CERCARBONO
Certified Carbon Standard

Methodology M/EE-EG001

Implementation of GHG Emission Reduction Projects Through Renewable Energy Use for Electric Power Generation

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Version 2.2

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Acronyms and abbreviations

BESS	Battery Energy Storage Systems
CCMP	Climate Change Mitigation Program or Project
CDM	Clean Development Mechanism
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
MRV	Measuring, Reporting, and Verification System
NDC	Nationally Determined Contribution
NIS	National Interconnected System
NIZ	Non-Interconnected Zone
ORC	Organic Rankine Cycle
PDD	Project Description Document
SDGs	Sustainable Development Goals
VVB	Validation and Verification Body

Terms and definitions

The terms and definitions providing guidance for thorough understanding of this methodology are included in the ***Terms and Definitions of the Voluntary Certification Programme of Cercarbono*** document, available at www.cercarbono.com, section: Documentation.

Summary

This methodology has been developed to allow for carbon credits generation through Climate Change Mitigation Programs or Projects (CCMP) focused on electric power generation using renewable energy, displacing fossil fuel-based in a grid forming part of a National Interconnected System (NIS) or in a Non-Interconnected Zone (NIZ) in a certain geographical area. The CCMP start date is established according to provisions as per in current version of ***Cercarbono's Protocol for Voluntary Carbon Certification*** (hereinafter ***Cercarbono's Protocol***, available at www.cercarbono.com, section: Documentation).

To be eligible, CCMPs must abide with herein proposed requirements, as well as with the principles established in the current version of ***Cercarbono's Protocol***. These projects aim to displace fossil fuels used to satisfy electric power demand requirements of a system (either sourced from a NIS, or any other NIZ, isolated grid or system in a certain country). In all cases, it must be demonstrated that in the absence of the project, fossil fuel would be used to generate and supply such power requirements. This methodology covers activities regarding construction of new (greenfield) power generation facilities, capacity addition to existing power generation plants, or power generation plant equipment rehabilitation, replacement or retrofit for one or more existing power generation facilities using renewable energy sources.

Methodological elements to identify the baseline scenario, according to specific CCMP activities are included. They shall be considered for calculations of baseline GHG emissions. Project scenario GHG emissions shall be monitored and/or calculated according to their characteristics, allowing in turn calculation of total and net GHG emissions reduction during the crediting period.

This methodology provides required guidelines and means for estimation of such emissions reduction, as well as general guidelines associated to CCMP data / documentation management and monitoring.

1 Introduction

Climate change is one of the main challenges human society faces. Changes associated to this global issue can disrupt life in Earth, at least as we know it. Use of energy from or generated through fossil fuels is one of the main causes of this situation, as it is responsible for about half of the global GHG emissions generation in our planet, according to reported data from the Intergovernmental Panel on Climate Change (IPCC).

Transition towards less GHG intensive energy sources, renewable resources use, and optimization of energy generation, transmission, storage, and consumption processes are necessary steps to promote sustainable energy and energy matrices' decarbonization in various countries, where electric power generation related GHG emissions rank high in the inventories of such gases in different countries.

In considering this problem and the need to advance solutions, actions tending to the instrumentation of a reduced environmental impact power generation technologies-based energy transition have been implemented, especially as related to GHG emissions generation from related processes.

The use and transition toward renewable energy sources for electric power generation has gained impulse over the past decades and although some countries have a significant share of such energy sources within their energy matrix, there is still a long way ahead for renewable energy to become common practice in many countries. According to the International Energy Agency[1], in 2022 the electric power generation industry was responsible for emitting 14,8 $GtCO_2$. This can be explained by the fact renewable energy-based electric power generation contributed only 29,6 % of total power generation.

Due to their nature, renewable energy sources such as hydroelectric, solar, wind, geothermal and different types of marine energy sources are either considered carbon-neutral or can achieve net GHG emissions reduction, as compared with electric power generation facilities using fossil fuels as primary energy source.

Thus, renewable energy sources are fundamental in decarbonizing the world's energy matrices, positioning themselves as one of the main mitigation pathways to tackle climate change.

This methodology aims to supporting acceleration of decarbonization of electric systems in different countries, specifically those in which renewable energy-based power generation is not common practice or/and faces barriers to its implementation, through the development of environmental impact mitigation programs or projects able to generate emission reduction credits for trading within the international voluntary carbon market or in other environments, following the parameters set for Measuring, Reporting, and Verification Systems (MRV) in each country.

This methodology is not specific to a certain renewable source-based electric power generation technology, which allows for mature, as well as emerging technologies-based CCMPs

[1] International Energy Agency (IEA, 2023).

to be developed, providing they present a clear baseline and project scenario identification and adequate monitoring.

2 Principles

The principles establish the basis for justification and explanations requested in this document. CCMP's using this methodology shall comply and refer the relevant principles and how they are applied according to current version of ***Cercarbono's Protocol***, consistent with contents and guidance as per in ISO 14064-2:2019 Standard. Notwithstanding, it is highly recommended that such standard is consulted, as therein extended concepts, explanations and criteria elements complementing which is already stated in ***Cercarbono's Protocol*** can be found.

3 Objective and application field

This methodology is specific and applicable to Cercarbono's voluntary carbon certification programme. It may be used by any natural or legal person, both public or private, aiming to develop renewable energy-based electric power generation programs or projects, displacing fossil fuel-based electric power generation, either within a National or Regional Interconnected System (hereinafter NIS), or in other isolated or non-nationally / regionally interconnected electric systems, commonly referred as Non-Interconnected Zones (hereinafter NIZ), or whichever denomination they may have in a given country, in such a way as to comply with all legal requirements to which they are subject in the country the CCMP is implemented, intended to qualify for results-based payments or similar compensations as a result of actions achieving GHG emissions reduction.

3.1 Scope

This methodology provides basic recommendations considering principles described in ***Cercarbono's Protocol***, for the development and implementation of renewable energy based CCMPs for electric power generation (Energy Sector).

In this methodology, renewable energy-based technology types CCMPs use for electric power generation include, but are not limited to:

- Hydroelectric: hydroelectric centrals, plants or facilities with reservoir or running-water type or integrated in water networks, with or without pumping storage features.
- Wind: onshore / offshore wind centrals, plants, or facilities.
- Solar: photovoltaic or solar concentration electric power generation centrals, plants, or facilities.
- Geothermal: dry steam, flash steam or binary cycle geothermal power centrals, plants, or facilities.
- Other renewable energy-based electric power generation technologies (e.g., marine energy, thermal or saline gradient, etc.).

This methodology is applicable for any electric power generation unit using any renewable energy type as in the above listing, except for biomass[2], connected to an electric supply system, independent from installed capacity, provided initiative's additionality is demonstrated (see ***Section 5***).

CCMPs shall comply with the requirements of the Measuring, Reporting, and Verification System (MRV), or similar, systems in force in the jurisdiction governing its operation, in addition to all relevant requirements and provisions as per in ***Section 3.2***.

Applicable activities in this methodology's framework correspond to installation of new (greenfield) plants, as well as capacity additions, rehabilitation, equipment retrofit or replacement in existing renewable energy-based power generation plants. The CCMP may include the integration of a Battery Energy Storage System (BESS), in which case it shall be consistent with any of the modalities included this methodology.

Considerations to establish CCMP's operation start date are included in current version of ***Cercarbono's Protocol***, section: **CCMP start date**.

3.2 Technical and programme regulatory framework's compliance

The following documents[3], in their current versions, are complementary and essential for application of this methodology:

- Cercarbono's Protocol for Voluntary Carbon Certification.
- Procedures of Cercarbono's Certification Programme.
- Terms and Definitions of the Voluntary Certification Programme of Cercarbono.
- Cercarbono's Tool to Demonstrate Additionality of Climate Change Mitigation Initiatives.
- Cercarbono's Tool to Report Contributions from Climate Change Mitigation Initiatives to the Sustainable Development Goals.
- Guidelines for Mapping Presentation and Analysis.
- Safeguarding Principles and Procedures of Cercarbono's Certification Programme.

