus a tenth or hundredth of a per cent. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |

*Table 26. Data / Parameter monitored*

| **Data / Parameter:** | **$EG_{hpu,h}$** |
|---|---|
| Data unit: | MWh |
| Description: | Observed power output of ‘hpu’ unit for week ‘x’ |
| Source of data: | Operations data log available at the project site |
| Measurement procedures (if any): | Hourly data records for each power generating unit in the project boundary from the year previous to the implementation of the project activity shall be used to characterize the baseline scenario. The data shall be stored until two years after the end of the crediting period |
| Any comment: | Meters shall be tested annually and calibrated as recommended by the manufacturer. All measurements should use calibrated measurement equipment that is maintained regularly and checked for its functioning |

## 6. Project scenario

7.1. Project emissions are zero.

$$PE_y = 0$$

7.2. The emission reduction by the project activity during a given year y (ERy) is the difference between the baseline emissions (BEy) and project emissions (PEy) and leakage emissions (LEy), as follows:

$$ER_y = BE_y - PE_y$$

where:

ERy – Emissions reductions of the project activity during the year y in t $CO_2$;

$BE_y$ – Baseline emissions during the year y in t $CO_2$;

PEy – Project emissions during the year y in t $CO_2$;

7.3. In the process of implementing a climate project, project developers may face certain risks and barriers. To assess the risks, the project developer should develop a risk matrix. For more details, see Appendix 1.

7.4. It should be noted that if the actual generation is less than the baseline generation for a given week, it will be treated as a negative value and deducted from the total annual savings. If in the unlikely event a project activity temporarily results in a negative emission reduction, i.e. baseline emissions minus project emissions are negative, any further Emission Reductions will only be issued when the emissions increase has been compensated by subsequent emission reductions by the project activity

## 7 Leakage assessment

8.1. According to the Order of the Ministry of Economic Development of Russia dated May 11, 2022 № 248 project activities should not lead to an aggregate increase in greenhouse gas emissions or reduce their absorption levels outside the scope of such activities. At the same time, it is necessary to consider and fully account leakage for a project activity in accordance with the methodology below.

8.1. Leaks of project activity are not typical for this type of projects, therefore they are not taken into account.

## 8. Non-permanence risk analysis

9.1. Not applicable for this type of project.

## 9. Methods to prevent double counting, negative impacts on the environment and society.

10.1. Climate project should demonstrate its compliance with all legal requirements in the jurisdiction where it is located. The project developer needs to minimize the risk that his project might result in negative impacts for local communities, biodiversity and the environment. Projects should not cause an increase in atmosphere, soil, surface and ground water pollution as well as lead to any community conflicts, land tenure issues, forceful evictions, human rights violations, or worsened health and wellbeing due to restricted access to a forest or nature area.

10.2. The project developer should make efforts to avoid double counting[10] between project areas (project boundaries), between company reporting and reporting on the project, between the reporting of different companies, between the subjects of the Russian Federation and different

[10] Double counting: accounting for GHG emissions or removals more than once. Double counting can occur between organizations, i.e. two or more reporting organizations take ownership of the same GHG emissions or removals. Double counting can also occur inside an organization when GHG emissions or removals are taken into account in different categories (this type of double counting should not occur). (ISO/TR 14069:2013 Greenhouse gases - Quantification and reporting of greenhouse gas emissions for organizations - Guidance for the application of ISO 14064-1). See also GOST R ISO 14080-2021. National Standard of the Russian Federation. Greenhouse gas management and related activities. A system of approaches and methodological support for the implementation of climate projects.

countries in the case of international transfer of carbon credits. In the latter case, it is necessary to demonstrate that the carbon credits transferred at the international level are excluded from the accounting of the quantitative goals of the defined at the national level contribution of the Russian Federation.

## 10.Update of the baseline at the renewal of the crediting period

11.1.At the renewal of crediting period, the project is subject to verification with elements of validation and a technical assessment by a validation and verification body to determine necessary updates to the baseline, the additionality and the quantification of emission reductions. In order to update the baseline, it is necessary to revise and update the main parameters and assumptions used in established baseline approach (point's 3.2.1-3.2.3). The baseline shall be representative of the conditions for the beginning of a new crediting period and be valid for that period. The additionality at the renewal of the crediting period is checked for compliance to the criteria under Tool № 1 at the date of the beginning of the new crediting period.

11.2.At the renewal of crediting period, it is impossible to change the established baseline approach earlier (Best available technologies; Ambitious benchmark; Existing actual or historical emissions).

