CLEAN DEVELOPMENT MECHANISM

AM0104

Large-scale Methodology

Interconnection of electricity grids in countries with economic merit order dispatch

Version 02.0.0

Sectoral scope(s): 01

United Nations
Framework Convention on
Climate Change

TABLE OF CONTENTS **Page**

1. Introduction

1. The following table describes the key elements of the methodology:

Table 1. Methodology key elements

Typical projects	Project activities consisting of the construction of one or multiple new interconnection lines to connect two grids
Type of GHG emissions mitigation action	Energy efficiency. Displacement of more GHG intensive technology/technique by less GHG intensive

2. Scope, applicability, and entry into force

2.1. Scope

2. This methodology applies to project activities consisting of the construction of one or multiple new interconnection lines[1] to connect two grids.

2.2. Applicability

3. The methodology is applicable under the following conditions:

   (a) The geographic and system boundaries for the relevant grids can be clearly identified and information on the characteristics and composition of grids is available;

   (b) Electricity exchange of the previously isolated grid with other grid(s) through the interconnection line(s) that might be constructed after implementation of the project activity shall be monitored;

   (c) After the implementation of the project activity, there will be only one dispatch centre responsible for the operation of the resulting grid (previously isolated and main grid);

   (d) The total installed power capacity in the previously isolated grid is less than 10 per cent of the total installed power capacity in the main grid in the year prior to the implementation of the project activity.

4. In addition, the applicability conditions included in the tools referred to below apply.

2.3. Entry into force

5. The date of entry into force of the revision is the date of the publication of the EB 70 meeting report on 23 November 2012.

[1] The previously isolated grid and main grid, transmission lines and schedule of interconnection have to be clearly identified in the CDM-PDD. If the project activity is implemented in stages throughout several years, the schedule has to be considered in the development of the baseline and project scenarios.

3. Normative references

6. This baseline and monitoring methodology is based on the following proposed new methodology:

   (a) "NM0353: Grid connection of previously isolated electricity systems in countries with merit order dispatch" prepared by Isolux Corsán Concesiones and EQAO."

7. This methodology also refers to the latest approved versions of the following tools:

   (a) "Tool for the demonstration and assessment of additionality;"

   (b) "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period;"

   (c) "Tool to calculate the emission factor for an electricity system."

8. For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

3.1. Selected approach from paragraph 48 of the CDM modalities and procedures

9. "Existing actual or historical emissions, as applicable".

4. Definitions

10. The definitions contained in the Glossary of CDM terms shall apply.

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

   (a) **Grid** - is an electricity network, including transmission and distribution lines and power plants. The spatial extent of the grid includes the power plants that are physically connected through transmission and distribution lines that can be dispatched by a dispatch centre without significant transmission constraints. The spatial extent of the grid shall be determined by following the procedures in the latest version of the "Tool to calculate the emission factor for an electricity system";

   (b) **Low-cost/must-run units** - are power units with low marginal generation costs or power plants that are dispatched independently from the daily or seasonal load of the grid. They mainly include geothermal, wind, biomass, nuclear and solar generation. Certain power plants using fossil fuels could also be used as must-run unit;

   (c) **Power unit** - is a facility that generates electricity and supplies it to an electricity grid and, if applicable, to specific consumers. 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;

(d) **Transmission line** - is the physical infrastructure used to delivered electricity at high voltages from one point to another;

(e) **Interconnection** - is the connection of two grids through the installation of one or many transmission lines. After implementation of the project activity, the interconnection line is used to delivered electricity from the main grid to the previously isolated grid;

(f) **Previously isolated grid** - is a grid that has no interconnection with any grid prior to the implementation of the project activity and which is being connected to a main grid as a result of the project activity.

(g) **Main grid** - is a grid that due to the project activity is being connected to the previously isolated grid by interconnection line;

(h) **Economic merit order dispatch** - is a procedure that enables the identification of the optimum loading for each power unit in a grid with multiple power units, aiming at the lowest cost of electricity generation, while ensuring a safe operation of the grid;

(i) **Dispatch centre** - is the entity responsible for the operation, planning and scheduling and the centralized dispatch of power units, and that uses the economic merit order dispatch in order to ensure a safe and economic operation of the grid;

(j) **Monitoring period *m*** - The period, for which a monitoring report is submitted, the verification is performed and for which issuance of CERs is requested by the Designated Operational Entity (DOE). A monitoring period can be shorter duration than one year, but the last monitoring report in a year *y* shall end on the same date the annual report from a dispatch centre is ended. For example, if a dispatch centre publishes annual reports for the period from 1 January to 31 December, last monitoring period of the year shall ends on 31 December or if it is only one monitoring period in the year it shall starts on 1 January and ends on 31 December. Under this methodology, emission reductions are calculated for each monitoring period *m*;

(k) **Net quantity of electricity delivered** - The amount of electricity effectively delivered by the project activity interconnection and consumed in the previously isolated grid. In the case of the previously isolated grid will be connected through an interconnection line to another grid after the implementation of the project activity, the amount of electricity transferred from the previously isolated grid through the new interconnection shall be discounted from the net quantity of electricity delivered.

5. Baseline methodology

5.1. Project boundary

12. The spatial extent of the project boundary includes all power units physically connected to the main grid and all power units connected to the previously isolated grid prior to the start date of project activity. The spatial extent of the grids shall be determined in accordance with the “Tool to calculate the emission factor for an electricity system”.