Following CDM tools[4]:

- *Tool 03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion.*
- *Tool 05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation.*
- *Tool 07: Tool to calculate the emission factor for an electricity system.*
- *Tool 10: Tool to determine the remaining lifetime of equipment.*

[2] Exclusion of this renewable energy source obeys to its unique characteristics, which imply a leakage assessment as well as other criteria transversal to land uses, not covered or applicable to equational development shared by the remaining technologies included.
[3] Available at www.cercarbono.com, section: Documentation.
[4] Or those substituting them at implementation of Paris Agreement's Art. 6.4 mechanism. Available at: www.cdm.unfccc.int.

In addition, it is based on some elements of CDM methodologies:

- *ACM0002 Large-scale Consolidated Methodology: Grid-connected electricity generation from renewable sources*. Version 20.0.
- *AM0103: Renewable energy power generation in isolated grids*. Version 4.0.

3.3 Compliance with applicable regulation and legal provisions

In the framework of this methodology, CCMP owner shall demonstrate the facilities where the CCMP is implemented comply with issuance and presentation of required licenses, permits and environmental management plans, as well as all applicable regulations according to the technology employed in the subject jurisdiction before the start of any validation / verification activity, and during the whole crediting period and its potential renewals.

The VVB performing CCMP's validation and/or verification under this methodology, shall also comply with accreditation requirements as dictated in the host country for the CCMP, shall possess demonstrable technical knowledge about the relevant technology the initiative is aiming to obtain a validation / verification for.

GHG emissions reduction achieved by the CCMP, as applicable, shall be entered in the national registry of a given country (provided they correspond to GHG emissions reduction commitments assumed by such country), including applicable provisions of the Nationally Determined Contribution (NDC) corresponding adjustments' mechanism, given the case, in line with international efforts on Measuring, Reporting, and Verification of climate change initiatives.

4 Eligibility and inclusion requirements

This methodology is aimed to be employed for baseline scenario identification, CCMP GHG emissions quantification and monitoring, as required for renewable energy-based electric power generation-focused CCMP development, featuring renewable energy use in new (greenfield) power generation facilities, as well as through retrofit, rehabilitation, replacement or capacity expansions[5] for existing facilities, which comply with start date as established in ***Cercarbono's Protocol***, displacing more GHG intensive source-based electricity, either delivered to a NIS or a NIZ[6].

Types of activities eligible for inclusion or implementation as a CCMP under this methodology, must consider the use of at least one eligible renewable energy source, from the ones referred in ***Section 3***, as well as comply with applicability conditions specific to such renewable energy source as defined in this methodology, including:

[5] Sometimes referred as “repowering”.
[6] In the case of NIZs including combined heat and power facilities, CDM's Methodological *Tool 05* provisions shall be followed for emission factor calculation shall be followed.

1. Construction of new facilities for electric power generation.
2. Improvements to systems or equipment in existing facilities either in the form of:
   - Retrofit,
   - Rehabilitation, or
   - Replacement.
3. Generation capacity increase in existing facilities.
4. In case the CCMP includes the integration of a Battery Energy Storage System (BESS)[7], used in wind or solar or other electric power facilities, following modalities apply:
   - BESS integrated in construction of new facilities.
   - BESS included in a CCMP for capacity increase in an existing facility.
   - BESS as a part of a CCMP for retrofitting an existing facility.
   - Equipping an existing facility with a BESS without any other change to such facility.

This methodology is not applicable for the development of CCMPs with the objective of thermal/mechanical/any other type of energy generation for use off-limits of the electric power generation process / as electric power generation-associated cogeneration.

In the case of captive facilities (for self-consumption), substituting others operating with a mix of fossil fuels, for baseline emissions calculation purposes, the emission factor corresponding to the least carbon-intensive fossil fuel used in such mix shall be used, using a reference historical period (previous to project implementation), not less than one year and not exceeding three years[8].

This methodology is not applicable for the development of CCMPs involving biomass combustion-based units or facilities.

In cases where units or facilities' retrofit, rehabilitation or replacement is considered, as well as for capacity increase, this methodology is applicable provided continuing with current operation and maintenance practices with existing (operating) power generation equipment is the most plausible baseline scenario.

CCMPs using renewable energy sources different from hydroelectric, shall comply with all above-described applicable requirements, conditions, and criteria, as well as with applicability conditions included in methodological tools referred in this document.

4.1 Applicability conditions for CCMPs including BESS

The owner/holder of the CCMP shall demonstrate the BESS has been conceived as a component of the project from the design stage, or that its integration into the existing project does not imply another activity modifying nameplate capacity or operability of involved facilities, by means of supporting documentary evidence.

BESS charge shall be performed by using CCMP generated electric power and only under excessive demand situations, external or locally generated fossil fuel-based electric power

[7] Rechargeable battery systems grouped in multi-cell clusters, which also feature cell operation and energy management systems, thermal control systems, power conditioning modules and grid connection systems with various operating modes responding to facility status and energy demand in the receiving grid.
[8] Refer to CDM's Methodological *Tool 05*.

its to be used for that purpose, in which case corresponding emissions shall be accounted for.

Electric power not generated by the CCMP through renewable energy sources, used for BESS charging, shall not surpass a threshold corresponding to 2 % of the total electric power generated by the CCMP for a certain monitoring period using renewable energy sources exclusively.

If such 2 % threshold is surpassed for any calendar month within the monitoring period, Carboncer shall not be issued for such month.

4.2 Applicability conditions for hydroelectric CCMPs

Hydroelectric CCMPs shall comply with following specific criteria:

- CCMP activity is implemented in one or more reservoirs or intake works, without changes in design volume or capacity of any of them.
- In CCMPs involving a volume change in one or more reservoirs, power density as calculated in ***Equation 15***, must be greater than 4 W/m^2.
- Power density of the reservoir or reservoirs included in CCMP limits, whatever their type, shall be greater than 4 W/m^2. [9, 10]

Following criteria are applicable to integrated hydroelectric CCMPs[11]:

- It shall be demonstrated water flow from upstream plants or units included in the CCMP is directed to downstream plants or units, and all involved plants or units jointly contribute to total power generation capacity of the integrated CCMP.
- An assessment of the water balance feeding the grouped CCMP plants or units shall be presented, considering all relevant seasonal water availability scenarios (mainstream, tributaries, and rain) for power generation, as well as all possible combinations of reservoirs and without them, to demonstrate that the specific combination used in the CCMP optimizes power generation as compared with other options. Such assessment shall comprise at least five years prior to CCMP implementation.

4.3 Ownership

The owner/holder of the CCMP must obtain express permission from the legal facility or land owner/holder where the CCMP is to be developed, as applicable.

[9] Harmonized with defined thresholds in other certification programmes or standards for this parameter, specifically the criteria as per in CDM's EB 23, Annex 5, page 1.

[10] In case of grouped projects, and for power plants whose individual installed capacity is less than 15 MW, this applicability condition could be waived, provided the subject facilities jointly amount to less than 10 % of the total installed capacity considering the sum of such installed capacity from all plants included in the grouped project.

[11] Projects which operate using the same hydric stream, body or channel, which intake works sequentially positioned along it (each one downstream from the previous one), whose discharges are sent back to such water stream.

For private, public, or mixed property facilities, express records authorizing project implementation must be provided, including those from the owner(s), holder(s) or right holder(s), as applicable.

Legally valid, unobjectionable evidence of property rights for the applicable jurisdiction over rights of use, exploitation or total property of the project's facilities must be provided, in addition to all applicable licenses / environmental permits.

Ownership rights over GHG emissions reduction must be demonstrated by involved party(ies), i.e., a document signed by all involved parties defining participation, claims or rights transfer regarding GHG emissions reduction shall be presented.

