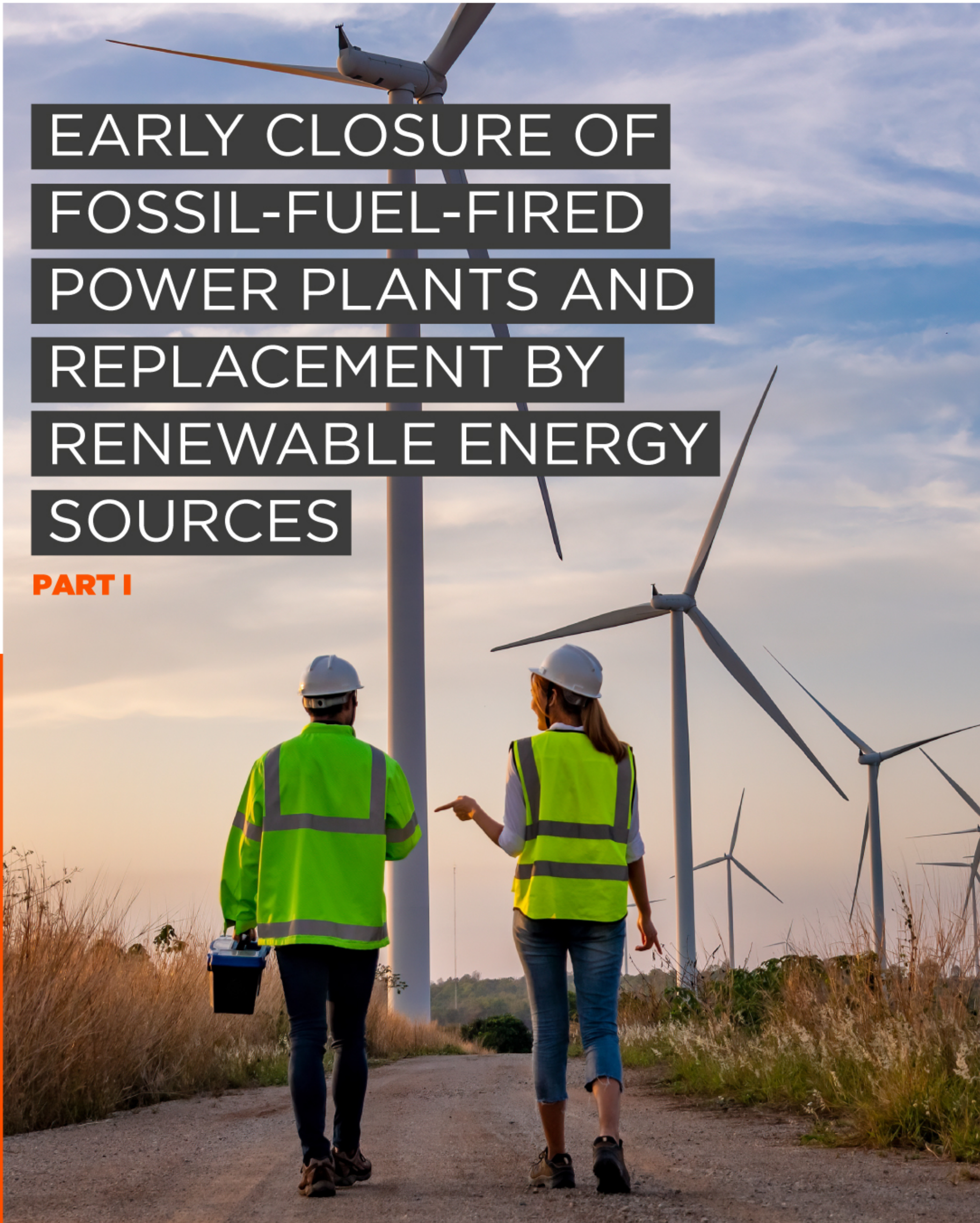
EARLY CLOSURE OF FOSSIL-FUEL-FIRED POWER PLANTS AND REPLACEMENT BY RENEWABLE ENERGY SOURCES

PART I



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METHODOLOGY

Early closure of fossil-fuel-fired power plants and replacement by renewable energy sources

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Early closure of fossil-fuel-fired power plants and replacement by renewable energy sources

Version: 04 Date: September 23, 2022 Sector: Energy industries (renewable/non-renewable sources)

1 Introduction

The main aspects of the methodology are described in Table 1.

Table 1 Methodology key elements

Project activity type	Moving the cessation of operation to an earlier date of one or several fossil fuel-based thermal power generation plants/units, incorporating in their replacement one or several renewable energy-based power generation plants/units.
GHG emission reduction type	Displacement of electricity that would have been produced using fossil fuels, with high carbon emissions.
GHG emission reduction scope	Emission reductions resulting from moving the cessation of operation date to an earlier date of thermal generation plants/units compared to the date of cessation of operations of the baseline scenario.

2 Definitions

For the purpose of this methodology, the following definitions apply.

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

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

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

Equipment: the term equipment includes all types of equipment related to industrial, commercial, and residential facilities, for example, power plant equipment such as boilers, turbines (steam, gas, wind, hydro), electric generators, pumps, motors, engines, and heat transfer equipment such as heaters, coolers, etc. In the context of this tool, the term equipment may refer to a single component or an assembly of several components. However, the term equipment does not include (a) stationary infrastructure, such as buildings, roads or railroads, bridges, tunnels, hydraulic dams, (b) vehicles, such as cars, buses, trains, and (c) consumer goods (except industrial appliances, such as chillers, refrigerators, etc.).

Decommissioned state: corresponds to the action of dismantling the parts or structures of a power plant/generating unit.

Unused state: corresponds to keeping the plant/generating unit installed, but not in a condition for use, since it has been intentionally rendered unusable or the facilities have been left clean of oils, fuels, ashes, lime, etc., the electrical connections are insulated, and/or others.

Standby state: corresponds to the action of maintaining the power plant/generating unit in a standby operating state, i.e., in conditions to enter a new operating state, in the circumstance that the electric system requires it. In the case of Chile, a power plant that ceases operation may change its state to a "Strategic Reserve Operating Status" (ERE), whose objective is to provide security to the National Electric System. ERE plants may only be required to change its state to an operating state by the National Electric Coordinator in situations of extreme urgency in which a significant supply deficit is foreseen. A plant may remain in ERE for 5 years before its definitive closure. Other countries should consider alternative definitions appropriate to their legislation.

Regular operation: State after the start of operations and before the plant's decommissioning, dismantling, or transfer to standby status.

Integrated hydropower project: It is the integration of multiple hydropower plants/units with single or multiple reservoirs designed to work together.

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

Existing reservoir: a reservoir is to be considered as an "existing reservoir" if it has been in operation for at least three years before the implementation of the project activity.

Power system: is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity (i. e., the renewable energy plant location, and the thermal power plant location).

Remaining lifetime: The remaining lifetime of equipment is the time during which existing equipment can continue to operate before it has to be replaced/disposed of for technical reasons, such as equipment age, safety reasons, or deteriorated performance. The remaining lifetime refers to years or hours of operation.

Technical lifetime: Refers to the total time during which the equipment is technically designed to operate from the time it is first put into service. Technical life is expressed in years or hours of operation.

3 Sources

This methodology takes as reference Clean Development Mechanism (CDM) registered methodologies, which present elements that are applied directly or are adapted for the development of this decarbonization methodology.