## 11.References

1. Order of the Ministry of Economic Development of Russia dated May 11, 2022 № 248 "On approval of the criteria and procedure for classifying projects implemented by legal entities, individual entrepreneurs or individuals, as climate projects, the form and procedure for

reporting on the implementation of a climate project" (Registered with the Ministry of Justice of Russia on May 30, 2022 № 68642).

2. GOST R ISO 14064-1-2021. National Standard of the Russian Federation. Greenhouse gases. Part 1. Requirements and Guidance for Quantification and Reporting of Greenhouse Gas Emissions and Absorption at the Organization Level (approved and enacted by Rosstandart Order No. 1029-st dated 30.09.2021).
3. GOST R ISO 14064-2-2021. National Standard of the Russian Federation. Greenhouse gases. Part 2. Requirements and Guidelines for Quantification, Monitoring and Reporting Documents for Projects to Reduce Greenhouse Gas Emissions or Increase Their Absorption at the Project Level (approved and enacted by Order No. 1030-st of Rosstandart dated September 30, 2021).
4. GOST R ISO 14064-3-2021. National Standard of the Russian Federation. Greenhouse gases. Part 3. Requirements and Guidance for Validation and Verification of Greenhouse Gas Statements (approved and enacted by Rosstandart Order No. 1031-st of 30.09.2021).
5. GOST R ISO 14065-2014 National Standard of the Russian Federation. Greenhouse gases. Requirements for greenhouse gas validation and verification bodies for their application in accreditation or other forms of recognition (approved and enacted by Order of Rosstandart of 26.11.2014 № 1869-st).
6. GOST R ISO 14066-2013. National Standard of the Russian Federation. Greenhouse gases. Requirements for competence of greenhouse gas validation and verification groups (approved and enacted by Order of Rosstandart of 17.12.2013 № 2274-st).
7. GOST R ISO 14080-2021. National Standard of the Russian Federation. Greenhouse Gas Management and Related Activities. System of approaches and methodological support for the implementation of climate projects (approved and enacted by Order of Rosstandart No. 1033-st dated 30.09.2021).
8. IPCC 2006. Guidelines for National Greenhouse Gas Inventories of the Intergovernmental Panel on Climate Change, 2006 / Edited by S. Iggleston, L. Buendia, K. Miwa, T. Ngara and K. Tanabe. // T.1-5. - IGES// Hayyam. 2006.
9. AM0052 Large-scale methodology: Increased electricity generation from existing hydropower stations through Decision Support System optimization. Version 03.0
10. AM0052 Large-scale methodology: Increased electricity generation from existing hydropower stations through Decision Support System optimization. Version 03.0

## Appendix 1. Risk management

As a part of the project implementation, it is recommended to develop a risk assessment system with a description of the most likely risks that may arise at all stages of the climate project. For such an assessment, the project developer should develop a detailed matrix with the following information, as a minimum:

(i) The main stages of the implementation of the climate project;

(ii) Description of the risks that may arise at each stage of the climate project;

(iii) Description of the probability of occurrence of risks. For this, the rating options "low, medium, high" or any other understandable numerical scales can be used;

(iv) Description of the impact of each risk on the results of the entire project. This can also be done using "low, medium, high" or any other understandable numerical scale;

(v) Description of the period of influence of each risk on the entire climate project;

(vi) Development of measures to minimize or avoid each type of risks;

(vii) The time for the implementation of each measure that reduces or prevents the occurrence of risks is indicated.

An example of a template with a risk matrix is shown in Table 1.

*Table 1. Risk matrix template*

| **Stage of climate project implementation** | **Description of risks** | **Probability of occurrence** | **Impact on the project** | **Impact period** | **Risk minimization methods** | **Implementation period** |
|---|---|---|---|---|---|---|
| | | low<br>medium<br>high | low<br>medium<br>high | Preparation period<br>1-2 years after the implementation<br>The entire period of the climate project | Detailed description of mitigation measures for each risk | Description of the time frame for the implementation of these activities |
| | | Scale from 1 to 5 or others | Scale from 1 to 5 or others | | | |

## Appendix 2. Recommended approach for calculation of grid emissions factor (emission factor for an electricity system)

1. Currently, there are no legislatively approved grid emission factors for greenhouse gases (GHG) in the Russian Federation.

2. If the initial data required to calculate the grid emission factor for the baseline and project scenarios is available, the climate project developer has the right to calculate it independently. In this case, it is

recommended to use the Guidelines for the quantitative calculation of the volume of indirect energy emissions of greenhouse gases (Order of the Ministry of Natural Resources № 330 (29.06.2017)[11]) and the principles for calculating indirect energy emissions defined in GOST R ISO 14064-1-2021[12].