13. The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table 1:

Table 2. Emission sources included in or excluded from the project boundary

Source		Gas	Included	Justification/Explanation
Baseline	Power generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This is conservative
		N_2O	No	Excluded for simplification. This is conservative
Project activity	Power generation	CO_2	Yes	Main emission source
		CH_4	No	Excluded for simplification. This emission source is assumed to be very small
		N_2O	No	Excluded for simplification. This emission source is assumed to be very small
	Emissions from the new equipments installed under the project activity	SF_6	Yes	Emissions related to SF_6 used in new equipment installed under the project activity

5.2. Identification of the baseline scenario

14. In order to identify the baseline scenario the following three steps shall be applied:

5.2.1. Step 1: Define alternative scenarios to the proposed CDM project activity

15. Apply Step 1 of the "Tool for the demonstration and assessment of additionality". In applying Step 1, the alternative scenarios identified should include:

(a) The "proposed project activity undertaken without being registered as a CDM project activity"; or

(b) The proposed project activity undertaken at a later point in time (e.g. due to existing regulations, end-of-life of existing equipment, financing aspects).

5.2.2. Step 2: Identification of barriers and assessment of alternative scenarios that are not prevented by these barriers

16. Apply Step 3 of the "Tool for the demonstration and assessment of additionality".

17. As the proposed project activity is undertaken without being registered as a CDM project activity is one of the considered alternatives, any barrier that may prevent the proposed CDM project activity to occur shall be included in the list of identified barriers. All alternatives shall be compared to the same set of barriers.

5.2.2.1. Outcome of Step 2:

18. If there is only one alternative scenario that is not prevented by any of the identified barriers, then this alternative scenario is identified as the baseline scenario.

19. Where more than one credible and plausible alternative remains, project participants shall, as a conservative assumption, use the alternative baseline scenario that results in the lowest baseline emissions as the most likely baseline scenario, or conduct an investment analysis.

5.2.3. Step 3: Investment analysis

20. Conduct an investment analysis, consistent with the guidance in Step 2 of the latest version of the "Tool for the demonstration and assessment of additionality". In applying Step 2, describe any specific financing and/or subsidizing mechanisms to which such projects are eligible in the host country as introductory background information. The most economically attractive alternative is deemed as the most plausible baseline scenario.

21. The methodology is only applicable if the baseline scenario is the continuation of the current situation, that is no interconnection is constructed and electricity demand of the isolated grid is meeting by power units connected to the isolated grid.

5.3. Additionality

22. The latest version of the "Tool for the demonstration and assessment of additionality" shall be applied.

23. In applying Step 4, the latest similar activities undertaken in the sector shall be described (including disclosing non-confidential information about the PP's latest similar activities, if any, when they were undertaken, what has changed since then, etc.).

24. Existing policy incentives and public subsidies granted to the project activity shall be explicitly stated and included in the assessment of additionality.

5.4. Baseline emissions

25. Baseline emissions shall be determined based on: (i) the net quantity of electricity generated in the main grid and delivered to the previously isolated grid as a result of the project activity; (ii) the quantity of electricity transferred from the previously isolated grid to the grid(s) other than the main grid; and (iii) the baseline emission factor of the previously isolated grid.

26. For the monitoring period *m* baseline emissions shall be determined applying the following equation:

$$BE_m = \left(EG_{main\_grid} - EG_{isol\_grid\_export}\right) \times EF_{BL.CO2,m} \qquad \text{Equation (1)}$$

Where:

BE_m	=	Baseline emissions during the monitoring period *m* (t CO_2)
EG_{main_grid}	=	Net quantity of electricity delivered to the previously isolated grid through the interconnection during the monitoring period *m* (MWh)
$EG_{isol\_grid\_export}$	=	Quantity of electricity transferred from the previously isolated grid to the grid(s) other than the main grid (MWh)
$EF_{BL,CO2,m}$	=	Baseline CO_2 emission factor for the previously isolated grid during the monitoring period *m* (t CO_2/MWh)

27. For the first and the fixed crediting period:

$$EF_{BL,CO2,m} = EF_{isol,grid,CM} \quad \text{Equation (2)}$$

Where:

$EF_{isol\_grid,CM}$	=	Combined margin CO_2 emission factor for the previously isolated grid during the monitoring period *m* (t CO_2/MWh)

28. The emission factor of the previously isolated grid should be calculated ex ante using the latest version of the "Tool to calculate the emission factor for an electricity system".

29. In the case of future planned project activity, the emission factor of the previously isolated grid is estimated by applying the "Tool to calculate the emission factor for an electricity system" and using three years data prior the time of publication of PDD for global stakeholders' consultations. However, during the first project activity verification the emission factor of the previously isolated grid shall be recalculated and the final figure shall be defined as the most conservative one between both figures, estimated at the time of PDD publication and at the time of interconnection.

30. For the project activities applying for renewable crediting period the $EF_{BL,CO2,m}$ should be considered as minimum between EF1 & EF2:

    (a) **EF1** - The build margin, calculated according to the "Tool to calculate emission factor for an electricity system*"* for previously isolated grid based on the updated data till the interconnection is established due to project activity;

    (b) **EF2 - Option A** - Modelling of the previously isolated electricity system's performance should be performed. The model would be run ex post using as an input the electricity demand level and pattern observed in the grid and would indicate how this respective demand would be met by the power plants in the absence of the transmission line. This output could then be used to estimate the emissions corresponding to the baseline situation. The emission factor will be the emission factor of set of the power plants (grid mix) which would be determined by the modelling. It is required that simulation models as described are available in the host country and transparently documented;

(c) **EF2 - Option B** - Emission factor is calculated as per the following procedure:

(i) Step 1: Determine the additional amount of electricity supplied in the previously isolated during the last year of the crediting period $(EG_{main\_grid} - EG_{isol\_grid\_export})$;

(ii) Step 2: Identify all the plants that have been built in the previously isolated grid during the crediting period;

(iii) Step 3: Identify the options for set of power plants which would have built to supply the additional amount of energy identified in Step 1. The set of power plants should include the set of plants identified in Step 2. The options to be considered can be previous trend in the isolated grid or any other cost effective options available on 7th and 14th year;

(iv) Step 4: Calculate the emission factor of all the alternatives of set of power plants and emission factor of least emission alternative should be considered.