This methodology is based on elements from the following methodologies:

- Title: Grid-connected Electricity Generation from Renewable Sources. Reference: CDM Methodology ACM0002, Version 20.[1]
- Title: Renewable energy projects replacing part of the electricity production of one single fossil fuel fired power plant that stands alone or supplies to a grid, excluding biomass projects. Reference: CDM Methodology CDM AM0019, Version 2.[2]

In addition, this methodology refers to the following CDM methodological tools:

Title: Methodological tool. Tool to calculate project or leakage CO2 emissions from fossil fuel combustion. Reference: TOOL03, Version 2.[3]

Title: "Tool to determine the remaining lifetime of equipment". Reference: TOOL10, Version 1.[4]

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[1] CDM methodology ACM0002, version 20, extracted from:

https://cdm.unfccc.int/methodologies/DB/XP2LKUSA61DKUQC0PIWPGWDN8ED5PG

[2] CDM methodology AM0019, version 2, extracted from:

https://cdm.unfccc.int/methodologies/DB/7FFSYZXS2CQHL2051XI5QBASYNZ2RF

[3] CDM Tool 03, version 2, extracted from:

https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-03-v2.pdf/history_view

[4] CDM Tool 10, version 1, extracted from:

https://cdm.unfccc.int/methodologies/PAmethodologies/tools/am-tool-10-v1.pdf/history_view

4 Scope

This methodology applies to project activities that consider moving the cessation of operation to an earlier date of one or more fossil fuel-based thermal power generation plants/units and incorporating in their replacement one or several renewable energy-based power generation plants/units.

5 Methodology applicability

The project activity must meet the following applicability conditions:

- The cessation of operation of the fossil fuel-based power generation plant(s)/thermal unit(s) under the project activity scenario shall be earlier than a previous scheduled cessation of operation under the baseline scenario that considers voluntary commitments, regulatory requirements, and/or remaining useful life of the equipment, whichever is earlier.
- For each of the plants/thermal units to be replaced, it must be demonstrated the baseline fuel type that have been used as the primary fuel for the last 5 years.
- Thermal power generation plants/units may change it state to a decommissioned, unused, or standby status, according to the definitions in this methodology.
- The project activity must implement one or more power generation plants/units based on renewable energy sources, which will replace in part or in full the decrease in the supply of electricity generated by the cessation of operation of the fossil fuel-based thermal power generation plant(s)/unit(s). The renewable energy generation plant(s)/unit(s) to be implemented must correspond to one or more of the following technologies: hydro power plant/unit with or without reservoir, wind power plant/unit, geothermal power plant/unit, solar power plant/unit, wave power plant/unit or tidal power plant/unit. Biomass is excluded. If one or more of the renewable power plants consider battery storage, the energy injected from the batteries into the system can be quantified for the emission reduction calculation, provided that the project participant can demonstrate that the batteries are fed exclusively with energy generated by the respective renewable power plant.
- Renewable energy generation plants/units may be new projects or projects to add capacity to an existing plant. In the case of capacity addition to an existing renewable power plant, the existing plant must have commenced commercial operation at least five years before the project activity.
- Thermal fossil fuel-fired power plants/units and renewable energy power plants/units must be owned and/or controlled by the same economic group.
- Thermal power plants/units generating electricity based on fossil fuels and power plants/units generating electricity based on renewable energies must inject energy into the same interconnected system.
- The time lag between the early cease of operation date of the first thermal generating plant/unit and the commissioning of the first renewable energy generating plant/unit may not exceed two years. The project activity may consider this time lag for initiatives

that implement a renewable energy generating unit/plant before the fossil fuel-fired thermal generating unit/plant ceases operation or initiatives where the fossil-fired thermal generating unit/plant ceases operation before the implementation of the renewable energy generating unit/plant.

- The project activity may consider the operational cessation of one or several fossil fuel-based thermal power plant(s)/generating unit(s) and the implementation of one or several renewable energy power plant(s)/generating unit(s). All power plants/ generating units within the scope of the project activity shall comply with the applicability conditions.
- In the case of hydropower plants, the project activity must consider one of the following conditions:
    - The project activity is implemented in one or several reservoirs, with no change in the volume of any of the reservoirs.
    - The project activity is implemented in one or several reservoirs, where the volume of the reservoir(s) increases and the energy density, calculated using the method presented in methodology ACM0002, is greater than 4 W/m2.
    - The project activity considers one or several new reservoirs, and the energy density is greater than 4 W/m2.
    - The project activity considers an integrated hydroelectric project with multiple reservoirs, where the energy density of any of the reservoirs, calculated using the method presented in the ACM0002 methodology, is less than 4 W/m2, and all the following conditions must apply:
        - The energy density, calculated using the total installed capacity of the integrated project, given by the method presented in methodology ACM0002, is greater than 4 W/m2.
        - Water flow between reservoirs is not used by any other hydroelectric unit that is not part of the project activity.
        - The capacity of the unit(s) with an energy density of less than 4 W/m2 must be less than or equal to 15 MW and less than 10% of the total installed capacity of the integrated hydropower project.
    - The project participant shall, in the case of integrated hydroelectric power plants, develop:
        - Demonstrate that water flow from upstream plants/units flows directly to the downstream reservoir and collectively constitutes the generating capacity of the integrated hydropower project; or
        - Provide a water balance analysis covering the feed to the generating units, with all possible combinations of reservoirs and without the construction of reservoirs. The purpose of performing the water balance is to demonstrate the requirement of specific combinations of reservoirs for the optimization of electric generation. This demonstration should be performed based on the specific scenario of water availability in different seasons to optimize the water input to the generating units. Therefore, this water balance will take into account seasonal flows of rivers, tributaries, and rainfall over at least five years before project implementation.

6 Baseline methodology

6.1 Project boundary

The project activity boundaries consider the physical space where the fossil fuel-based thermal power generation plants/units operate and the physical space where the renewable energy generation plants/units will be implemented.

The emission sources and GHGs included and excluded in the project boundary are shown in the following table:

Table 2 Emission sources and GHGs included and excluded from the project boundary

Source		GEI	Included	Justification/ Explanation
Baseline	Source 1: CO2 emissions from electricity generation at the thermal power plant/generating unit, which is displaced by the renewable power plant/generating unit.	CO_2	YES	Main emission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
Project Activity	Source 1: CO2 emissions from electricity generation at the thermal power plant/generating unit after early cessation of operations.	CO_2	YES	Main mission source
		CH_4	No	Minor emission source
		N_2O	No	Minor emission source
	Source 2: For geothermal and hydroelectric plants consider sources and GHGs described in CDM methodology ACM0002.	CO_2	-	According to CDM ACM0002 methodology
		CH_4	-	According to CDM ACM0002 methodology
		N_2O	-	According to CDM ACM0002 methodology

6.2 Identification of the baseline scenario

The baseline scenario considers that, if the project activity had not been implemented, the fossil fuel-fired thermal power plants/units would have continued to operate according to the historical situation until the end of their technical lifetime, the retirement date committed in the context of a voluntary agreement or their scheduled retirement date due to regulatory requirements, whichever is earlier, and the renewable power plant/unit would not have been installed.

6.3 Identification of emission reduction periods

This methodology considers the emissions reduction from thermal power plants/units as a result of bringing their operational cessation to an earlier date relative to the baseline scenario. By the above, renewable plants/units in operation can displace energy that would have been generated by a thermal plant during the period between the date of early operational cessation of such thermal plant and the date of the planned cessation of operation of the baseline scenario, which may be defined by previous voluntary commitments, regulatory requirements and/or the remaining useful life of the equipment (whichever is earlier).

The displacement of energy from a thermal power plant/unit *t* by a renewable power plant/unit *r* may occur in a period such as to comply, at the same time, with the following criteria:

a) The beginning of the period for which the generation of the thermal power plant/unit *t* is displaced by renewable power plant/unit *r* cannot precede the date of the effective regular operation cessation of the thermal power plant/unit *t*.

b) The end of the period for which the generation of the thermal power plant/unit *t* is displaced by renewable power plant/unit *r* may not exceed the date of operational cessation of the baseline scenario of the thermal power plant/unit *t*.

c) The beginning of the period for which the generation of the thermal power plant/unit t is displaced by renewable power plant *r* cannot precede the date of the start of the regular operation of the renewable power plant/unit *r*.

In order to be able to choose the periods appropriately, it is necessary to define:

$Date_{BL,t}$ Date on which plant/thermal unit t would have ceased operation in the absence of the project activity (baseline scenario).

$Date_{PJ,t}$: Date on which the power plant/thermal unit *t* ceases operation in the project scenario (early operational cessation date).

$Date_{REN,r}$ **:** Date on which the renewable power plant *r* starts operation in the project scenario.