To determine the grid emission factor, a regional method for calculation of indirect energy emissions is used, which reflects the average intensity of greenhouse gas emissions at facilities generating electrical and thermal energy consumed by the organization (Order of the Ministry of Natural Resources № 330).

According to GOST R ISO 14064-1-2021 (Appendix E), emissions from imported electricity must be calculated by the project developer using a location-based approach[13] by applying an emission factor that best characterizes the relevant electric power system, i.e. leased transmission line, local, regional or national grid average emission factor. The grid-averaged emission factors should refer to the emissions of the reporting year, if available, or otherwise the latest available year. Grid-averaged emission factors for imported electricity should be based on the average consumption pattern from the electric power system from which the electricity is consumed.

Grid emission factors may also include other indirect emissions associated with electricity generation, such as transmission and distribution losses.

The requirements and guidance described in ISO 14064-1-2021 for electricity also apply to consumed and transferred heat, steam, cooling air and compressed air.

In case of energy from cogeneration facilities, it is necessary to use approaches to separate various forms of energy[14].

Association "NP Market Council (Sovet Rynka)" and JSC "ATS" have developed a concept for calculating and publishing greenhouse gas emission factors for the energy system of the Russian Federation[15]. Based on the results of the peer review, independent international auditors issued an assurance certificate, and this concept received a validation report[16]. It is assumed that the implementation of this concept will lead to the more accurate calculation and publication of grid emission factors. The approaches outlined in the concept can also be used by the project developer to calculate the emission factor of the electric power system.

[11] Order of the Ministry of Natural Resources and Ecology of the Russian Federation (29.06.2017 № 330) "On approval of guidelines for quantifying the volume of indirect energy emissions of greenhouse gases"

[12] GOST R ISO 14064-1-2021. National Standard of the Russian Federation. Greenhouse gases. Part 1. Requirements and Guidance for Quantification and Reporting of Greenhouse Gas Emissions and Absorption at the Organization Level (approved and enacted by Rosstandart Order 30.09.2021 №1029-st)

[13] The location-based approach is a method for quantifying indirect energy emissions based on average emission factors from energy production for a given geographic location, including local, regional or national boundaries

[14] For example, calculation of specific fuel consumption in accordance with the "Guidelines for the distribution of specific fuel consumption in the production of electrical and thermal energy within combined generation of electrical and thermal energy, used for the purpose of tariff regulation in the heat supply", legislatively approved by the Order of the Ministry of Energy of the Russian Federation (12.09.2016 №952)

[15] The concept of calculation and publication of greenhouse gas emission factors for the energy system of the Russian Federation URL: https://www.np-sr.ru/sites/default/files/koncepciya_kev.pdf

[16] As part of the validation procedure, a detailed verification of the Concept was carried out for its compliance with the requirements of the international standards in the field of accounting and reporting on greenhouse gas emissions (TÜV AUSTRIA). Based on the results of the audit, the Concept was recognized by international experts as complying with high international standards and best international practices for calculating energy system emission factors. URL: https://www.np-sr.ru/sites/default/files/zaklyuchenie_o_validacii_koncepcii.pdf

3. If it is impossible to calculate the grid emission factor on its own, the project developer can use grid emission factors from the following sources:

Source 1. JSC "Administrator of the Trading System" in test mode in 2021 launched an Internet resource that publishes the grid CO2 emission factor for the first synchronous zone of the Russian Federation for various time periods (hour, day, month, year) [17].

Source 2. Emission factors of the International Energy Agency (IEA). The data is updated annually for the entire energy system of the regions (including the Russian Federation) and reflects the average carbon intensity of electricity and heat generation[18].

Source 3. Climate Transparency Global Partnership develops G20 climate indicators. The agency publishes annually reports from the G20[19] countries, including the average energy emission factor.

4. Methods and approaches applied to the calculation of the grid emission factor should be documented and specified in the PDD. It is necessary to justify the chosen calculation methodology, disclose information about the source of the initial data used, transparently and accurately document your own procedure for calculating the grid emission factor, or describe the properties of the selected and applied grid emission factor.

[17] URL: https://www.atsenergo.ru/results/co2
[18] URL: https://www.iea.org/data-and-statistics/data-product/emissions-factors-2021
[19] URL: https://www.climate-transparency.org/g20-climate-performance/g20report2022#1531904804037-423d5c88-a7a7