5.5. Project emissions

31. Project emissions include:

(a) Emissions from the increase in generation of electricity by power units in the main grid for the purpose of transferring electricity to the previously isolated grid;

(b) Emissions from the generation of electricity by power units in the previously isolated grid, which occur when electricity is delivered from the previously isolated grid to the main grid;

(c) Emissions of SF_6 from equipment that is installed due to the project activity.

32. Project emissions during the monitoring period *m* are calculated as follows:

$$PE_m = PE_{main\_grid,m} + PE_{isol\_grid,m} + PE_{SF6,m} \quad \text{Equation (3)}$$

Where:

PE_m	=	Project emissions during the monitoring period *m* (t CO_2)
$PE_{main\_grid,m}$	=	Project emissions in the main grid due to the delivery of electricity to the previously isolated grid during the monitoring period *m* (t CO_2)
$PE_{isol\_grid,m}$	=	Project emissions in the previously isolated grid due to the delivery of electricity to the main grid during the monitoring period *m* (t CO_2)
$PE_{SF6,m}$	=	Project emissions of SF_6 from new equipment (e.g. transformers) installed under the project activity during the monitoring period *m* (t CO_2e)

5.5.1. Project emissions from electricity delivery to the previously isolated grid

33. Emissions related to electricity transfer to the previously isolated grid shall be calculated based on: (i) the net quantity of electricity generated in the main grid and delivered to the previously isolated grid as a result of the project activity; (ii) the quantity of electricity transferred from the previously isolated grid to the grid(s) other than the main grid; and (iii) on the emission factor of the main grid. The approach on how the emission factor of the main grid shall be determined is based on the following assumptions:

    (a) The main grid uses the most efficient power units, in terms of marginal cost, to satisfy its own demand first. Therefore, units with higher marginal costs are used to generate the electricity to be delivered;

    (b) Low cost/must-run units are not generating electricity to be delivered to the previously isolated grid;

    (c) Possible methane emissions from big reservoirs will occur anyway even if the project activity is not implemented, as these emissions are unlikely to depend significantly on the amount of power generated in these plants;

    (d) Electricity generated from hydropower units could be assumed to be delivered to the previously isolated grid if the interconnection can result in an increase in electricity generation from hydro power. This is only the case if there is an excess of the water resource available at the time when electricity is delivered (e.g. water is spilled).

34. Two options are provided to determine these emissions.

5.5.1.1. Option 1: Approach based on the assessment of the power units at the merit order in the main grid

35. In applying this option, the emission factor is determined based on the economic merit order data from the dispatch center using a step-wise approach provided below.

36. The approach is based on the concept of the shift of hydro resources over the time. The interconnection of two grids does not necessarily imply that more electricity from hydropower units is generated, but it could only result in shifts when electricity from hydropower units is generated. For example, if electricity would be supplied via the interconnection from a hydro dominated grid during the wet season only, it would be generated purely by hydro plants. However, during the dry season when no electricity may be supplied to the previously isolated grid the main grid may need to use more fossil fuels to cover the shortage of water in the reservoirs.

37. In order to include hydropower units in the determination of the emission factor, excess of the water resource shall be demonstrated. It shall be done by providing information regarding water spillage in the main grid.

38. This approach uses ex post merit order data from the dispatch center of the main grid and can only be applied if the necessary data is available.

39. Hourly data shall be used if such data is available from the dispatch center. Daily data may be used if it can be demonstrated that hourly data are not available. The project emissions are determined through the following steps:

5.5.1.1.1. Step A: Identify power units that generate electricity in each hour/day in the main grid

40. For each hour/day when electricity is delivered to a previously isolated grid:

    (a) Identify all power units located in the main grid that supplied electricity to the grid during the hour or day;

    (b) Exclude from the set of power units identified in Sub-step (a) the following types of power units: (i) must-run units; and (ii) power units at which CDM projects were registered;

    (c) Rank the remaining dispatched power units after Sub-step (b) by decreasing economic merit order (in $/kWh);

    (d) Start from the power unit with the higher cost of generation and select the set of power units required to cover the hourly/daily amount of electricity delivered to the previously isolated grid.

41. Electricity delivered to the main grid from another country, i.e. import from another country, shall be accounted.

42. If the total energy imported is less than five per cent of total electricity generated in the main grid, then disregard the possible emissions.

43. Otherwise the possible effect on emissions from import should be accounted as follows: (i) determine the amount of transfer per hour/day (in kWh); (ii) use the cost of import (in $/kWh) to rank electricity delivered, assuming the energy was produced by a single power unit; and (iii) use the operating margin emission factor (t CO_2/MWh) for the grid where electricity is generated.

5.5.1.1.2. Step B: Identify the type of the set of power units

44. The set of power units identified in the previous step may consist of: (a) only fossil fuel fired units; (b) a mix of fossil fuel fired units and hydro power units; or (c) only hydro power units.

45. For each hour/day where hydro power unit(s) are included in the set, assess whether any water was reported to be spilled[2] in the main grid during that hour or day.

46. Based on this assessment, for each hour or day of the monitoring period m, determine which of the following two configurations applies:

    (a) Configuration 1:

        (i) All power units identified in Step A are fossil fuel fired units;

        (ii) All power units identified in Step A are hydro power units and water was spilled during the hour or day;

        (iii) A mix of fossil fuel fired units and hydro power units were identified in Step A and water was spilled during the hour or day.

[2] Spilled water (in m3/s) in the main grid by hydropower plants.