$Date_{BL,t}$ **:** This can correspond to a voluntary retirement date previously committed to by the project participant or other entity with the corresponding authority, a date mandated by legal requirements, or the date of the end of the technical lifetime of the equipment, whichever is earlier.

In practice, the period in which the project activity will generate an emission reduction due to the displacement of fossil fuel-based electricity generation from plant/unit *t* by renewable electricity generation from plant/unit *r* will start no earlier than the later the date of the first day of the project activity and the date of the last day of the project activity. $Date_{PJ,t}$ and $Date_{REN,r}$ and will end, at the latest, on the date corresponding to $Date_{BL,t}$.

If $Date_{PJ,t}$ or $Date_{REN,r}$ are later than $Date_{BL,t}$ the project activity will not be able to generate an emission reduction as a result of the displacement of generation from thermal power plant/unit *t* by generation based on renewable sources from power plant/unit *r*.

The generation of a thermal plant/unit can be displaced by one or more renewable plants, just as a renewable plant/unit can displace the generation of one or more thermal plants if the conditions mentioned above for the definition of the generation reduction periods are met.

As an example, there is a way of defining the periods for one year and a project activity with multiple plants. Consider a case in which two thermal plants/units (*T1* and *T2*) brought their cessation of operation date to an earlier date and two renewable plants/units (*R1* and *R2*) started operating in that year.

Figure 1 shows the detail of the date of cessation of operation by anticipating ($Date_{PJ,T1}$) and date of cessation of operation in the baseline scenario ($Date_{BL,T1}$) of the plant/unit *T1*; the date of early cessation of operation ($Date_{PJ,T2}$) of plant/unit *T2* (*T2*'s cessation of operation date in the baseline scenario is after year *y*); the commissioning dates for renewable plants *R1* and *R2* ($Date_{REN,R1}$ y $Date_{REN,R2}$); and dates indicating the beginning and end of the year *y*.

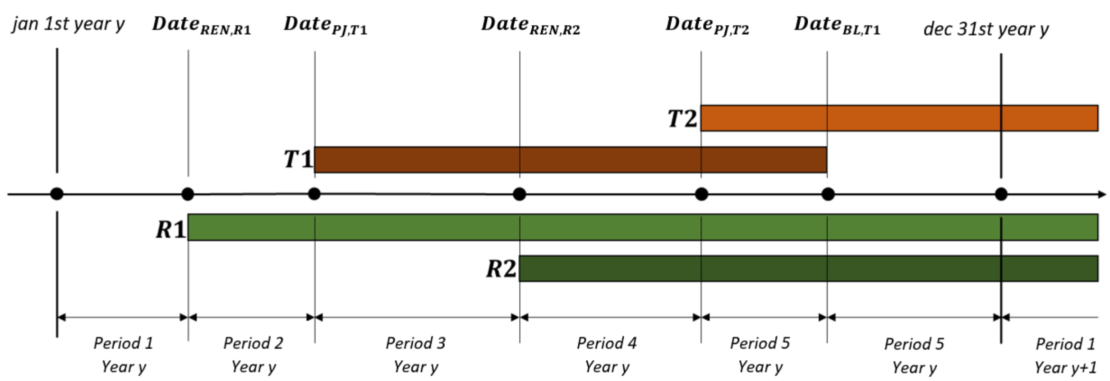


Figure 1: Example of identification of emission reduction periods.

As shown in Figure 1, six periods are defined in which displacement occurs differently among the four plants involved in the project activity in year *y*. Table 3 shows in detail what happens in each of these periods. Table 3 shows in detail each of the following periods:

Table 3: Characterization of periods identified in the example

Year	Period	Start date	End date	Are displaced	Displaced by
y	1	$01/01/y$	$Date_{REN,R1}$	-	-
y	2	$Date_{REN,R1}$	$Date_{PJ,T1}$	-	-
y	3	$Date_{PJ,T1}$	$Date_{REN,R2}$	$T1$	$R1$
y	4	$Date_{REN,R2}$	$Date_{PJ,T2}$	$T1$	$R1, R2$
y	5	$Date_{PJ,T2}$	$Date_{BL,T1}$	$T1, T2$	$R1, R2$
y	6	$Date_{BL,T1}$	$12/31/y$	$T2$	$R1, R2$

In this example, in periods 1 and 2, there is no energy displacement and therefore no emission reduction since conditions a), b) and c) above are not met simultaneously. In periods 3 - 6 there is energy displacement between different plants/units, depending on which ones meet the criteria within the start and end dates of each period.

It is recommended to define a new period each time a thermal plant/unit makes its cessation of operation effective, or when a thermal plant/unit reaches its cessation of operation date from the baseline scenario, or when a new renewable plant/unit comes into operation, and when there is a change of year, as presented in the example. This methodology allows other period definition options if the criteria are met.

From this section of the document onwards, renewable plants that are operational and generating power in a given period *p* will be denoted with a subscript *i*, and thermal plants that meet the criteria for generating curtailments in that period will be denoted with a subscript *k*.

6.4 Project emissions

Project emissions are given by the emissions generated by the operation of renewable power plants/units produced in each period and fossil fuel-based thermal power plants/units that ceased regular operation but within the same period have generated electricity while in standby status. For a period *p* in year *y*, the project emissions consist of:

$$E_{PJ,p,y} = \sum_{i} E_{PJ,i,p,y} + \sum_{k} E_{PJ,k,p,y} \qquad \text{Eq.1}$$

Where:

$E_{PJ,p,y}$: Emissions of the project scenario in period p of year *y* (tCO_2eq).

$E_{PJ,i,p,y}$: Project scenario emissions due to the operation of renewable generation plant/unit *i* in period p of the year *y* (tCO_2eq).

$E_{PJ,k,p,y}$: Emissions of the project scenario in period *p* of the year *y* due to the operation of the fossil-fuel-fired power plant/thermal generation unit *k* (tCO_2eq).

Then, the emissions of the project in the year *y* are given by:

$$E_{PJ,y} = \sum_{p} E_{PJ,p,y} \qquad \text{Eq.2}$$

Where:

$E_{PJ,y}$: Project scenario emissions in the year *y* (tCO_2eq).

Project emissions from the operation of renewable power plants ($E_{PJ,i,p,y}$) are zero for solar, wind, run-of-river hydro, tidal, and wave projects. For geothermal and reservoir hydroelectric projects, project emissions must follow the CDM methodology ACM0002.

Project emissions from the operation of thermal power plants/units in the project scenario must comply with the CDM methodology tool "TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion".

If a thermal power plant has not generated electricity in the period, and therefore the emissions due to its operation are null ($E_{PJ,k,p,y} = 0$), this must be validated ex-post during the reduction verification stage using one of the following:

a) Demonstrate that the thermal generating plant/unit was dismantled.
b) Have a document issued by the competent authorities that proves that the power plant/generating unit did not inject electricity into the electricity system during the period.
c) Provide public information from the competent entities showing that there was no injection of electricity to the power grid during the period.

6.5 Baseline emissions

The electricity generation of the renewable generation plants/units will displace the generation of the thermal plants/units that will cease operation early. For each period, the amount of energy that will be displaced by the renewable generation plants/units is limited to the minimum between a) the sum of the average generation of the last three[5] years of regular operation[6] of each thermal plant/unit k during such period and b) the sum of the electricity generation of the renewable generation plants/units *i* in the period *p*.

[5] For thermal power plants that are in operation at the time the PDD is prepared, we can use the average of the last three most recent calendar years at the time the PDD is prepared to estimate the value of the ex-ante reductions. However, it must be updated to the effective value of the average generation of the last three calendar years of regular operation, before the operational cessation, for the process of verification of the emission reductions.

[6] Generation from periods in which the plant was in standby or similar status is not considered within the average.

$$EG_{PJ,DISP,p,y} = MIN\left(\sum_{k} EG_{BL,AVG,k,p} ; \sum_{i} EG_{PJ,i,p,y}\right) \qquad \text{Eq.3}$$

Where:

$EG_{PJ,DISP,y}$: Generation displaced in the project scenario from fossil fuel-based thermal plants/units by renewable generation plants/units in period *p* of year *y* (MWh).