4.4 General objective of the CCMP

The CCMP objective shall be described in the PDD, highlighting the expected positive impact from its implementation and the expected mitigation potential.

It shall also include, as a minimum, the main activity(ies) description, geographical location for implementation of the project activity(ies), involved actors and the operation period for project activity(ies).

5 Additionality

Additionality in this methodology shall be demonstrated by applying the current version of ***Cercarbono's Tool to Demonstrate Additionality of Climate Change Mitigation Initiatives***.

6 CCMP boundaries

6.1 Spatial limits

CCMP spatial limits refer to the physical and geographical site for renewable energy-based electric power generation facilities. The spatial extent of the CCMP includes the central, plant or facility or the energy facility and all related and ancillary systems used for physical connection to a NIS or NIZ.

The site where the CCMP central or unit is installed must be specified in terms of the country, second level (state, department, province or similar), and third level (municipality or similar) political subdivisions, including geographical coordinates using the official reference system for the country where the CCMP is located, including location information as per in ***Guidelines for Mapping Presentation and Analysis***.

On top of the above referred requirements, the CCMP shall follow Cercarbono's guidelines on CCMP limits as per in the current version of ***Cercarbono's Protocol***.

6.2 Temporary limits

Project duration: is the period (in years) from the start (day.month.year) to the final (day.month.year) date of the CCMP's mitigation actions.

Accreditation or Crediting period: accreditation or crediting period is defined according to relevant provisions in current version of ***Cercarbono's Protocol***, section: **Crediting period**.

Installed technology useful life or lifetime, which must be demonstrated when the requested accreditation period is greater than the default remaining life as per in the current version of CDM's Methodological *Tool 10*, corresponds to the period during which the main power generation system / equipment can comply with its function under adequate operational cost-efficiency and safety.

7 Baseline scenario

7.1 GHG emission sources in baseline scenario

GHG emission sources to be considered in CCMP baseline scenario are described in ***Table 1***.

Table 1. GHG emission sources considered in baseline scenario.

Source	GHG	Included	Explanation
GHG emissions due to electric power generation displaced by the CCMP.	CO_2	Yes	Referred to emissions due to fossil fuel-based electric power generation either in a NIS or a ZIN, in power generation facilities displaced by the CCMP. Each fossil fuel used for electric power generation produces these three GHGs when subject to combustion. CH_4 and N_2O are excluded, as this makes emissions estimate conservative.
	CH_4	No	
	N_2O	No	

The project responsible shall ensure CCMP's-related GHGs and emission sources are identified.

Guidance provided in ***Cercarbono's Protocol***, related to emission sources, shall also be considered.

7.2 Baseline scenario GHG emissions calculation

Calculation of baseline GHG emissions is related to implementation features of the CCMP and its development modality. Thus, and even when different options for calculation are described below, according to such features, in general baseline scenario emissions are as per in ***Equation 1***.

$$BLE_t = NPGS_t \times EFES_t$$ ***Equation 1***

Variable	Units	Description
BLE_t	tCO_2e	Baseline GHG emissions during period ***t*** of baseline scenario.
$NPGS_t$	*MWh*	Net electric power generation due to CCMP implementation supplied to an electric system (either a NIS or a NIZ, as applicable) in period ***t***.

$EFES_t$	tCO_2e/MWh	Emission factor for the electric system the CCMP supplies energy (either a NIS or a NIZ, as applicable) in period ***t***.

7.2.1 Net electric power generation calculation

Calculation form for this parameter is dependent on the CCMP's implementation modality and will vary depending on whether it is referred to a new (greenfield) facility, a retrofit, a rehabilitation, or the replacement of power generation units. At the same time, renewable energy source's and power generation technology's own features shall be considered. In following sections, each relevant modality or modality / renewable energy source / technology combination identified is dealt with.

7.2.1.1 New (greenfield) electric power generation facilities using renewable energy

The baseline scenario is the electric power supplied by the CCMP to the NIS or NIZ, displacing that which would be generated by other plant connected to the relevant electric system and/or by new electric power generation facilities. Electric power generated in the baseline scenario is defined as per in ***Equation 2***.

$$NPGS_t = NPGP_t \quad \textit{Equation 2}$$

Variable	Units	Description
$NPGS_t$	*MWh*	Net electric power generation due to CCMP implementation supplied to an electric system (either a NIS or a NIZ, as applicable) in period ***t***.
$NPGP_t$	*MWh*	Net electric power generation from CCMP project plants or units, supplied to an electric system (either a NIS or a NIZ) in period ***t***.

7.2.1.2 Retrofit, rehabilitation or replacement of existing renewable energy-based electric power generation facilities

In this case, the baseline scenario shall be defined based on historical data for electric power generation, considering the continuation of the pre-CCMP implementation prevailing historical state.

Given electric power generation variability in time due to renewable energy sources' nature, due consideration shall be given to this fact when assessing such historical data.

Baseline scenarios can be:

- Continuation of the current situation, i.e., operation of the power generation plant under the same conditions observed before CCMP activity implementation. Additional electricity generated due to CCMP operation would be produced by existing and new power plants connected to the local electric grid.

– Any other technical, financially sound alternative which would increase power generation at a site different from that of the CCMP. Among others, different degrees of equipment replacement, retrofit or rehabilitation performed on the units for fossil fuel shift to other fuel could be considered.

Electric power generated in a renewable energy-based power plant may experience significant variations from year to year, given differences in energy source availability or behaviour (e.g., rainy season and droughts, average annual wind speed, or solar irradiation).

As a result, using not enough historical pre-CCMP implementation data or not considering such variables, could induce significant uncertainty. Electricity generation in the baseline scenario is calculated by using ***Equation 3***.

$$NPGS_t = NPGP_t - (NPGH_t + \sigma_h) \qquad \textbf{Equation 3}$$

Variable	Units	Description
$NPGS_t$	*MWh*	Net electric power generation due to CCMP implementation supplied to an electric system (either a NIS or a NIZ, as applicable) in period t.
$NPGP_t$	*MWh*	Net electric power generation from CCMP project plants or units, supplied to an electric system (either a NIS or a NIZ) in period t.
$NPGH_t$	*MWh*	Net historic annual electric power generation supplied to the electric system (either a NIS or a NIZ) by existing plants or units before CCMP implementation, adjusted to represent that corresponding to period t.
σ_h	*MWh*	Standard deviation for net historical annual electric power generation supplied to the electric system (either a NIS or a NIZ) by existing plants or units before CCMP implementation.

In case $(NPGH_t + \sigma_h) > NPGP_t$, then it shall be considered that:

$$NPGS_t = 0 \qquad \textbf{Equation 4}$$

In determining $NPGH_t$, the CCMP owner may choose a period comprising at least five-year data for historic electric power generation, up to the year immediately previous to CCMP's start date, among the following:

(a) From commercial operation start date[12].
(b) Five years before that in which CCMP started.

[12] Time period extends up to the year previous to CCMP start date.

(c) From the date of last retrofit, rehabilitation, or capacity addition, as applicable[13].

It shall be justified, when selected historical period is not that of the complete five-years immediately previous to CCMP implementation, the rationale for such selection, which shall be demonstrated is representative of expected operation under normal conditions[14].

In rehabilitation projects, when it can be demonstrated the facility had no operating period during the five calendar years before a rehabilitation, then:

$$NPGH_t = 0 \qquad \textbf{Equation 5}$$

For equipment or units' retrofit and replacement as referred in this section, it shall be demonstrated the remaining useful life of the subject facilities (in particular that of the main power generating equipment), is longer than that of the applicable accreditation period, according to guidelines as per in current version of CDM's Methodological *Tool 10*, or that substituting or complementing it. From that point in time, it is considered:

$$NPGS_t = 0 \qquad \textbf{Equation 6}$$

7.2.1.3 Capacity increase to existing renewable energy-based electric power generation facilities

The baseline scenario is the existing facility supplying the electric system (either a NIS or a NIZ), according to historical data until the end of its useful life, determined as per in guidance included in CDM's Methodological *Tool 10*, or that substituting or complementing it, and that electricity supplied by the new equipment or facilities would be supplied to the relevant electric system by other connected facilities. From the end of the existing facility's useful life, it is considered the baseline scenario is the same as the project scenario, thus it is considered no further emissions reduction occurs.