(b) Configuration 2:

(i) All power units identified in Step A are hydro power units and no water was spilled during the hour or day;

(ii) A mix of fossil fuel fired units and hydro power units were identified in Step A and no water was spilled during the hour or day.

5.5.1.1.3. Step C: Calculate the emission factor

5.5.1.1.3.1 Sub-step C.1: The hourly/daily set of power units belongs to configuration 1

47. In this situation, excess water is available for power generation during the hour or day or any hydropower unit has not been identified in the set. It is therefore assumed that the increase of power generation due to the transfer of electricity to the previously isolated grid can (at least partially) be met by an increase in hydro power generation. For this reason, the average emission factor of the identified set of power plants is used for that hour or day.

48. Calculate the weighted (considering electricity generated) average CO_2 emission factor of the set of power plants identified in Step A above for the hour or day *g*, as follows:

$$EF_{main\_grid\ g} = \frac{\sum_n \left(EG_{n,g} \times EF_{EL,n,g}\right)}{\sum_n EG_{n,g}} \quad \text{Equation (4)}$$

Where:

$EF_{main\_grid,g}$	=	CO_2 emission factor for the set of the grid power units in the hour/day *g* during the monitoring period *m* (t CO_2/MWh)
$EG_{n,g}$	=	Net quantity of electricity generated and dispatched to the main grid by power unit n in the hour/day g during the monitoring period *m* (MWh)
$EF_{EL,n,g}$	=	CO_2 emission factor of the grid power unit n in the hour/day *g* during the monitoring period *m* (t CO_2/MWh)
g	=	Hour/day during the monitoring period m, where the set of power units belongs to configuration 1
n	=	Power unit included in the hourly/daily set

49. Emission factor of the grid power unit n can be determined in accordance with Option A (excluding Option A.3) provided for the simple OM determination which is outlined in the latest version of the "Tool to calculate the emission factor for an electricity system".

5.5.1.1.3.2 Sub-step C.2: The hourly/daily set of power units belongs to configuration 2

50. The set of power units in configuration 2 reflects a situation where no excess of water is available. In other words, in the absence of the project activity water wouldn't be spilled but could be used later to cover demand of the main grid. Therefore, hydropower plants shall be excluded from the set of units used to calculate the emission factor.

51. Calculate the weighted (considering electricity generated) average of the emission factors corresponding to the hourly/daily set d of fossil fuels power units, as follows:

$$EF_{main\_grid,d} = \frac{\sum_l \left(EG_{l,d} \times EF_{EL,l,d}\right)}{\sum_l EG_{l,d}} \quad \text{Equation (5)}$$

Where:

$EF_{main\_grid,d}$	=	CO_2 emission factor for the set of the grid fossil fuel power units in the hour/day *d* during the monitoring period *m* (t CO_2/MWh)
$EG_{l,d}$	=	Amount of electricity generated and dispatched to the main grid by the fossil fuel power unit *l* in the hour/day *d* during the monitoring period *m* (MWh)
$EF_{EL,l,d}$	=	CO_2 emission factor of grid power unit *l* in the hour/day *d* during the monitoring period *m* (t CO_2/MWh)
d	=	Hour/day during the monitoring period *m*, where the set of power units belongs to configuration 2
l	=	Fossil fuels power unit included in the hourly/daily set

52. Emission factor of the grid power unit *l* can be determined in accordance with Option A (excluding Option A.3) provided for the simple OM determination which is outlined in the latest version of the "Tool to calculate the emission factor for an electricity system".

5.5.1.1.4. Step D: Account for the shift of hydro recourses

53. The configuration 2 of daily/hourly set of power units reflects the situation where water is used to generate the electricity and delivery it to the previously isolated grid, while in the baseline this resource could be used to meet own demand of the main grid, but later in time.

54. To account for this possible effect the average emission factor corresponding to all fossil fuel fired power units of the main grid shall be applied to the amount of electricity that was generated by hydro power units and delivered to the previously isolated grid during the hour or day that belongs to configuration 2.

55. For the last monitoring period in the year or for the monitoring period with the length equal to the length of the annual report from the dispatch centre the following steps shall be applied.

5.5.1.1.4.1 Sub-step D.1: Account for the limited availability of hydro resources

56. For the year *y* calculate the difference between the amount of electricity delivered to the previously isolated grid and the amount of electricity generated by the set of fossil fuel power units during the days/hours where no spillage of water was identified:

$$EG_{diff,y} = \frac{\sum_d \left(EG_{main\_grid,d} - \sum_l EG_{l,d}\right)}{\left(1 - TL_{main\_grid}\right)} \quad \text{Equation (6)}$$

Where:

$EG_{diff,y}$	=	Difference between the amount of electricity delivered to the previously isolated grid and amount of electricity generated by the set of fossil fuel power units *l* during the year *y* (MWh)
$EG_{main\_grid,d}$	=	Net quantity of electricity delivered to the previously isolated grid in the hour/day *d* during the monitoring period *m* (MWh)
$EG_{l,d}$	=	Net quantity of electricity generated and delivered to the main grid by grid fossil fuel power unit *l* in the hour/day *d* during the monitoring period *m* (MWh)
TL_{main_grid}	=	Transmission losses related to electricity (ratio of generated and delivered) transfer within the boundaries of the main grid during the monitoring period *m* (%)
d	=	Hour/day during the monitoring period *m*, where the set of power units corresponds to configuration 2
l	=	Fossil fuels power unit included in the hourly/daily set

5.5.1.1.4.2 Sub-step D.2: Calculate the annual average emission factor of fossil fuel fired power units

57. Calculate the annual weighted (considering electricity generated) average emission factor corresponding to all fossil fuel fired power units, excluding must-run power units, dispatched to the main grid during the year y to estimate the emission factor $EF_{avg,y}$:

$$EF_{avg,y} = \frac{\sum_k EG_k \times EF_{EL,k}}{\sum_k EG_k} \quad \text{Equation (7)}$$