$EG_{BL,AVG,k,p}$: Average generation for the year considering p, of the last three years of regular operation of the power plant/thermal generating unit based on fossil fuels *k*. (MWh)

$EG_{PJ,i,p,y}$: Electricity generation in the project scenario of renewable generation plant/unit *i* in period p of year *y*. (MWh)

If the energy generation of the thermal power plant/unit for the three previous years is available in an annual basis only, the average energy generation is calculated as follow:

$$EG_{BL,AVG,k,p} = EG_{BL,AVG,k} \times \frac{days_p}{days_{year}} \qquad \text{Eq.4}$$

Where:

$EG_{BL,AVG,k}$: Average generation of the last three years of regular operation of the thermal power plant/generation unit based on fossil fuels *k*. (MWh)

$days_p$: Duration of period *p*. (días)

$days_{year}$: Duration of the year. (días)

Likewise, if the energy generation of the renewable power plant/unit is available in an annual basis only, the average energy generation is calculated as follow:

$$EG_{PJ,i,p,y} = EG_{PJ,i,y} \times \frac{days_p}{days_{year}} \qquad \text{Eq.5}$$

Where:

$EG_{PJ,i,y}$: Electricity generation in the project scenario of renewable generation plant/unit *i* in year *y*. (MWh)

The baseline emissions for the year y are given by:

$$E_{BL,y} = \sum_{p} E_{BL,p,y} \qquad \text{Eq.6}$$

Where:

$E_{BL,y}$: Baseline emissions in year y.(tCO_2eq)

$E_{BL,p,y}$: Baseline emissions in period *p* of the year *y*. (tCO_2eq)

Also, the baseline emissions for the period *p* in year *y* are given by:

$$E_{BL,p,y} = EG_{PJ,DISP,p,y} \times EF_{BL,p,y} \qquad \text{Eq.7}$$

Where:

$E_{BL,p,y}$: Baseline scenario emissions in period *p* of year *y* (tCO_2eq).

$EG_{PJ,DISP,p,y}$: Generation displaced from fossil fuel-based thermal power plants/units by renewable generation plants/units in the project scenario in period *p* of year *y* (MWh).

$EF_{BL,p,y}$: Average emission factor, weighted by the average annual baseline generation of thermal power plants that comply with the criteria to generate emission reductions in period *p* of the year *y* (tCO2eq/MWh).

Variable $EF_{BL,p,y}$ is calculated as the generation-weighted average of the emission factor of each of the *k* power plants that complies with the criteria for generating emission reductions in period *p*:

$$EF_{BL,p,y} = \frac{\sum_k (EF_{BL,AVG,k} \times EG_{BL,AVG,k,p})}{\sum_k EG_{BL,AVG,k,p}} \qquad \text{Eq.8}$$

Where:

$EF_{BL,AVG,k}$: Average emission factor for the last three years of regular operation of the thermal power plant *k*. (tCO_2/MWh)

Variable $EF_{BL,AVG,k}$ is calculated as the average emission factor of the power plant/thermal generating unit in the baseline scenario. ($EF_{BL,k,a}$), for the last three years of regular operation *a*[7] of the plant/unit.

The baseline emission factor ($EF_{BL,k,a}$) for a given year is provided by:

$$EF_{BL,k,a} = \frac{EF_{BL\,Fuel,k,a} \times F_{BL\,Fuel,k,a}}{EG_{BL,k,a}} \qquad \text{Eq.9}$$

[7] Thermal power plants that are in operation at the time the PDD is prepared, corresponds to the last three most recent calendar years at the time the PDD is prepared (ex-ante value) and must be updated to the last three years of regular operation, before the cessation of operations, for the process of verifying the reduction of emissions (ex-post value).

Where:

$EF_{BL,k,a}$: Emission factor of the thermal power plant/generating unit *k* in the baseline scenario in the regular year of operation *a* (tCO_2eq/MWh).

$EF_{BL\ Fuel,k,a}$: CO2 emission factor of the fossil fuel used in the baseline scenario at plant/unit *k* in the regular year of operation *a* (tCO_2eq/ton).

$F_{BL\ Fuel,k,a}$: Baseline fuel consumption of the plant/thermal unit *k* in the year of regular operation *a* (ton).

$EG_{BL,k,a}$: Generation of plant/thermal unit *k* in the baseline scenario in the regular operating year *a* (MWh).

6.6 Emissions leakage

No other leakage emissions are considered. The emissions potentially arising due to activities such as power plant construction and upstream emissions from fossil fuel us (e.g., extraction, processing, transport etc.) are neglected.

6.7 Emission reductions

Emission reductions are given by:

$$ER_y = E_{BL,y} - E_{PJ,y} \quad \text{Eq.10}$$

Where:

ER_y: Emission reductions from the project in the year *y* (tCO_2e/year).

$E_{BL,y}$: Emissions from the baseline scenario in year *y* (tCO_2e/year).

$E_{PJ,y}$: Emissions from the project scenario in year *y* (tCO_2e/year).

6.8 Data and parameters not monitored

In addition to the parameters listed in this section, the parameters used in other methodologies or methodological tools referenced in this methodology should be taken into consideration.

Data/Parameter:	$Date_{BL,t}$
Parameter unit:	-
Description:	Date on which the thermal power plant *t* would have ceased operation in the absence of the project activity.
Data source:	It requires official documents proving:

	a) Cease of operation date of the corresponding plant/unit voluntarily committed in case there is an agreement of this type. b) Cease of operation date of the corresponding plant/unit from operation due to legal or regulatory requirements if such regulations exist. c) Cease of operation date of the plant/unit due to the end of its technical lifetime. The remaining lifetime of the plant/unit must be calculated according to the methodological tool "TOOL10: Tool to determine the remaining lifetime of equipment". Among the dates indicated, the earlier date should be chosen.
Measurement method (if applicable):	-
Comments:	-

7 Monitoring methodology

7.1 Monitored data and parameters

In addition to the parameters listed in this section, the parameters used in other methodologies or methodological tools referenced in this methodology should be taken into consideration.

Data/Parameter:	$Date_{PJ,t}$
Parameter unit:	-
Description:	The date on which the thermal power plant/unit *t* ceases its operation in the project scenario (early cessation of operation).
Data source:	Document accrediting the cessation of the regular operation of the plant/unit by the electricity coordinator or the corresponding authority.
Measurement method (if applicable):	-
Comments:	-

Data/Parameter:	$Date_{REN,r}$
Parameter unit:	-
Description:	The date on which the renewable power plant *r* starts its operation in the project scenario.
Data source:	Document accrediting the entry into operation of the plant/unit by the electricity coordinator or the corresponding authority.
Measurement method (if applicable):	-
Comments:	-

Data/Parameter:	$EG_{PJ,i,p,y}$
Parameter unit:	MWh
Description:	Electricity generation in the project scenario of plant/renewable generating unit *i* in period *p* of year *y*.
Data source:	Monitored data.
Measurement method (if applicable):	Continuous monitoring by the monthly record.
Comments:	-

Data/Parameter:	$E_{PJ,k,p,y}$
Parameter unit:	tCO_2eq
Description:	Emissions of the project scenario in period *p* of the year *y* due to the operation of the fossil-fuel-fired power plant/thermal generation unit *k* (tCO_2eq).
Data source:	Calculated according to the methodological tool "TOOL03: Tool to calculate project or leakage CO2 emissions from fossil fuel combustion", taking into account the following considerations: a) $E_{PJ,k,p,y}$ corresponds to the variable $PE_{FC,j,y}$ of the tool. b) The tool uses annual fuel consumption values, when $E_{PJ,k,p,y}$ is associated with a period *p*. To calculate $E_{PJ,k,p,y}$ should use fuel consumption values recorded in each period p instead of annual values. If you do not have fuel consumption values for the required period, you can consider that the value is proportional to the annual consumption, analogous to Eq.4.
Measurement method (if applicable):	-
Comments:	This variable can be considered equal to zero for the entire credit period if it is:

	c) Demonstrates that the thermal generating plant/unit was dismantled. d) It has a document issued by the competent authorities that proves that the power plant/generating unit did not inject electricity into the electricity system during the period. e) It provides public information from the competent entities showing that there was no injection of electricity to the electricity grid during the period.