Once the operation of the project activity has started, if there is no demonstration of remaining useful life for the baseline facilities, only default values as per in CDM's Methodological *Tool 10* are to be applied.

7.2.1.3.1 Wind, solar or marine power generation facilities

Given capacity increases at these types of facilities do not significantly affect renewable energy source availability in existing facilities, different from the project facilities, then $NPGS_t$ can be determined as per in ***Equation 7***.

$$NPGS_t = NPGA_t \qquad \textbf{Equation 7}$$

[13] See previous footnote.
[14] E.g., in situations where extraordinary circumstances prevented the facility operation or a significant part of it, or its normal operation, during significant periods within the historical 5-year period.

Variable	Units	Description
$NPGS_t$	*MWh*	Net electric power generation due to CCMP implementation supplied to an electric system (either a NIS or a NIZ, as applicable) in period t.
$NPGA_t$	*MWh*	Net electric power generation supplied to the relevant electric system (either a NIS or a NIZ), by the plants or units constituting the capacity increase in the CCMP in period t.

Under this approach, $NPGA_t$ shall be determined through direct measurement of electric power generated and supplied by the plants or units constituting the capacity increase.

This approach may also be used for other renewable energy types not herein specified which comply (and demonstrate that) with the premise of no or non-significant affectation to renewable energy source availability for existing facilities, different from those of the subject CCMP.

7.2.1.3.2 Hydroelectric or geothermal power generation facilities

For these types of renewable sources, capacity increase at the same site of original facilities may cause interactions affecting power generation potential of existing units or plants. Due to this fact, in such cases and CCMP implementation modality, calculation approach as per in ***Section 7.2.1.2*** shall be used.

In this case, $NPGP_t$ is the net electric power generation supplied to the electric system (either a NIS or a NIZ), by the plants or units in period t, including those constituting the capacity increase as per in the CCMP. Given this, it is not required a segregated measurement for the electric power generation for the plants or units constituting such capacity increase.

This approach could also be used for other renewable energies not herein mentioned, for which the premise of no or non-significant affectation to renewable energy source availability for existing facilities cannot be demonstrated.

7.2.2 Relevant electric system emission factor calculation

Two cases shall be differentiated, as described before:

- In case electric power is supplied to a NIS, $EFES_t$ may be calculated according to guidelines as per in current version of CDM's Methodological *Tool 07* or that complementing or substituting it, or NIS' administrator- or regulator-calculated values, or values calculated by any other organization having such function may be used, according with the guidelines included in above referred Methodological tool.
- In case the CCMP supplies power to a NIZ type electrical system, then $EFES_t$ shall be calculated according to ***Equation 8***.

$$EFES_t = \frac{\sum_{k=1}^{K} \sum_{c=1}^{C} FFZN_{c,k,t} \times FFHV_{c,t} \times FFEF_{c,t}}{\sum_{k=1}^{K} ZNPG_{k,t}} \qquad \textbf{Equation 8}$$

Variable	Units	Description
$EFES_t$	*tCO₂e/MWh*	Emission factor for the electric system the CCMP supplies energy to (in this case a NIZ) in period ***t*** (calculated from fuel usage and power generation in NIZ ***k*** captive plants in period ***t***).
$FFZN_{c,k,t}$	*Volume or mass units*	Volume or mass of type ***c*** fossil fuel used by captive power plant ***k*** for electric power generation in period ***t***[15].
$FFHV_{c,t}$	*MJ/ volume or mass unit*	Average low heating value for type ***c*** fossil fuel used in period ***t***.
$FFEF_{c,t}$	*tCO₂e/MJ*	Average emission factor for type ***c*** fossil fuel used in period ***t***.
$ZNPG_{k,t}$	*MWh*	Power generation by captive power plant ***k*** in period ***t***.
k	*NA*	Captive plant index.
K	*Captive plants count*	Total captive plants.
c	*NA*	Fossil fuel type index.
C	*Fuel type count*	Total fossil fuel types used by a captive plant.

8 Project scenario

8.1 GHG emission sources in project scenario

GHG emissions to be considered in project scenario are described in ***Table 2*** below.

Table 2. GHG emission sources considered in project scenario.

Source	GHG	Included	Explanation
Fossil fuel combustion for electric power generation.	CO_2	Yes	Fossil fuel combustion for electric power generation. Methane or nitrous oxide emissions, even when small, shall be considered for conservativeness.
	CH_4	Yes	
	N_2O	Yes	
Methane emissions in hydroelectric CCMPs.	CH_4	Yes	Related to anaerobic decomposition of organic matter in water reservoirs.
Emissions of non-condensable gases in geothermal plants.	CO_2	Yes	Emissions due to steam CO_2 and CH_4 content in dry- or flash geothermal steam or to fugitive emissions in binary cycles.
	CH_4	Yes	
Emissions of non-condensable gases from heat exchanger	HC or refrigerant	Yes	Leaks from these binary cycle components, which use hydrocarbons or HFCs with different global warming potentials as working fluids.

[15] For NIZs including combined heat and power (CHP) facilities, provisions as per-in CDM's *Tool 05* shall be followed for emission factor consideration, through correct allocation of fossil fuel employed exclusively for electric power generation. Consideration therein indicating all energy used by such CHP facilities is to be allocated to electric power generation is not allowed, given in this case that does not correspond to a conservative option.

Source	GHG	Included	Explanation
working fluid in binary geothermal plants.			
Emissions of non-condensable gases in other electric power generation systems.	CO_2	Yes	Sub-product of thermal- or saline gradient electric power generation processes through vapor pressure difference, among others.
Fossil fuel-based imported electric power from a NIS or a NIZ or from a dedicated power generating unit.	CO_2	Yes	Charging of battery energy storage systems (BESS). Methane or nitrous oxide emissions not considered as they are deemed as negligible.
	CH_4	No	
	N_2O	No	

8.2 GHG emissions calculation in project scenario

GHG emissions due to actions such as power generation central construction, soil preparation, upstream emissions due to fossil fuel used for transporting, extraction, processing or manufacturing of components, equipment and facilities related to the technology used by the CCMP are considered as not significant.

For most of the electric power generation activities, CCMP GHG emissions (PE_t) will not be significant for calculations. Notwithstanding, there may be some implementation modalities or renewable energy sources or electric power generation technologies that might generate a reasonable amount of GHG emissions in the project scenario, which shall be quantified according to ***Equation 9***.

$$PE_t = FFPE_t + GTPE_t + HEPE_t + BCPE_t + NCGE_t \qquad \textit{Equation 9}$$

Variable	Units	Description
PE_t	tCO_2e	CCMP GHG emissions in period ***t***.
$FFPE_t$	tCO_2e	CCMP GHG emissions due to fossil fuel combustion in period ***t***.
$GTPE_t$	tCO_2e	CCMP GHG emissions due to operation of geothermal plants of any type in period ***t***.
$HEPE_t$	tCO_2e	CCMP GHG emissions generated in hydroelectric plant reservoirs in period ***t***.
$BCPE_t$	tCO_2e	CCMP GHG emissions from BESS charging using fossil fuel-based electric power imported from a NIS or a NIZ or a dedicated power generation unit in period ***t***.
$NCGE_t$	tCO_2e	CCMP GHG emissions due to non-condensable gases in other electric power generation systems, as a byproduct of renewable energy-based electric power generation technologies, not specifically described in this methodology, in period ***t***.

Data disaggregation level can be determined by CCMP responsible, but in general at least annual data within period ***t*** shall be included when monitoring frequency is not indicated in the monitored parameters table in ***Section 14.2***.