Where:

$EF_{avg,y}$	=	CO_2 emission factor for grid fossil fuel power units dispatched to the main grid during the year *y* (t CO_2/MWh)
EG_k	=	Net quantity of electricity generated and delivered to the main grid by grid fossil fuel power unit *k* during the year *y* (MWh)
$EF_{EL,k}$	=	CO_2 emission factor of grid fossil fuel power unit *k* during the year *y* (t CO_2/MWh)
k	=	Fossil fuels power unit connected to the main grid during the year *y*, excluding must-run generation

58. Emission factor of the grid power unit k can be determined in accordance with Option A (excluding Option A.3) provided for the simple OM determination which is outlined in the latest version of the “Tool to calculate the emission factor for an electricity system”.

5.5.1.1.5. Step E: Calculate project emissions from electricity delivered to the previously isolated grid

59. In case monitoring periods have shorter duration than year, approach on how project emissions from electricity delivered to the previously isolated grid shall be determined is

different for the last monitoring period of the year *y* compared to the other monitoring periods over the year.

60. For (i) each monitoring period *m* that have shorter duration than year, except the last monitoring period of the year *y*, or for (ii) the monitoring period with the length equal to the length of the annual report from the dispatch centre project emissions related to electricity delivered to the previously isolated grid shall be calculated accounting for the days/hours *g* and *d*, where days/hours *g* corresponds to configuration 1 set of power units, while days/hours *d* corresponds to configuration 2 set of power units:

$$PE_{main\_grid,m} = \sum_{g} PE_{main\_grid,g} + \sum_{d} PE_{main\_grid,d} \quad \text{Equation (8)}$$

61. For the last monitoring period *m* of the year *y* project emissions related to electricity delivered to the previously isolated grid shall be calculated taking into account effect of shortage of hydro resources, as follows:

$$PE_{main\_grid,m} = \sum_{g} PE_{main\_grid,g} + \sum_{d} PE_{main\_grid,d} + EG_{diff,y} \times EF_{avg,y} \quad \text{Equation (9)}$$

With:

$$PE_{main\_grid,g} = \frac{EF_{main\_grid,g} \times \left(EG_{main-grid,g} - EG_{isol\_grid\_export,g}\right)}{\left(1 - TL_{main\_grid}\right)} \quad \text{Equation (10)}$$

$$PE_{main\_grid,d} = EF_{main\_grid,d} \times \sum_{l} \left[\frac{EG_{l,d}}{1 - \left(TL_{main\_grid}\right)}\right] \quad \text{Equation (11)}$$

Where:

$PE_{main\_grid,m}$	=	Project emissions in the main grid due to the delivery of electricity to the previously isolated grid during the monitoring period *m* (t CO_2)
$PE_{main\_grid,g}$	=	Project emissions from electricity delivered to the previously isolated grid during the hour/day g during the monitoring period *m* (t CO_2e)
$PE_{main\_grid,d}$	=	Project emissions from electricity delivered to the previously isolated grid during the hour/day *d* during the monitoring period *m* (t CO_2e)
m	=	Monitoring period during the year *y*

$EF_{main\_grid,g}$	=	CO_2 emission factor for the set of the grid power units in the hour/day *g* during the monitoring period *m* (t CO_2/MWh)
$EG_{main\_grid,g}$	=	Net quantity of electricity delivered to the previously isolated grid in the hour/day *g* during the monitoring period *m* (MWh)
$EG_{isol\_grid\_export,g}$	=	Amount of electricity transferred from the previously isolated grid to the grid(s) other than the main grid in the hour/day *g* during the monitoring period *m* (MWh)
g	=	Hour/day during the monitoring period *m* of the year *y*, where the set of power units belongs to configuration 1
$EG_{diff,y}$	=	Difference between the amount of electricity delivered to the previously isolated grid and amount of electricity generated by the set of fossil fuel power units *l* during the year *y* (MWh)
$EF_{main\_grid,d}$	=	CO_2 emission factor for the set of the grid power units in the hour/day *d* during the monitoring period *m* of the year *y* (t CO_2/MWh)
$EG_{l,d}$	=	Amount of electricity generated and dispatched to the main grid by grid power unit *l* in the hour/day *d* during the monitoring period *m* (MWh)
$EF_{avg,y}$	=	CO_2 emission factor for grid fossil fuel power units in year *y* (t CO_2/MWh)
TL_{main_grid}	=	Transmission losses related to electricity (ratio of generated and delivered) transfer within the boundaries of the main grid during the monitoring period *m* (%)
d	=	Hour/day during the monitoring period *m*, where the set of power units belongs to configuration 2
l	=	Fossil fuels power unit included in the hourly/daily set

5.5.1.2. Option 2: Approach based on the most GHG intensive power units

62. In applying this option, emissions are determined using the amount of electricity delivered to the previously isolated grid and the emission factor of the main grid. The approach on how the emission factor shall be determined is based on the weighted average emission factor for the set of the most GHG intensive power units that required to cover the amount of electricity delivered to the previously isolated grid.

63. This option is only applicable if the length of a monitoring period is chosen to be equal to the length of annual report from the dispatch centre. The first monitoring period could be shorter than one year because of the start date of the crediting period, but shall end the same date annual report from the dispatch centre ends.