Data/Parameter:	$EG_{BL,AVG,k,p}$
Parameter unit:	MWh
Description:	Average generation for the year that considers *p*, of the last three years of the regular operation of the power plant/thermal generation unit based on fossil fuels *k*.
Data source:	Based on historical operational records.
Measurement method (if applicable):	Acquired data from continuous monitoring with monthly records (at least) during the last three years of regular operation of the power plant.
Comments:	If specific data for period *p* do not exist, a proportional value equivalent to the annual value can be calculated according to Eq. 4.

Data/Parameter:	$EG_{BL,AVG,k}$
Parameter unit:	MWh
Description:	Average generation of the last three years of regular operation of the power plant/thermal generating unit based on fossil fuels *k*.
Data source:	Calculated from historical operational records.
Measurement method (if applicable):	Acquired Data from continuous monitoring with the monthly record (at least) during the last three years of regular operation of the power plant.
Comments:	For plants that are in operation at the time the PDD is prepared, data from the three most recent years of operation can be used for the ex-ante estimate, but the value must be recalculated with data from

	the last three years of operation for the emission reduction verification process.

Data/Parameter:	$EF_{BL\ Fuel,k,a}$
Parameter unit:	tCO_2eq/ton
Description:	CO2 emission factor of the fossil fuel used in the baseline scenario at plant/unit *k* in the regular operating year *a*.
Data source:	The following sources of information can be used: a) Values provided by the fuel supplier (if this information is available, it is preferred). b) Measurements by the project participant. c) Regional or national default values. d) Default values at the lower uncertainty limit with a 95% confidence interval of the IPCC.
Measurement method (if applicable):	For (a) and (b): Measurements should follow national or international fuel standards. For (a): If the fuel supplier provides the lower calorific value and CO2 emission factor on their invoices, and based on measurements of that specific fuel, this emission factor should be used. If another source was used for the CO2 emission factor or the CO2 emission factor is not provided, use options (b), (c), or (d).
Comments:	The subscript *a* denotes each of the last three calendar years of regular operation of plant *k*. For plants in operation at the time of PDD preparation, the most recent three calendar years of operation can be used for the ex-ante estimation, but the value should be recalculated with data from the last three calendar years before cessation of operation for the emission reduction verification process.

Data/Parameter:	$F_{BL\ Fuel,k,a}$
Parameter unit:	ton

Description:	Baseline fuel consumption of plant/thermal unit *k* in the regular operating year *a*.
Data source:	Historical operational records
Measurement method (if applicable):	Acquired Data from continuous monitoring with the monthly record (as a minimum) during the last three years of the regular operation of the plant.
Comments:	The subscript *a* denotes each of the last three consecutive years of the regular operation of plant *k*.

Data/Parameter:	$EG_{BL,k,a}$
Parameter unit:	MWh
Description:	Generation of plant/thermal unit *k* in the baseline scenario in the regular operation year *a*.
Data source:	Historical operational records.
Measurement method (if applicable):	Acquired Data from continuous monitoring with the monthly record (at least) during the last three years of regular operation of the power plant.
Comments:	The subscript *a* denotes each of the last three consecutive years of regular operation of plant *k*. For plants that are in operation at the time the PDD is prepared, the most recent three calendar years of operation may be used for the ex-ante estimation, but the value should be recalculated with data from the last three calendar years before cessation of operation for the emission reduction verification process.

Data/Parameter:	$EF_{BL,k,a}$
Parameter unit:	tCO_2eq/MWh
Description:	Emission factor of the thermal generating plant/unit *k* in the baseline scenario in the year of regular operation *a*.
Data source:	Calculated.

Measurement method (if applicable):	-
Comments:	The subscript *a* denotes each of the last three consecutive years of regular operation of plant *k*. For plants that are in operation at the time the PDD is prepared, the most recent three calendar years of operation may be used for the ex-ante estimation, but the value should be recalculated with data from the last three calendar years before cessation of operation for the emission reduction verification process.

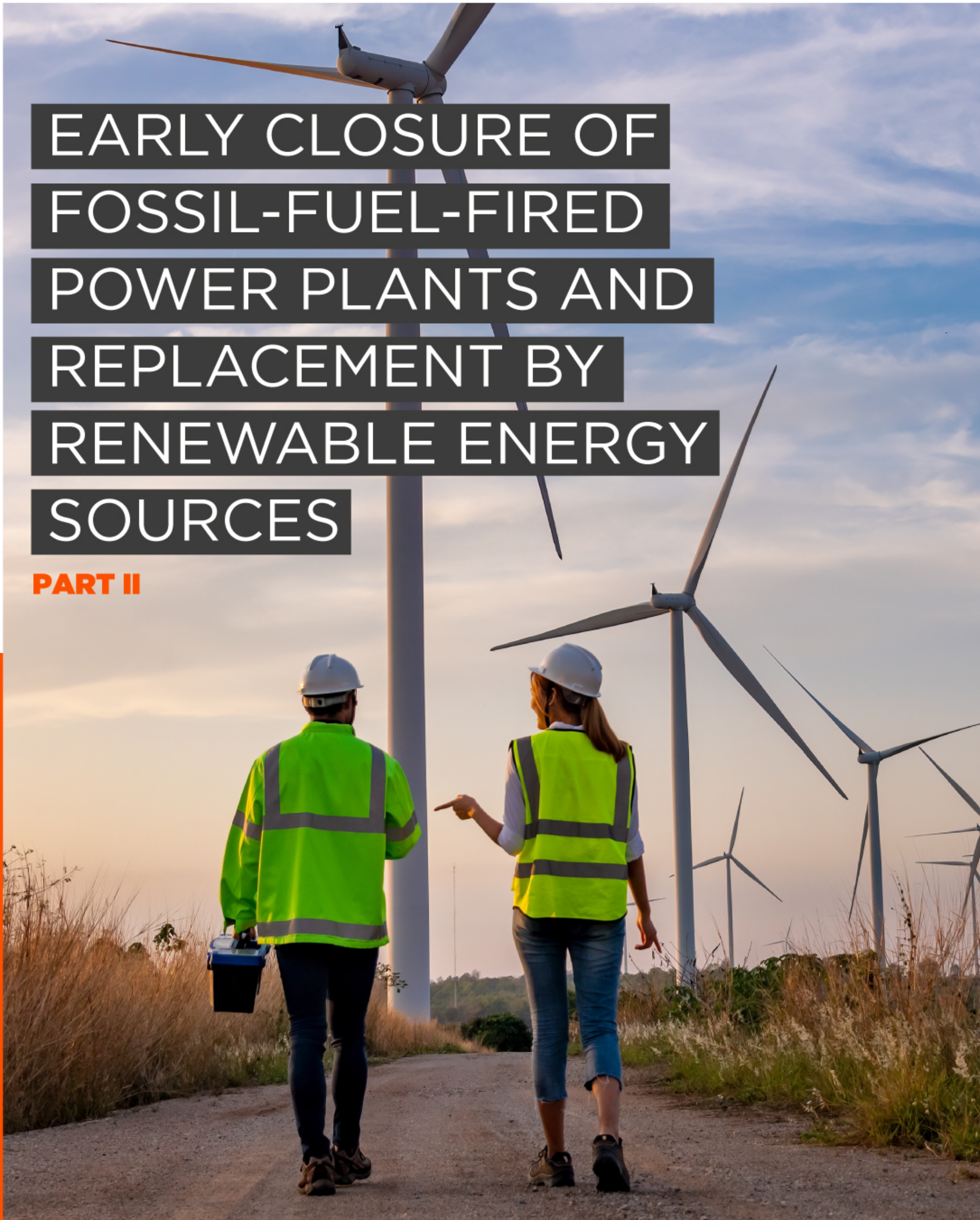
Data/Parameter:	$EF_{BL,AVG,k}$
Parameter unit:	tCO_2eq/MWh
Description:	The average emission factor of the last three years of the regular operation of the thermal power plant *k*, which complies with the criteria to generate emission reductions in year y.
Data source:	Calculated.
Measurement method (if applicable):	Average values of $EF_{BL,k,a}$ for the last three years of regular operation of the plant *k*.
Comments:	For plants that are in operation at the time the PDD is prepared, the most recent three calendar years of operation may be used for the ex-ante estimation, but the value should be recalculated with data from the last three calendar years before cessation of operation for the emission reduction verification process.