There should be correspondence between period ***t*** used for CCMP's GHG emissions calculation and period ***t*** used for estimating baseline scenario.

Technological changes or updates to equipment, different from main power generation technology that may generate emissions attributable to CCMP operation shall be reported and such GHG emissions shall be quantified as part of the CCMP's project emissions.

The responsible for the CCMP shall identify and quantify any other GHG emission sources that may be attributable to CCMP operation, as long as their inclusion is justified, as well as associated results obtained.

Selection of calculation methods for such GHG emissions, as applicable, corresponds to CCMP owner. Such methods shall be recognized and based on IPCC's guidelines or on valid emissions calculation methodologies, according to the principles established in the current version of ***Cercarbono's Protocol***.

8.2.1 Emissions due to fossil fuel use

Facilities using fossil fuel for electric power generation during CCMP implementation shall quantify corresponding carbon dioxide emissions as $FFPE_t$ (CCMP project emissions due to use of fossil fuels, such as those resulting from their consumption in transportation equipment, heavy machinery or backup electric power generators intended to maintain generation levels in situations of reduced renewable energy source availability), according with guidance provided in current version of CDM's Methodological *Tool 03*, or that complementing or substituting it.

Emissions due to fossil fuel consumption in electric power generators used exclusively in start-ups or failure of the main electric power backup source (auxiliary electric network), are considered as negligible, thus they can be omitted from this calculation.

8.2.2 Emissions due to geothermal power plant operation

During geothermal power plant operation, non-condensable gases separated from geothermal steam are released, among them mainly CO_2 and to a lesser extent, CH_4. In modern dry- or flash steam geothermal power plant operation, a significant portion of non-condensable gases separated from steam is reinjected into the geothermal reservoir. For binary cycles, geothermal fluid[16] is reinjected without exposure to the atmosphere, and fugitive emissions may be present due to equipment components leaks, which shall be also quantified. These two emissions generation mechanisms are considered for its calculation, according to ***Equation 10*** and related.

$$GTPE_t = GTPE_{DFS,t} + GTPE_{BC,t} \qquad \textit{Equation 10}$$

[16] Fluids extracted from geothermal wells, not suitable to be used at dry steam plants, or residual fluids from such plants, which generally are present as two-phase fluids, although they can be used as steam or liquid, depending on process conditions.

Variable	Units	Description
$GTPE_t$	tCO_2e	CCMP GHG emissions due to geothermal power plant operation of any type in period ***t***.
$GTPE_{DFS,t}$	tCO_2e	CCMP GHG emissions due to dry/flash steam geothermal power plant operation in period ***t***.
$GTPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to fugitive emissions in the operation of binary cycle geothermal power plant in period ***t***.

8.2.2.1 Dry or flash steam geothermal power plants

For this type of electric power generation facilities, specific considerations as per in ***Equation 11*** apply.

$$GTPE_{DFS,t} = (GSMF_{CO2,t} + GSMF_{CH4,t} \times GWP_{CH4}) \times GSP_t \qquad \textbf{Equation 11}$$

Variable	Units	Description
$GTPE_{DFS,t}$	tCO_2e	CCMP GHG emissions due to dry/flash steam geothermal power plant operation in period ***t***.
$GSMF_{CO2,t}$	tCO_2e/t steam	CO_2 mass fraction in geothermal steam produced in period ***t***.
$GSMF_{CH4,t}$	tCH_4/t steam	CH_4 mass fraction in geothermal steam produced in period ***t***.
GWP_{CH4}	tCO_2e/tCH_4	CH_4 global warming potential applicable for emissions estimation period.
GSP_t	t steam	Geothermal steam production sent to power generation facility in period ***t***.

8.2.2.2 Binary cycle geothermal plants

For this type of power generation facilities, fugitive emissions may be present both in process side (steam or low enthalpy geothermal liquid circuit), and in Organic Rankine Cycle (ORC) side, where there may be working fluid leaks, in most cases a hydrocarbon or hydrofluorocarbon (HFC) with refrigerant characteristics. Both cases are covered in ***Equation 12***.

$$GTPE_{BC,t} = GSPE_{BC,t} + WFPE_{BC,t} \qquad \textbf{Equation 12}$$

Variable	Units	Description
$GTPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to fugitive emissions in the operation of binary cycle geothermal power plant in period ***t***.
$GSPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to non-condensable gas leaks from geothermal fluid in binary cycle geothermal power plant operation in period ***t***.
$WFPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to non-condensable gas leaks of working fluid in Organic Rankine Cycle (ORC) circuit in binary power plant in period ***t***.

In calculating $\boldsymbol{GSPE_{BC,t}}$, the method presented in ***Equation 13*** may be employed.

$$GSPE_{BC,t} = (IGF_{BC,t} - EGF_{BC,t}) \times (GFMF_{CO2,t} + GFMF_{CH4,t} \times GWP_{CH4}) \qquad \textbf{Equation 13}$$

Variable	Units	Description
$GSPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to non-condensable gas leaks from geothermal steam in binary cycle geothermal power plant operation in period ***t***.
$IGF_{BC,t}$	*t fluid*	Geothermal plant inlet geothermal fluid flow in period ***t***.
$EGF_{BC,t}$	*t fluid*	Geothermal plant exit geothermal fluid flow in period ***t***.
$GFMF_{CO2,t}$	tCO_2e/t *fluid*	CO_2 mass fraction in geothermal fluid produced in period ***t***.
$GFMF_{CH4,t}$	tCH_4/t *fluid*	CH_4 mass fraction in geothermal fluid produced in period ***t***.
GWP_{CH4}	tCO_2e/tCH_4	CH_4 global warming potential applicable for emissions estimation period.

In case the difference between geothermal fluid inlet and exit flow to/from the plant is less than 1 %, then $\boldsymbol{GSPE_{BC,t}}$ does not need to be quantified.

$\boldsymbol{WFPE_{BC,t}}$ can be calculated according to ***Equation 14***.

$$WFPE_{BC,t} = WFLR_t \times GWP_{WF} \qquad \textbf{Equation 14}$$

Variable	Units	Description
$WFPE_{BC,t}$	tCO_2e	CCMP GHG emissions due to non-condensable gas leaks of working fluid in Organic Rankine Cycle (ORC) circuit in binary power plant in period ***t***.
$WFLR_t$	*t working fluid*	Leaked/replaced working fluid in period ***t***.
GWP_{WF}	tCO_2e/t *working fluid*	Working fluid global warming potential applicable for emissions estimation period.

8.2.3 Emissions from hydroelectric power plant reservoirs

Given the emissions estimation method for this source is dependent on implementation features, and in reservoir(s)-associated power density within CCMP boundaries, and in addition to minimum threshold for this parameter, as per in ***Section 4.1***, power density calculation methods for possible cases, according to applicability conditions included in this methodological documents, are presented.

8.2.3.1 Power density calculation

The CCMP power density shall be calculated by using ***Equation 15***.

$$CPD = \frac{CIC - BLIC}{CSA - BLSA} \qquad \textbf{Equation 15}$$

Variable	Units	Description
CPD	W/m^2	CCMP power density.
CIC	W	Hydroelectric power generation installed capacity after CCMP implementation.
$BLIC$	W	Hydroelectric power generation installed capacity before CCMP implementation.
CSA	m^2	Total surface area of CCMP reservoirs after CCMP implementation, measured when filled at gross storage capacity.
$BLSA$	m^2	Total surface area of CCMP reservoirs before CCMP implementation, filled at gross storage capacity.

For new (greenfield) power generation facilities, where no reservoirs existed before CCMP implementation, both $BLIC$, and $BLSA$, shall be considered as zero.