64. The following steps shall be applied in order to determine the annual project emissions attributable to electricity delivered to the previously isolated grid:

    (a) List all fossil fuel fired power units in the main grid, excluding: (i) must-run power units; and (ii) power units where CDM projects were registered;

    (b) Determine the emission factor of each power unit in the list $EF_{EL,q}$;

(c) Rank all power units based on their emission factor;

(d) Determine the amount of electricity generated by all power units, which is defined in Step 1. If data is not available, the amount of electricity generated and dispatched to the main grid by power unit *q* can be determined based on the installed capacity of the power unit and assumption that it can run for 6000h at full load as follows:

$$EG_q = IC_q \times 6000 \quad \text{Equation (12)}$$

Where:

EG_q = Net quantity of electricity generated and dispatched to the main grid by the power unit *q* in the year *y* (MWh)

IC_q = Installed capacity of the power unit *q* (MW)

(e) Start on the top (the plant with the most GHG intensive emission factor) and select the set of power units required to cover the amount of electricity delivered to the previously isolated grid during the monitoring period *m*. Electricity delivered to the main grid from another country, that is import, should be accounted as one power unit based on: (i) the amount of transfer per hour/day (in kWh); and (ii) operating margin emission factor (t CO_2/MWh) for the grid where electricity is generated;

(f) Calculate the weighted (considering electricity generated) average emission factor of the set of fossil fuel fired power units identified in Sub-step (e) above, as follows:

$$EF_{main\_grid} = \frac{\sum_q EG_q \times EF_{El,q}}{\sum_q EG_q} \quad \text{Equation (13)}$$

Where:

EF_{main_grid} = CO_2 emission factor for the electricity delivered to the previously isolated grid during the monitoring period m (t CO_2/MWh)

EG_q = Net quantity of electricity generated and dispatched to the main grid by power unit *q* during the monitoring period *m* (MWh)

$EF_{EL,q}$ = CO_2 emission factor of power unit *q* during the monitoring period *m* (t CO_2/MWh)

65. Emission factor of the grid power unit *q* can be determined in accordance with Option A (excluding Option A.3) provided for the simple OM determination which is outlined in the latest version of the "Tool to calculate the emission factor for an electricity system".

(a) Annual project emissions attributable to the amount of electricity delivered to the previously isolated grid shall be calculated as follows:

$$PE_{main\_grid,m} = \left(EG_{main\_grid} - EG_{isol\_grid\_export}\right) \times EF_{main\_grid} \quad \text{Equation (14)}$$

Where:

$PE_{main\_grid,m}$ = Project emissions in the main grid due to the transfer of electricity to the previously isolated grid during the monitoring period *m* (t CO_2)

EG_{main_grid} = Net quantity of electricity delivered to the previously isolated grid through the interconnection during the monitoring period *m* (MWh)

$EG_{isol\_grid\_export}$ = Quantity of electricity transferred from the previously isolated grid to the grid(s) other than the main grid (MWh)

EF_{main_grid} = CO_2 emission factor for the electricity delivered to the isolated grid during the monitoring period *m* (t CO_2/MWh)

5.5.2. Project emissions from electricity generated in the isolated grid and delivered to the main grid

66. Emissions that occur when electricity is generated in the previously isolated grid and delivered to the main grid shall be accounted and calculated based on the amount of electricity delivered to the main grid and on the operating margin emission factor of the previously isolated grid calculated ex ante by using the latest version of the "Tool to calculate the emission factor for an electricity system".

$$PE_{isol\_grid,m} = \frac{EG_{isol\_grid} \times EF_{isol\_grid,OM}}{\left(1 - TL_{isol\_grid}\right)} \quad \text{Equation (15)}$$

Where:

$PE_{isol\_grid,m}$ = Project emissions in the previously isolated grid due to the transfer of electricity to the main grid during the monitoring period *m* (t CO_2)

EG_{isol_grid} = Net quantity of electricity generated by plants of the previously isolated grid and delivered to the main grid during the monitoring period *m* (MWh)

TL_{isol_grid} = Transmission losses related to electricity transfer within the boundaries of the previously isolated grid during the monitoring period *m* (%)

$EF_{isol\_grid,OM}$ = Operating margin CO_2 emission factor for the previously isolated grid during the monitoring period m (t CO_2/MWh)

5.5.3. Project emissions of SF_6 from equipment installed under the project activity

67. Emissions of SF_6 from new equipment installed under the project activity during the monitoring period *m* ($PE_{SF6,m}$), in tonnes of CO_2e, are calculated as follows:

$$PE_{SF6,m} = M_{SF6} \times GWP_{SF6} \quad \text{Equation (16)}$$

Where:

$PE_{SF6,m}$ = Project emissions of SF_6 from new equipment (e.g. transformers) installed under the project activity during the monitoring period *m* (t CO_2e)

M_{SF6} = The average quantity of SF_6 emitted from equipment installed under the project activity during the monitoring period *m* (t SF_6)

GWP_{SF6} = Global warming potential of SF_6 (t CO_2e/t SF_6)

68. Determination of $PE_{SF6,m}$ can be excluded from the ex ante estimation of emission reductions at the time of validation.