Data/Parameter:	$EF_{BL,p,y}$
Parameter unit:	tCO_2eq/MWh
Description:	Average emission factor, weighted by the average annual baseline generation of the thermal power plants that meet the criteria for generating emission reductions in period *p* of the year *y* (tCO_2eq/MWh).
Data source:	Calculated.

Measurement method (if applicable):	According to Eq.7.
Comments:	-

EARLY CLOSURE OF FOSSIL-FUEL-FIRED POWER PLANTS AND REPLACEMENT BY RENEWABLE ENERGY SOURCES

PART II



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Emission reduction monitoring and reporting protocol

Date: 09/23/2022

Emission reduction monitoring and reporting protocol

The project proponent must periodically report on the performance of the emission reduction project by completing a Monitoring Report, which presents the project implementation status, the variables monitored, and the emission reductions generated during the period.

The preparation of this report must consider the methodology presented in the methodology " Early closure of fossil-fuel-fired power plants and replacement by renewable energy sources" and in the PDD of the project activity.

This document provides guidelines for completing chapters 3 and 4 of the Monitoring Report.

This document is complementary to the methodology "Early closure of fossil fuel based thermal power plants and replacement by renewable energy sources" and the PDD of the project activity and aims to provide more specific guidelines regarding the actions to be taken by the project proponent. In case there is any aspect not covered in this protocol, the methodology and the PDD of the project activity will prevail.

1 Required information

The methodology requires collecting information on different variables to calculate the emission reductions generated by the project activity. Some of these variables were initially defined in the PDD ex-ante, while others must be measured, other variables must come from different sources (public information, IPCC, among others), and others are calculated based on different variables.

This section indicates the information that must be collected to calculate emissions according to the methodology, the periodicity of the required measurements, sources of information, and others. The collected information must be presented in section 3 of the Monitoring Report.

Below is a description of each of the required variables.

1.1 Dates of thermal power plant closure under baseline scenario

Identified in the methodology as the parameter $Date_{BL,t}$, is the date on which thermal power plant t would have ceased operation had the project not been implemented.

The subscript t denotes the thermal power plants under consideration in the project activity. For example, if a project considers the early closure of two plants "C1" and "C2", information on the baseline closure dates for both plants would have to be collected: $Date_{BL,C1}$ y $Date_{BL,C2}$.

Purpose of the information

This date is required to identify the end of the period where a thermal power plant can generate emission reductions due to its early closure and replacement by renewable generation sources.

Sources of information

The baseline scenario cessation date is the earlier of the following dates:

a) Cease of operation date of the corresponding plant/unit voluntarily committed in case there is an agreement of this type.

b) Cease of operation date the corresponding plant/unit from operation due to legal or regulatory requirements if such regulations exist.

c) Cease of operation date of the plant/unit due to the end of its technical lifetime. The remaining lifetime of the plant/unit must be calculated according to the methodological tool "TOOL10: Tool to determine the remaining lifetime of equipment".

For each case, we require the following documentation (or equivalent) to support these dates:

a) Copy of the agreement stating the commitment of the date of cessation of operation subscribed, signed by a competent entity.

b) Identification and statement of the regulation or law that requires the cessation of operation on the indicated date.

c) Technical report prepared by a third party according to the conditions of the "TOOL10" methodological tool.

The documentation required for option c) applies in all cases. For a) and b) documents are required only when the described option applies to the plant (when there is a voluntary agreement and/or a law or regulation requiring the cessation of operation).

Monitoring of the information

Value is defined only once, ex-ante, applied for the entire credit period. It does not require monitoring.

1.2 Effective operation cessation dates of thermal power plants

Identified in the methodology as the parameter $Date_{PJ,t}$, it is the date on which thermal power plant *t* effectively ceased operation, being decommissioned, unused, or remaining in standby status.

The subscript *t* denotes the thermal power plants considered in the project activity. For example, if a project considers the early cessation of operation of two plants "C1" and "C2", information on the effective operation cessation dates for both plants would have to be collected: $Date_{PJ,C1}$ and $Date_{PJ,C2}$.

Thermal power plants that have not ceased operation at the end of the period considered for the monitoring report do not generate emission reductions in the period, so they should not be considered as such.

Purpose of the information
This date is required to identify the beginning of the period where a thermal power plant can generate emission reductions due to its early closure and replacement by renewable generation sources.

Sources of information
Documentation is required to prove the date of disconnection, decommissioning, or transfer to standby status of the plant by a competent entity.

Monitoring of the information
Once the date of cessation of operation associated with a generating plant/unit has been identified, it does not require subsequent monitoring. The value and supporting document associated with each plant/unit must be recorded.

1.3 Renewable power plant start-up dates

Identified in the methodology as the parameter $Date_{PJ,r}$, is the date on which the renewable power plant *r* began operation.

The subscript *r* denotes the renewable plants considered in the project activity. For example, if a project considers the early cessation of operation of two plants "R1" and "R2", information on the baseline operation start dates for both "R1" and "R2" would need to be collected: $Date_{PJ,R1}$ and $Date_{PJ,R2}$.

Renewable power plants that have not started operating at the end of the period considered for the monitoring report do not generate emission reductions during that period, therefore should not be considered as such.

Purpose of the information
This date identifies the beginning of the period where a renewable power plant can generate emission reductions due to the displacement of fossil fuel-based generation.

Sources of information
It requires documentation proving the date of entry into operation of the plant by a competent entity.

Monitoring of the information
Once the date is defined, no further monitoring is required.

1.4 Generation from thermal power plants in the baseline scenario

It is required to collect information on the generation of the last three years of the regular operation of the thermal power plants that can generate curtailments during the period (they have ceased operation and have not yet exceeded their baseline operation cessation date).

In the methodology, this parameter is identified as $EG_{BL,k,a}$, where the subscript *k* denotes the plants that can generate curtailments within the period *p* and a denotes each of the three years of the regular operation of the plant.

For example, consider the case of a plant "C1" that ceased its regular operation on 05/31/2018. For this plant, generation data should be collected for the last three consecutive years, called $EG_{BL,C1,A1}$, $EG_{BL,C1,A2}$ y $EG_{BL,C1,A3}$, where A1, A2, and A3 denote the required periods:

- A1: 06/01/2015 to 05/31/2016,
- A2: 06/01/2016 to 05/31/2017,
- A3: 06/01/2017 to 05/31/2018.

Purpose of the information
The annual generation of each plant *k* is used to calculate the average of the last three years of regular operation. The average sum for each *k* power plant is used to calculate the energy displaced by the project activity.

Sources of information
Historical plant operational records.
A cross-check of the project developer's operational records data with those reported by a competent entity should be performed to ensure that they are consistent.

Monitoring of the information
Use the data recorded by the meter closest to the injection point to the respective electrical system.

It is required that a meter with continuous monitoring capabilities and a monthly record, as a minimum.

It is required the following information about the meter:

- Type
- Accuracy class
- Serial number

It also requires information on the QA/QC procedures applied to the meter, including calibration processes.

1.5 Renewable Power Plant Generation

Identified as $EG_{PJ,i,p,y}$ in the methodology, it is the generation of renewable plant *i* in period *p*.

The subscript *i* denotes the renewable plants that can generate curtailments within period *p* (started operation and generated during the period).

Purpose of the information
This value is used to calculate baseline scenario emissions.

Sources of information

Historical operational records of the power plant's electricity generation.

A cross-check of the project developer's operational records data with those reported by a competent entity should be performed to ensure that they are consistent.