8.2.3.2 Calculation of emissions from reservoirs

8.2.3.2.1 Reservoirs with power density > 4 W/m^2 and ≤ 10 W/m^2

For this range of power densities, CCMP's GHG emissions shall be calculated according to *Equation 16*.

$$HEPE_t = \frac{HREF \times TEPG_t}{1000} \quad \textit{Equation 16}$$

Variable	Units	Description
$HEPE_t$	tCO_2e	CCMP GHG emissions generated in hydroelectric plant reservoirs during period t.
$HREF$	$kgCO_2e/MWh$	Default emission factor for hydroelectric power plant reservoirs.
$TEPG_t$	MWh	Total electric power generation by the CCMP, including electricity supplied to the relevant electric system (either a NIS or a ZIN), as well as electric power for self-consumption during period t.
1000	kg/t	Conversion factor.

8.2.3.2.2 Reservoirs with power density > 10 W/m^2

For this power density range, it shall be considered that:

$$HEPE_t = 0 \quad \textit{Equation 17}$$

8.2.4 Emission from BESS charging using fossil fuel-based electric power from a NIS, a NIZ, or a dedicated power generation unit

When the BESS is charged by using electric power from a NIS, then $BCPE_t$ can be calculated according with guidance as per in current version of CDM's Methodological *Tool 05*, or that complementing or substituting it.

When the BESS is charged by using electric power from fossil fuel-based power generation units, then $BCPE_t$ can be calculated according with guidance as per in current version of CDM's Methodological *Tool 03*, or that complementing or substituting it.

8.2.5 GHG emissions due to non-condensable gases in other electric power generation systems, as a byproduct of renewable energy-based electric power generation technologies, not specifically described in this methodology

In these cases, $NCGE_t$ calculation methodology shall be justified and have the endorsement or make reference to publications of internationally recognized organizations or institutions in the development or implementation of the specific technology.

8.3 Leakage

No leakage due to CCMP implementation is considered for activities covered under this methodology.

9 GHG emissions reduction

GHG emissions reduction from the CCMP is obtained by subtracting project scenario GHG emissions from baseline scenario GHG emissions, according to following equation:

$$ER_t = BLE_t - PE_t \qquad \textit{Equation 18}$$

Variable	Units	Description
ER_t	tCO_2e	Emissions reduction during period ***t***.
BLE_t	tCO_2e	Baseline scenario GHG emissions during period ***t***.
PE_t	tCO_2e	CCMP project scenario GHG emissions during period ***t***.

10 Grouped projects

Grouped projects are composed by instances such as electric power generation centrals, plants, or facilities which for a given MRV process are unified to achieve an environmental impact mitigation through a single CCMP.

It shall be demonstrated that each of these instances comply with all established criteria in the host country regulations, as well as those in ***Cercarbono's Protocol*** and in this methodology, to be eligible for such joint consideration and, given the case, to generate marketable emissions reduction credits.

For several emissions reduction instances to become unified in a single CCMP, the subject renewable energy source shall be the same for all of them and additionality shall be individually assessed for each instance.

The PDD shall include a clear and separate description of the CCMP responsible(s), either natural or legal person(s), the CCMP's spatial and temporary extents, as well as that of the grouped project as a whole, and associated GHG emissions ownership. In addition, achieved and projected GHG emissions reduction achieved through the accreditation period shall be disaggregated by individual instance, and the cumulative sum of them shall also be reported.

It shall be taken into account, as indicated in ***Cercarbono's Protocol***, that the addition of new instances to grouped projects, after the CCMP's start date, does not modify the CCMP's ending date, nor the dates and grantable crediting periods in terms of their termination dates and useful life of the originally implemented facilities (i.e., all included activities will end either on their useful life end date, on the CCMP's ending date, or on the end date for the last grantable crediting period, whichever is first.

Monitoring requirements associated to these initiatives shall be followed by each one of the grouped instances.

On top of the above described guidelines, the requirements regarding grouped projects as per in current version of ***Cercarbono's Protocol*** shall be considered in any case.

11 Uncertainty

In addition to provisions in section: **Uncertainty** of ***Procedures of Cercarbono's Certification Programme***, related to uncertainty quantification and treatment as related to measurement results and other monitored parameters, an uncertainty assessment shall be performed by the CCMP during planning and implementation phases, in accordance with Annexes A.3.5, A.3.6, and A.3.8 of ISO 14064-2:2019 Standard or sections and/or annexes substituting them in future versions of such standard.

The owner/holder of the CCMP shall pursue minimizing the uncertainty of the initiative-related information and data.

12 Contributions to UN's Sustainable Development Goals

In the framework of Cercarbono´s voluntary carbon certification programme, CCMPs shall report their contributions to SDGs by means of ***Cercarbono's Tool to Report Contributions from Climate Change Mitigation Initiatives to the Sustainable Development Goals***. Assessment of application of such tool will be part of the verification process. The rubric of the SDG tool shall be duly signed by the VVB in charge of the verification event.

CCMPs adequately implementing Cercarbono's SDGs tool shall be awarded a differentiation seal, shown on the retirement certificate and in EcoRegistry platform.

13 Safeguards

The CCMP must check that it does not produce net harm in accordance with the ***Safeguarding Principles and Procedures of Cercarbono's Certification Programme***.

14 CCMP monitoring

All information and data related to the CCMP shall be subject for validation and verification, under the guidelines of ISO 14064-3:2019 and ***Cercarbono's Protocol***. Additionally, all collected information as per by the monitoring plan shall be electronically filed and stored to allow for future consultation for at least four years past the end date of the accreditation period.

14.1 Description of the monitoring plan

The CCMP owner/holder shall possess al required information to demonstrate the results and statements related to the project comply with all principles and are in line with the methodological requirements of this document, those in ***Cercarbono's Protocol*** and ***Procedures*** and in Annexes A.3.5, A.3.6, and A.3.8 of ISO 14064-2:2019 Standard, or sections and/or annexes substituting them in future versions of such standard, referred to emissions reduction quantification, data quality management and CCMP's documentation.

Required measurements for variable monitoring requiring it, either direct variable specific measurements, or indirect measurements to allow for monitored variable calculation, shall be performed using calibrated equipment and instrumentation according to relevant industry standards and practices, according to methodological documents relevant to CCMP implementation, or following vendor/manufacturer recommendations, as applicable.

Calibration frequency shall be dictated by manufacturer recommendations or applicable regulation standards. The minimum calibration frequency in the absence of such references shall be yearly.

For measurements derived from lab analysis or reported by suppliers, it shall be assumed involved meters comply with this, provided such companies or organizations have a valid certified product quality system in place.

The CCMP responsible shall develop and implement a monitoring plan, in compliance with conditions as per in ***Cercarbono's Protocol***, section: **CCMP monitoring** and item 6.10 of ISO 14064-2:2019 Standard on the same subject.

14.2 Monitored data or parameters

Data and parameters requiring monitoring are presented in ***Table 3***.