5.6. Leakage

69. Project activities applying this methodology may result in deforestation due to the construction of transmission lines. This shall be accounted as a one-time leakage and determined using the following procedure:

(a) Divide the transmission line into segments not exceeding 5km, and attribute each segment the type of vegetation (forest land, grassland, cropland, etc.) and location (tropical/temperate, wet/dry), according to classifications cited in IPCC 2006 Guidelines, Volume 4;

(b) If the segment can be classified as forest land, then calculate the area of segment deforested on the basis of the length of segment deforested for segment *i* ($L_{DEF,i}$) and average width of segment deforested for segment *i* ($W_{DEF,i}$);

(c) Assign a default value for aboveground biomass for segment *i* ($M_{A,i}$) to be deforested for each segment, on the basis of conservative interpretation of tables 4.7 and 4.8 of IPCC 2006 Guidelines, Volume 4, chapter 4;

(d) Calculate the total leakage due to deforestation as follows:

$$LE_1 = \sum_i \left(L_{DEF,i} \times W_{DEF,i} \times M_{A,i} \times 0.5 \times \frac{44}{12} \right) \quad \text{Equation (17)}$$

Where:

LE_1 = Leakage emissions during the first monitoring period (t CO_2)

$L_{DEF,i}$ = Length deforested for segment *i* (100m)

$W_{DEF,i}$ = Width deforested for segment *i* (100m)

$M_{A,i}$ = Aboveground biomass of land to be deforested for segment *i* (tonnes d.m./ha)

0.5 = Carbon fraction of dry matter (t-C/tonnes d.m.)

i = Segment of transmission line

70. Alternatively, if the information is required by the local regulation, it can be also used to determine the total area for each vegetation type and appropriately determine the total aboveground biomass to be deforested for the whole project, instead of performing

Steps 1-3. In this case the total aboveground biomass to be deforested has to be multiplied by (0.5x44/12) to determine leakage emissions.

5.7. Emission reductions

71. Emission reductions are calculated as follows:

$$ER_m = BE_m - PE_m - LE_1 \quad \text{Equation (18)}$$

Where:

ER_m = Emission reductions during the monitoring period *m* (t CO_2)

BE_m = Baseline emissions during the monitoring period *m* (t CO_2)

PE_m = Project emissions during the monitoring period *m* (t CO_2)

LE_1 = Leakage emissions during the first monitoring period (t CO_2)

5.8. Changes required for methodology implementation in 2nd and 3rd crediting periods

72. Refer to the latest approved version of the "Assessment of the validity of the original/current baseline and update of the baseline at the renewal of the crediting period".

5.9. Data and parameters not monitored

73. In addition to the parameters listed in section 5.9 below, the provisions on data and parameters not monitored in the tools referred to in this methodology apply.

Data / Parameter table 1.

Data / Parameter:	$EF_{isol\ grid,CM}$
Data unit:	t CO_2/MWh
Description:	Combined margin CO_2 emission factor for the previously isolated grid during the monitoring period *m* (t CO_2/MWh)
Source of data:	-
Value to be applied:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	*EFisol_grid,OM*
Data unit:	t CO_2/MWh
Description:	Operating margin CO_2 emission factor for the previously isolated grid during the monitoring period m (t CO2/MWh)
Source of data:	-
Value to be applied:	-
Any comment:	-

Data / Parameter table 3.

Data / Parameter:	$L_{DEF,i}$
Data unit:	100m
Description:	Length deforested for segment *i*
Source of data:	-
Value to be applied:	-
Any comment:	-

Data / Parameter table 4.

Data / Parameter:	$W_{DEF,i}$
Data unit:	100m
Description:	Width deforested for segment *i*
Source of data:	-
Value to be applied:	-
Any comment:	-

Data / Parameter table 5.

Data / Parameter:	$M_{A,i}$
Data unit:	tonnes d.m./ha
Description:	Aboveground biomass of land to be deforested for segment *i*
Source of data:	-
Value to be applied:	-
Any comment:	-

Data / Parameter table 6.

Data / Parameter:	GWP_{SF6}
Data unit:	t CO_2e/t C_2F_6
Description:	Global Warming Potential of SF_6
Source of data:	Relevant CMP decisions
Value to be applied:	Project participants shall update GWPs according to any decisions by the CMP. For the first commitment period GWP_{SF6}=23,900
Any comment:	The value applied is valid for the first commitment period

6. Monitoring methodology

74. All data collected as part of monitoring should be archived electronically and be kept at least for two years after the end of the last crediting period. One hundred per cent of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

75. In addition, the monitoring provisions in the tools referred to in this methodology apply.

6.1. Data and parameters monitored

Data / Parameter table 7.

Data / Parameter:	$EG_{main\ grid}$
Data unit:	MWh
Description:	Net quantity of electricity delivered to the previously isolated grid through the interconnection during the monitoring period *m*
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the main grid where it connected to the transmission line(s)
Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured
Any comment:	The beginning (points of connection to the main grid) and the end (points of connection to the previously isolated grid) of the transmission lines shall be identified. Electricity delivered to the previously isolated grid is measured at the beginning of the transmission line (without losses in interconnection line)

Data / Parameter table 8.

Data / Parameter:	$EG_{isol\ grid\ export}$
Data unit:	MWh
Description:	Quantity of electricity transferred from the previously isolated grid to the grid(s) other than the main grid
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the previously isolated grid where it connected to the transmission line(s)
Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured

Any comment:	The beginning (points of connection to the previously isolated grid) and the end (points of connection to the grid other than the main grid) of the transmission lines shall be identified. Electricity transferred from the previously isolated grid is measured at the beginning of the transmission line (without losses in interconnection line). Parameter shall be monitored only in case the previously isolated grid is connected to any grid other than the main grid during the crediting period

Data / Parameter table 9.

Data / Parameter:	$EG_{n,g}$
Data unit:	MWh
Description:	Net quantity of electricity generated and dispatched to the main grid by the power unit *n* in the hour/day *g* during the monitoring period *m*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-
Monitoring frequency:	Hourly or daily
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 10.

Data / Parameter:	$EF_{EL,n,g}$
Data unit:	t CO_2/MWh
Description:	CO_2 emission factor of the grid power unit *n* in the hour/day *g* during the monitoring period *m*
Source of data:	Publicly available official statistics or calculation
Measurement procedures (if any):	-
Monitoring frequency:	Hourly or daily
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 11.

Data / Parameter:	$EG_{l,d}$
Data unit:	MWh
Description:	Amount of electricity generated and dispatched to the main grid by the fossil fuel power unit *l* in the day *d* during the monitoring period *m*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-
Monitoring frequency:	Hourly or daily
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 12.