Monitoring of the information
Using the data recorded by the closest meter to the point of injection to the corresponding electrical system.
A meter with continuous monitoring capabilities and a monthly record, as a minimum, is required. The following meter information is required:

- Type
- Accuracy class
- Serial number

Information on the QA/QC procedures applied to the meter, including calibration processes, is also required.

1.6 Thermal power plant fuel consumption in the baseline scenario

It is required to collect information about fuel consumption for the last three consecutive years of regular operation of the thermal power plants that can generate reductions during the period (they have ceased operation and have not yet exceeded their baseline operation cessation date).

In the methodology, this parameter is identified as $F_{BL\ Fuel,k,a}$, where the subscript *k* denotes the plants that can generate curtailments within the period *p* and a denotes each of the three years of the regular operation of the plant.

For example, consider the case of a plant "C1" that ceased its regular operation on 05/31/2018. For this power plant, fuel consumption data should be collected for the last three consecutive years, let $F_{BL\ Fuel,C1,A1}$, $F_{BL\ Fuel,C1,A2}$ and $F_{BL\ Fuel,C1,A3}$, where A1, A2, and A3 denote the required periods:

- A1: 06/01/2015 to 05/31/2016,
- A2: 06/01/2016 to 05/31/2017,
- A3: 06/01/2017 to 05/31/2018.

Purpose of the information
This value is used to calculate the annual emission factor for each plant.

Sources of information
Historical operational records of plant fuel consumption.

Monitoring of the information
Continuous monitoring is required and at least monthly recording of fuel consumption. This monitoring can be measured directly (using a mass or volumetric meter) or indirectly. Regardless of the method used, consumption must be reported in tons.

The method used in the monitoring, the type of meters used, and information and backups on the parameters used for unit transformation (calorific value of the fuel, density, or others) must be indicated in detail.
The following information on the meter used is required:

- Type
- Accuracy class
- Serial number

Information on the QA/QC procedures applied to the meter, including calibration procedures, is also required.

1.7 Baseline fuels emission factor

Information on the baseline fuel emission factor, identified as parameter $EF_{BL\ Fuel,k,a}$, should be collected for the last three years of regular operation of the thermal power plants.

The subscripts *k* and a indicate the thermal power plant and the running year of fuel use.

For example, consider the case of a power plant "C1" that ceased regular operation on 05/31/2018. For such a power plant, fuel emission factor information should be collected for the last three running years, call $EF_{BL\ Fuel,C1,A1}$, $EF_{BL\ Fuel,C1,A2}$ and $EF_{BL\ Fuel,C1,A3}$, where A1, A2, and A3 indicate the required periods:

- A1: 06/01/2015 to 05/31/2016,
- A2: 06/01/2016 to 05/31/2017,
- A3: 06/01/2017 to 05/31/2018.

Purpose of the information
This value is used to calculate the annual emission factor for each plant.

Sources of information
The following sources of information can use:

a) Values provided by fuel supplier (if this information is available, this is preferred).

b) Measurements by the project promoter.

c) Regional or national default values.

d) Default values at the lower uncertainty limit with a 95% confidence interval of the IPCC.

Monitoring of the information

For (a) and (b): Measurements must comply with national or international fuel standards.
For (a): If the fuel supplier provides the lower calorific value and CO2 emission factor on their invoices, and these values relate to measurements of that specific fuel, this emission factor should be used. However, in case another source of CO2 emission factor is used or is not provided, use options (b), (c), or (d).

The methodology requires an emission factor in units of t_{CO2eq}/ton, so a unit transformation is required depending on the source of the values. In case this occurs, the parameters used (calorific value of the fuel, density, or others) have to be indicated, with their corresponding backups.

2 Emission reduction calculation for the period

Calculating emission reductions requires estimating how many emissions were generated by the project activity implementation (project emissions) and how many emissions would have been generated if the project had not been implemented (baseline emissions). The difference between the two values corresponds to the number of emissions that were reduced.

The calculation of emission reductions must be performed according to the methodology and the PDD of the project. This protocol indicates, how to apply the methodology for the step-by-step calculation in a general scenario. In case the project activity considers any particularity not covered in this document or requires more details on a specific topic, it should refer to the methodology.

The results obtained by applying this section of this guide are used to complete section 4 of the Monitoring Report.

2.1 Definition of reduction periods

Broadly speaking, for there to be emission reductions at a given time, two conditions must be met: 1) there must be one or several thermal power plants/units that, while they could be operating at that time according to their baseline operation cessation date, have ceased operation and are not generating, and 2) there must be one or several renewable power plants/units that are generating to supply - in whole or in part - the decrease in supply due to the cessation of operation of the thermal power plants.

The calculation of emission reductions requires the identification of which renewable plants/units are displacing the generation of which thermal plants/units at any given time. To achieve this, it is necessary to define periods of reduction.

In practice, the simplest way to identify emission reduction periods is to define a start/end of the period each time one of the following occurs:

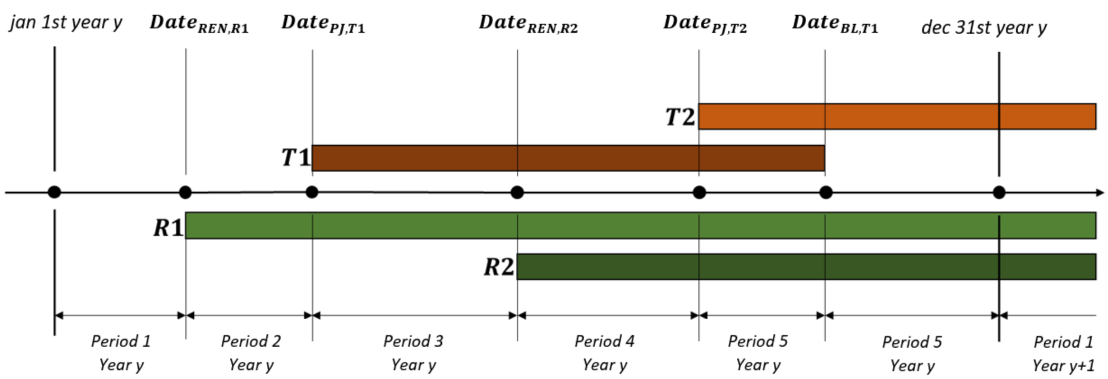
- Beginning of the year.

- A thermal power plant/unit ceased operation.
- The baseline operation cessation date of a thermal power plant/unit was reached.
- A renewable plant/unit began operation.
- End of year.

After identifying the start and end dates of each period, it is necessary to identify between which plants the displacement takes place in each period.

Consider the following example:

In the following figure is the detail of the early operation cessation date ($Date_{PJ,T1}$) (PJ,T1)) and operation cessation date in the baseline scenario ($Date_{LB,T1}$) of plant/unit T1; the early shutdown date ($Date_{PJ,T2}$) of plant/unit T2 (the shutdown date of T2 in the baseline scenario is after year *y*); the start of operation dates for renewable plants R1 and R2 ($Date_{REN,R1}$ y $Date_{REN,R2}$); and the dates indicating the beginning and end of year *y*.



The following table shows the periods identified and the plants/units between which the displacement takes place in the year *y*.

Year	Period	Start date	End date	Are displaced	Displaced by
y	1	$01/01/y$	$Date_{REN,R1}$	-	-
y	2	$Date_{REN,R1}$	$Date_{PJ,T1}$	-	-
y	3	$Date_{PJ,T1}$	$Date_{REN,R2}$	$T1$	$R1$
y	4	$Date_{REN,R2}$	$Date_{PJ,T2}$	$T1$	$R1, R2$
y	5	$Date_{PJ,T2}$	$Date_{BL,T1}$	$T1, T2$	$R1, R2$
y	6	$Date_{BL,T1}$	$31/12/y$	$T2$	$R1, R2$

Considering the table above, we observe, for example, how in period 4 of the year y plants R1 and R2 displace the generation of T1. In period 5 of the same year, the same R1 and R2 now displace the generation of T1 and T2. There is no displacement in period 1 since T1 and T2 had not yet ceased operations and R1 had not yet started operations. In period 2 there is no displacement either because even though R1 was in operation, T1 and T2 had not yet ceased operation.