Table 3. Variables and parameters requiring monitoring.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
$BLIC$	Hydroelectric power generation installed capacity before CCMP implementation.	W	CCMP site data.	N/A	Installed capacity according to vendor information, acceptance, and commissioning test records, or according to acceptable standards.
$BLSA$	Total surface area of CCMP reservoirs before CCMP implementation, filled at gross storage capacity.	m^2	CCMP site data.	N/A	Measurements performed by means of topographic surveys, maps, satellite data or other means.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
CIC	Hydroelectric power generation installed capacity after CCMP implementation.	*W*	Site data.	Installed capacity shall be determined according to vendor information, acceptance, and commissioning test records, or according to acceptable standards.	At the start of each accreditation period.
CSA	Total surface area of CCMP reservoirs after CCMP implementation, measured when filled at gross storage capacity.	m^2	Site data.	Measurements performed by means of topographic surveys, maps, satellite data or other means.	At the start of each accreditation period.
$EFES_t$	Emission factor for the electric system the CCMP supplies energy (either a NIS or a NIZ, as applicable) to in period ***t***.	tCO_2e/MWh	For NIS type electric systems, calculations based on electric sector operation records and new capacity planning, or data published by the regulating organism, provided it is calculated according to provisions as per in current version of CDM's Methodological *Tool 07*. For NIZ type electric systems, calculated according to ***Equation 8***.	Not applicable, these are measurement record database-based calculations.	For each monitoring period.
$EGF_{BC,t}$	Geothermal plant exit geothermal fluid flow in period ***t***.	*t fluid*	Direct measurement at plant.	Flow meters specifically designed for geothermal fluid (one or two phases) are used. Measurements from different spots may be integrated	Continuous with daily recording.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
				according to collecting and conduction system configuration, ensuring reported measurement represents total steam flow to CCMP facilities and applicable international standards are followed.	
$\boldsymbol{FFEF_{c,t}}$	Average emission factor for type ***c*** fossil fuel used in period ***t***.	*tCO_2e/MJ*	IPCC.	N/A	Average emission factor for fuel described for power generation purposes.
$\boldsymbol{FFHV_{c,t}}$	Average low heating value for type ***c*** fossil fuel used in period ***t***.	*MJ/Volume or mass units*	Lab analysis result from a certified lab or supplier data, or from universally accepted reference allowing for validation that subject fuel has identical characteristics as that described.	N/A	Certified lab analysis result or supplier provided certificate, or that reported in a universally accepted reference source in absence of such certificate.
$\boldsymbol{FFZN_{c,k,t}}$	Volume or mass of type ***c*** fossil fuel used by captive power plant ***k*** in period ***t***. For gaseous fuels, reported values shall be normalized[17]. (See note in ***Section 7.2.2***).	*Volume or mass units*	Measurements or integration from reading recordings.	Specific meters used for liquid or gas flow measurements, or in the case of liquid fuels, graduated scales on storage tanks may be used. In case the fuel is supplied from a single source for a single use (electric power generation), invoicing and	Continuous. In case of graduated scales, intervals between consecutive reading recordings shall not be greater than 24 hours.

[17] By "normalized", it is understood in this methodology, all magnitudes referred to volumes used shall be expressed considering the same reference pressure and temperature conditions (e.g., standard conditions, API conditions or another applicable reference system), clearly explaining this, including pressure and temperature values related to the reference system used, in all related documents.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
				measurement records provided by the fuel supplier can be used instead.	
$GFMF_{CH4,t}$	CH_4 mass fraction in geothermal fluid produced during period ***t***. Applicable to dry / flash / binary cycle geothermal projects.	tCH_4/t fluid	Certified lab analysis results.	Sampling shall be performed at producing wells and/or before power plant separator inlet, using ASTM E1675[18] standard for two-phase geothermal fluid sampling. Sampling is made by collecting non-condensable gases samples from the main geothermal fluid line using vessels containing a dissolvent and anti-oxidant solution. CO_2 is dissolved while the remaining compounds are maintained in vapor phase, which is then analysed by chromatography to determine residual gas content, including CH_4. Alkanes must be reported in methane terms following this technique.	At least quarterly.
$GFMF_{CO2,t}$	CO_2 mass fraction in geothermal fluid produced during period ***t***. Applicable to dry /	tCO_2/t fluid	Certified lab analysis results.	Sampling shall be performed at producing wells and/or before power plant separator inlet,	At least quarterly.

[18]ASTM International, Standard Practice for Sampling Two-Phase Geothermal Fluid for Purposes of Chemical Analysis, available at: www.astm.org.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
	flash / binary cycle geothermal projects.			using ASTM E1675[19] standard for two-phase geothermal fluid sampling. Sampling is made by collecting non-condensable gases samples from the main geothermal fluid line using vessels containing a dissolvent and anti-oxidant solution. CO_2 is dissolved while the remaining compounds are maintained in vapor phase, which is then analysed by chromatography to determine residual gas content, including CH_4. Alkanes must be reported in methane terms following this technique, determining CO_2 content by mass balance.	
$GSMF_{CH4,t}$	CH_4 mass fraction in geothermal steam produced during period ***t***. Applicable to dry / flash / binary cycle geothermal projects.	*tCH_4/t steam*	Certified lab analysis results.	Sampling shall be performed at producing wells and/or before power plant separator inlet, using ASTM E1675[20] standard for geothermal fluid sampling in vapor phase. Sampling is made	At least quarterly.

[19]ASTM Interntational, Standard Practice for Sampling Two-Phase Geothermal Fluid for Purposes of Chemical Analysis, available at: www.astm.org.
[20]ASTM International, Standard Practice for Sampling Two-Phase Geothermal Fluid for Purposes of Chemical Analysis, available at: www.astm.org.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
				by collecting non-condensable gases samples from the main steam line using vessels containing a dissolvent and antioxidant solution. CO_2 is dissolved while the remaining compounds are maintained in vapor phase, which is then analysed by chromatography to determine residual gas content, including CH_4. Alkanes must be reported in methane terms following this technique.	
$GSMF_{CO2,t}$	CO_2 mass fraction in geothermal steam produced in period ***t***. Applicable to dry / flash / binary cycle geothermal projects.	tCO_2e/t *steam*	Certified lab analysis results.	Sampling shall be performed at producing wells and/or before power plant separator inlet, using ASTM E1675[21] standard for geothermal fluid sampling in vapor phase. Sampling is made by collecting non-condensable gases samples from the main steam line using vessels containing a dissolvent and antioxidant solution. CO_2 is dissolved while the remaining compounds are	At least quarterly.

[21]ASTM Interntational, Standard Practice for Sampling Two-Phase Geothermal Fluid for Purposes of Chemical Analysis, available at: www.astm.org.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
				maintained in vapor phase, which is then analysed by chromatography to determine residual gas content, including CH_4. Alkanes must be reported in methane terms following this technique, finally determining CO_2 content by material balance.	
GSP_t	Geothermal steam production sent to power generation facility in period ***t***.	*t steam*	Direct field or plant measurement.	Flow meters specifically designed for geothermal fluid (one or two phases) are used. Measurements from different spots may be integrated according to collecting and conduction system configuration, ensuring reported measurement represents total steam flow to CCMP facilities and applicable international standards are followed.	Continuous with daily recording.
GWP_{CH4}	CH_4 global warming potential for applicable emissions estimation period.	tCO_2e/tCH_4	IPCC or value defined for mandatory use by regulatory authority.	N/A	According to Cercarbono's related communications and documentation, applicable to the corresponding monitoring period timespan in line with IPCC guidelines or as dictated by applicable specific regulation.
GWP_{WF}	Working fluid global warming potential for applicable	*tCO_2e/t working fluid*	IPCC or value defined for mandatory use by regulatory authority.	N/A	According to Cercarbono's related communications and documentation,