Data / Parameter:	$EF_{EL,l,d}$
Data unit:	t CO_2/MWh
Description:	CO_2 emission factor of grid power unit *l* in the day *d* during the monitoring period *m*
Source of data:	Publicly available official statistics or calculation
Measurement procedures (if any):	-
Monitoring frequency:	Hourly or daily
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 13.

Data / Parameter:	$EG_{main\ grid,g}$
Data unit:	MWh
Description:	Net quantity of electricity delivered to the previously isolated grid in the hour/day *g* during the monitoring period *m*
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the previously isolated grid where it connected to the transmission line(s)

Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured
Any comment:	The beginning (points of connection to the main grid) and the end (points of connection to the previously isolated grid) of the transmission lines shall be identified. Electricity delivered to the previously isolated grid is measured at the beginning of the transmission line (without losses in the interconnection line)

Data / Parameter table 14.

Data / Parameter:	$EG_{isol\ grid\ export,g}$
Data unit:	MWh
Description:	Amount of electricity transferred from the previously isolated grid to the grid(s) other than the main grid in the hour/day *g* during the monitoring period *m*
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the previously isolated grid where it connected to the transmission line(s)
Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured
Any comment:	The beginning (points of connection to the previously isolated grid) and the end (points of connection to the grid other than the main grid) of the transmission lines shall be identified. Electricity transferred from the previously isolated grid is measured at the beginning of the transmission line (without losses in the interconnection line) Parameter shall be monitored only in case the previously isolated grid is connected to any grid other than the main grid during the crediting period

Data / Parameter table 15.

Data / Parameter:	$TL_{main\ grid}$
Data unit:	-
Description:	Transmission losses related to electricity (ratio of generated and delivered) transfer within the boundaries of the main grid during the monitoring period *m*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-

Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 16.

Data / Parameter:	$EG_{main\ grid,d}$
Data unit:	MWh
Description:	Net quantity of electricity delivered to the previously isolated grid in the hour/day *d* during the monitoring period *m*
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the previously isolated grid where it connected to the transmission line(s)
Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured
Any comment:	The beginning (points of connection to the main grid) and the end (points of connection to the previously isolated grid) of the transmission lines shall be identified. Electricity delivered to the previously isolated grid is measured at the beginning of the transmission line (with losses in the interconnection line)

Data / Parameter table 17.

Data / Parameter:	EG_k
Data unit:	MWh
Description:	Net quantity of electricity generated and delivered to the main grid by grid fossil fuel power unit *k* during the year *y*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 18.

Data / Parameter:	$EF_{EL,k}$
Data unit:	t CO_2/MWh
Description:	CO_2 emission factor of grid fossil fuel power unit *k* during the year *y*

Source of data:	Publicly available official statistics or calculation
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 19.

Data / Parameter:	EG_q
Data unit:	MWh
Description:	Net quantity of electricity generated and dispatched to the main grid by the power unit *q* in the year *y*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 20.

Data / Parameter:	$EF_{EL,q}$
Data unit:	t CO_2/MWh
Description:	CO_2 emission factor of power unit *q* during the monitoring period *m*
Source of data:	Publicly available official data or calculation using default factors
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-

Any comment:	In case it can be demonstrated that official statistics is not available, emission factor can be calculated using: (a) Type of fuel used at power unit and relevant IPCC default value at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories; (b) Relevant IPCC default value of the fuel's emission factor at the upper limit of the uncertainty at a 95% confidence interval as provided in Table 1.3 of Chapter 1 of Vol. 2 (Energy) of the 2006 IPCC Guidelines on National GHG Inventories; (c) Default value of the power unit's efficiency provided by the latest version of the "Tool to calculate the emission factor for an electricity system", annex 1

Data / Parameter table 21.

Data / Parameter:	IC_q
Data unit:	MW
Description:	Installed capacity of the power unit *q*
Source of data:	Publicly available official data
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 22.

Data / Parameter:	EG_{isol_grid}
Data unit:	MWh
Description:	Net quantity of electricity generated by plants of the previously isolated grid and delivered to the main grid during the monitoring period *m*
Source of data:	Electricity meter
Measurement procedures (if any):	Shall be measured at substation(s) within the boundary of the main grid where it connected to the transmission line(s)

Monitoring frequency:	Continuously
QA/QC procedures:	Directly measured
Any comment:	The beginning (points of connection to the main grid) and the end (points of connection to the previously isolated grid) of the transmission lines shall be identified. Electricity delivered to the main grid is measured at the end of the transmission line (without losses in the interconnection line)

Data / Parameter table 23.

Data / Parameter:	$TL_{isol\ grid}$
Data unit:	-
Description:	Transmission losses related to electricity transfer within the boundaries of the previously isolated grid during the monitoring period *m*
Source of data:	Publicly available official statistics
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 24.

Data / Parameter:	$M_{SF6,m}$
Data unit:	-
Description:	The average quantity of SF_6 emitted from equipment installed under the project activity during the monitoring period *m*
Source of data:	Supplier receipts and purchase records
Measurement procedures (if any):	Extra amount of SF_6 injected in the equipments to maintain their operation standards each year
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 25.

Data / Parameter:	$EF_{imaingrid,CM}$
Data unit:	t CO_2/MWh
Description:	Combined margin CO_2 emission factor for main grid during the monitoring period *m* (t CO_2/MWh)

Source of data:	"Tool to calculate the emission factor for an electricity system"
Measurement procedures (if any):	"Tool to calculate the emission factor for an electricity system"
Monitoring frequency:	Annually after the 7th year from starting date of crediting period
QA/QC procedures:	-
Any comment:	-

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