2.2 Project emissions

Project emissions in a period ($E_{PJ,p,y}$) may correspond to the emissions generated by the operation of a renewable power plant considered in the project activity ($E_{PJ,i,p,y}$) or by the operation of a thermal power plant considered in the project activity that has already ceased its operation and generated within the period because it is in standby status ($E_{PJ,k,p,y}$), as shown in Eq.1 of the methodology.

$$E_{PJ,p,y} = \sum_{i} E_{PJ,i,p,y} + \sum_{k} E_{PJ,k,p,y}$$

Emissions associated with the renewable plant ($E_{PJ,i,p,y}$) are zero in most cases. For geothermal power plants and some hydroelectric reservoir power plants, it is required to calculate emissions according to the methodology.

In the case of generation from a thermal power plant that ceased operation and subsequently resumed generation, the associated emissions ($E_{PJ,k,p,y}$) must be calculated according to the methodology.

The project emissions for a year y are given by the sum of the project emissions of the periods contained in that year, as indicated in Eq.2 of the methodology.

$$E_{PJ,y} = \sum_{p} E_{PJ,p,y}$$

2.3 Baseline emissions

Baseline emissions correspond to the emissions that would have been generated if the project activity had not been implemented. The methodology considers that the thermal plants/units would have continued to operate until their baseline cease of operation date at levels and conditions similar to their last three years of regular operation and that the renewable plants/units would not have been implemented.

In order to calculate the baseline emissions for a period ($E_{BL,p,y}$) you need to know:

Baseline emission factor ($\boldsymbol{EF_{BL,p,y}}$): Indicates the number of emissions that would have been produced for each megawatt-hour generated by the thermal power plants producing in the period. It corresponds to an average value that is calculated based on the generation and fuel consumption of each plant in the last 3 years before its operational cessation.

Displaced energy ($\boldsymbol{EG_{PJ,DISP,p,y}}$): It is the energy generated by the renewable plants/units that makes up for the decrease in generation because of the thermal plants/units in a period. The displaced energy will be the minimum value between:

- Sum of the generation of the renewable power plants of the project activity that can be displaced in the period.
- Sum of the average generation of the last three years of operation of the plants that can be displaced in the period.

However, this limits emissions reductions only to what is being displaced: if the renewable generation is higher than the baseline thermal generation, only a fraction of the renewable generation is required to displace the thermal generation in its entirety (the other renewable fraction does not displace). In contrast, if baseline thermal generation is higher than a renewable generation, thermal generation does not displace all of the renewable generation (a fraction of the thermal generation does not displace).

2.3.1 Calculation of baseline emission factor ($EF_{BL,p,y}$)

The calculation of the baseline emission factor requires information on generation and fuel consumption in the baseline scenario of the thermal power plants that are displaced in the period (Sections 1.4 and 1.6 of this document) and information on the emission factor of the fuels used (Section 1.7 of this document).

First, it is necessary to calculate the emission factor of each plant *k* for each of its last three years of regular operation ($EF_{BL,k,a}$) according to Eq. 9 of the methodology:

$$EF_{BL,k,a} = \frac{EF_{BL\ Fuel,k,a} \times F_{BL\ Fuel,k,a}}{EG_{BL,k,a}}$$

The values for $EF_{BL\ Fuel,k,a}$, $F_{BL\ Fuel,k,a}$ and $EG_{BL,k,a}$ should be collected as indicated in Sections 1.7, 1.6, and 1.4 of this guide, respectively.

Then, the average emission factor for each plant k ($EF_{BL,AVG,k}$) is calculated as the average of the calculated annual emission factor values:

$$EF_{BL,AVG,k} = \text{Average}\ (EF_{BL,k,A1}, EF_{BL,k,A2}, EF_{BL,k,A3})$$

Where A1, A2, and A3 are each of the last 3 consecutive years of regular generation of plant k before the cessation of operation.

To calculate the baseline emission factor for the period, the generation value of each plant during the period ($EG_{BL,AVG,k,p}$) is required.

For this, it is first required to calculate the average baseline generation of each of the thermal power plants that are displaced ($EG_{BL,AVG,k}$).

This is nothing more than the simple average of the generation of the last three consecutive years of each plant.

$$EG_{BL,AVG,k} = \text{Average}\ (EG_{BL,k,A1}, EG_{BL,k,A2}, EG_{BL,k,A3})$$

Where A1, A2, and A3 correspond to each of the last 3 consecutive years of regular generation of the plant before operation cessation.

Then, the proportional generation value of each plant ($EG_{BL,AVG,k,p}$) is calculated for the period according to Eq. 4 of the methodology:

$$EG_{BL,AVG,k,p} = EG_{BL,AVG,k} \times \frac{days_p}{days_{year}}$$

Finally, the value of the baseline emission factor for the period is calculated as the average weighted by the generation of the thermal power plants that are displaced in the period, according to Eq.8 of the methodology.

$$EF_{BL,p,y} = \frac{\sum_k (EF_{BL,AVG,k} \times EG_{BL,AVG,k,p})}{\sum_k EG_{BL,AVG,k,p}}$$

2.3.2 Calculation of displaced energy

Baseline generation of thermal power plants/units

To calculate the energy displaced in a period, we require information on the generation of the renewable plants/units and the average baseline generation of the thermal plants/units displaced in the period.

The annual ($EG_{BL,AVG,k}$) average baseline generation of each power plant/thermal unit is calculated as the average annual generation of its last three consecutive years of operation. In other words:

$$EG_{BL,AVG,k} = \text{Average}\ (EG_{BL,k,A1}, EG_{BL,k,A2}, EG_{BL,k,A3})$$

Where A1, A2, and A3 correspond to each of the last 3 consecutive years of regular operation of the plant before the cessation of operation.

The values for $EG_{BL,k,a}$ should be collected as indicated in section 1.4 of this guide.

Since $EG_{BL,AVG,k}$ is an annual value, the value proportional to the length of the period ($EG_{BL,AVG,k,p}$) is calculated according to Eq.4 of the methodology:

$$EG_{BL,AVG,k,p} = EG_{BL,AVG,k} \times \frac{days_p}{days_{year}}$$

It requires a value of $EG_{BL,AVG,k,p}$ for each plant that is displaced in period.

Project generation renewable power plants/units

The renewable generation information ($EG_{PJ,i,p,y}$) should be collected as indicated in section 1.5 of this guide for each plant/renewable unit that displaces generation during the period.

In the case of having only annual generation data ($EG_{PJ,i,y}$), he generation of the period should be calculated according to Eq.5 of the methodology:

$$EG_{PJ,i,p,y} = EG_{PJ,i,y} \times \frac{days_p}{days_{year}}$$

It requires a value of $EG_{PJ,i,p,y}$ for each plant that is displaced in the period.

Generation displaced by the project activity

According to Eq.3 of the methodology, the displaced energy is given by the minimum value between the sum of the baseline generation of the thermal plants/units that are displaced and the generation of the renewable plants/units that they displace in a certain period:

$$EG_{PJ,DISP,p,y} = MIN\left(\sum_k EG_{BL,AVG,k,p}\, ; \sum_i EG_{PJ,i,p,y}\right)$$

Baseline emissions calculation

Finally, the baseline emissions ($E_{BL,p,y}$) are calculated as the product between the displaced energy and the baseline emission factor of the period, according to Eq.7 of the methodology.

$$E_{BL,p,y} = EG_{PJ,DISP,p,y} \times EF_{BL,p,y}$$

The project emissions for a year *y* are given by the sum of the baseline emissions of the periods contained in that year, as indicated in Eq.6 of the methodology.

$$E_{BL,y} = \sum_p E_{BL,p,y}$$

2.4 Emission reductions

The emission reduction (ER_y) of year *y* is given by the difference between the emissions of the baseline scenario ($E_{BL,y}$) and the emissions of the project scenario ($E_{PJ,y}$), according to Eq.10 of the methodology:

$$ER_y = E_{BL,y} - E_{PJ,y}$$