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
	emissions estimation period.				applicable to the corresponding monitoring period timespan in line with IPCC guidelines or as dictated by applicable specific regulation.
HREF	Default emission factor for hydroelectric power plant reservoirs.	*kgCO₂e/MWh*	CDM EB 23 Resolution or that substituting it.		90 $kgCO_2e$/ MWh or new substitute value.
$IGF_{BC,t}$	Geothermal plant inlet geothermal fluid flow in period ***t***.	*t fluid*	Direct measurement at field or plant.	Flow meters specifically designed for geothermal fluid (one or two phases) are used. Measurements from different spots may be integrated according to collecting and conduction system configuration, ensuring reported measurement represents total steam flow to CCMP facilities and applicable international standards are followed.	Continuous with daily recording.
$NPGA_t$	Net electric power generation supplied to the relevant electric system (either a NIS or a NIZ), by the plants or units constituting the capacity increase in period ***t***. Applies to capacity increase in wind, solar or marine facilities.	*MWh*	Records from meters employed for calculation or direct measurement of this parameter for supply to the relevant electric grid, discounting penalized power generation, as applicable.	Specific meters for energy flows exclusively from units or modules or plants constituting additional capacity are employed.	Continuous with hourly recording.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
$NPGH_t$	Net historic annual electric power generation supplied to the electric system (either a NIS or a NIZ) by existing plants or units before CCMP implementation, adjusted to represent that corresponding to period ***t***.	*MWh*	Calculation according to power generation records as per by selected modality among those described in ***Section 7.2.1.2***.	N/A	Calculation result, or ***$NPGH_t$ = 0*** if the subject facility did not operate during the five calendar years prior to a rehabilitation start.
$NPGP_t$	Net electric power generation from CCMP project plants or units, supplied to an electric system (either a NIS or a NIZ) in period ***t***.	*MWh*	Records from meters employed for calculation or direct measurement of this parameter for supply to from CCMP plants, the relevant electric grid, discounting penalized power generation, as applicable.	Specific meters for energy flow quantification are used. The value in case of direct measurement of total power generation, shall be affected according to implementation modality, to represent net power generation the CCMP delivers to the relevant electric system (either a NIS or a NIZ).	Continuous with hourly recording.
$TEPG_t$	Total electric power generation by the CCMP, including electricity supplied to the relevant electric system (either a NIS or a ZIN), as well as electric power for self-consumption in period ***t***.	*MWh*	Records from meters used for determination or direct measurement of gross electric power generation.	Specific meters for energy flow quantification at electric generator terminals are used.	Continuous with hourly recording.
$WFLR_t$	Leaked/replaced working fluid in period ***t***.	*t working fluid*	Direct measurement at plant.	In general, vessels allowing measured working fluid volumes	At each working fluid reinjection / replacement event.

Variable/parameter/data		Units	Data source	Measurement procedure	Applied value or periodicity
				are in place, allowing for sound records regarding working fluid amount and the CCMP plant/unit it was injected to. Such records are considered as valid evidence. Leak measurement is not considered as a practical option, as they may occur unexpectedly at any point in the system.	
$ZNPG_{k,t}$	Power generation by captive power plant ***k*** in period ***t***.	*MWh*	Records from meters used for determination or direct measurement of this parameter for grid supply purposes, discounting penalized power[22], as applicable.	Specific meters for energy flows for each unit or plant supplying electricity to a NIZ during monitoring period.	Continuous.
σ_h	Standard deviation for net historical annual electric power generation supplied to the electric system (either a NIS or a NIZ) by existing plants or units before CCMP implementation.	*MWh*	Calculation from electric power generation records as per selected modality from those described in ***Section 7.2.1.2***.	N/A	Calculation result.

14.3 Monitoring contributions to the Sustainable Development Goals

The monitoring of contributions to the Sustainable Development Goals is carried out according to the ***Cercarbono's Tool to Report Contributions from Climate Change Mitigation Initiatives to the Sustainable Development Goals***.

[22] Generated power sent to the grid, which is considered as "not delivered" for payment effects for the subject energy blocks sent to the system.

15 Effective participation

The CCMP shall guarantee and demonstrate stakeholders' participation (especially those for which its implementation might pose an environmental, social, or economic impact for their development or way of life). Such evidence may be documented in the granting of environmental and other kind of permits' issuance, complying with applicable regulations in the country the CCMP is implemented, or by documenting such interactions and consultations.

The CCMP must have in place a participation protocol including:

- Mapping of actors, i.e., an institutional map for all governance structures or institutions and leaders associated to CCMP-related decision-making in the territory.
- Consensus decisions with local governance structures.
- Consensus processes traceability.
- Request, grievances, complaints and inquiries' management and traceability thereof.
- A framework time schedule for CCMP-related decision making.
- A conflict management protocol.

On top of the above referred items, the CCMP shall comply with effective participation guidance and with the no net harm principle as described in the current version of ***Cercarbono's Protocol***.

Results of consultations with owners and participants in the CCMP shall be described in the Project Description Document (PDD).

16 Stakeholders' consultation

The stakeholders' consultation as per in this methodology shall be performed according to guidelines as per in section: **Public consultation of CCMPs** of ***Cercarbono's Protocol***, and as per in applicable reference documents.

All records and results of the public consultation process are kept and managed by Cercarbono.

17 Information management

The owner of the CCMP shall establish and apply quality management procedures according to the principles in this methodology for data, databases and documentation retrieving, management and control, including uncertainty assessment as applicable for baseline and project scenarios and monitoring activities[23].

[23] The owner of the CCMP may apply principles as per in ISO 9001 and ISO 14033 Standards for data quality management, namely: relevance, credibility, comparability, transparency, completeness, validity, pertinency and materiality.

The owner of the CCMP should reduce, as far as possible, uncertainties associated with GHG emissions reduction quantification. Thus, errors or omissions detected shall be identified and processed, and related documentary evidence shall be generated and kept.

The owner of the CCMP shall apply follow-up criteria and procedures, through which consistent assessments and audits to ensure accuracy of GHG emissions reduction quantification are performed, according to the monitoring plan.

When measurement and monitoring equipment is used, the owner of the CCMP shall make sure calibrated measurement and monitoring equipment is used and maintained as appropriate.

In addition, the CCMP owner shall ensure all staff involved with use of measurement instrumentation and monitored data qualifications are adequate. If necessary, such staff shall be trained.

All data and information related with CCMP's follow-up shall be recorded and documented.

18 CCMP documentation

It is required to keep all documentation and generated records in demonstrating CCMP's activity has been implemented in accordance with its design. Any deviation in implementing it as compared with the original design shall be technically justified and compliance with this methodology's guidelines, conditions, and procedures shall be demonstrated.

The CCMP owner shall have the documentation proving conformity of the GHG project with the requirements in this document. Such documentation shall be consistent with the validation and verification requirements as per in Cercarbono's voluntary carbon certification programme.

19 Transition regime for the use of other methodology versions

Once this methodology is published in Cercarbono's website, CCMP owners shall use it to generate carbon credits for associated GHG emissions reduction achieved.

A transition regime shall be considered from the initially used methodology or guideline to the present methodology. To that purpose, CCMP advancement according to Cercarbono's definition of project cycle shall be considered. Such cycle comprises five stages (as per in current version of ***Cercarbono's Protocol***). According to the stage the CCMP is in, the following shall be applied:

- If the CCMP is at Stage 1 or 2 (formulation and public comments), the CCMP shall integrate the methodology in full.
- If the CCMP is at Stage 3, 4 or 5 (validation, verification, or certification), the CCMP may implement the methodology originally selected from a programme other than Cercarbono. Otherwise, it shall use this methodology. If the CCMP is at Stage 5, credits will be issued based on originally selected methodology (including from a programme other than Cercarbono), provided such methodology is in force and authorized by Cercarbono.

20 CCMP validation and verification

Validation and verification requirements, additional to technical guidance in this methodology are described in current version of ***Cercarbono's Protocol*** and the ***Procedures*** document.

21 References

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United Nations Framework Convention on Climate Change (UNFCCC). *Tool 05 Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation*. Clean Development Mechanism. Available at: kutt.it/22Hbks.

United Nations Framework Convention on Climate Change (UNFCCC). *Tool 07 Tool to calculate the emission factor for an electricity system*. Clean Development Mechanism. Available at: kutt.it/xzd3Cn.

United Nations Framework Convention on Climate Change (UNFCCC). *Tool 10 Tool to determine the remaining lifetime of equipment*. Clean Development Mechanism. Available at: kutt.it/lxVYmW.

22 Document history

Version	Date	Comments/changes
1.0	17.08.2020	Initial version developed by Cercarbono's technical team with contributions from expert advisory, subject to public consultation from 01.09.2020 to 16.09.2020.
1.1	31.03.2021	Final version incorporating public consultation comments and complementary / additional elements.
2.0	26.06.2023	Version updated by Cercarbono's technical team, with major contents revision, submitted to independent expert third-party assessment.
2.1	12.04.2024	Version updated with comments from expert third-party assessment, submitted for public consultation from 12.04.2024 to 31.05.2024.
2.2	05.08.2024	Final version for publication in website incorporating public consultation comments and complementary / additional elements.