Draft baseline and monitoring methodology AM00XX

"Installation of high voltage direct current power transmission line"

I. SOURCES, DEFINITIONS AND APPLICABILITY

Sources

This baseline and monitoring methodology is based on elements from the following proposed new methodology:

- NM0334 "Installation of high efficient technology for power transmission" prepared by Adani Power Limited, India.

This methodology refers to the latest approved versions of the following methodological tools:

- Tool to calculate the emission factor for an electricity system;
- Combined tool to identify the baseline scenario and demonstrate additionality;
- Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period (This tool is annex to the "Procedures for renewal of the crediting period of a registered CDM project activity").

For more information regarding the proposed new methodologies and the tools as well as their consideration by the Executive Board please refer to <http://cdm.unfccc.int/goto/MPappmeth>.

Selected approach from paragraph 48 of the CDM modalities and procedures

"Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment".

Definitions

For the purpose of this methodology, the following definition applies:

Grid/project electricity system. Grid/project electricity system is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be dispatched without significant transmission constraints.

High voltage. High voltage is defined to have range of 69 kV to 765 kV.

HVAC (High Voltage Alternating Current) System. A HVAC power transmission system is an alternating current, long-distance, bulk power transmission system. It transfers the power from the 'point of origin/supply' to the 'point of receipt'.

HVDC (High Voltage Direct Current) System. A HVDC power transmission system is a direct current, long-distance, bulk power transmission system. It connects two separate high voltage AC Systems via a DC link**.** It is used to transfer electrical energy from 'point of origin/supply' to the 'point of receipt'. A HVDC power transmission system consists of three basic parts:

(a) First converter station to convert AC power to DC power (referred to as the rectifier);

(b) Transmission line; and

(c) Second converter station to convert DC power back to AC power (referred to as the inverter).

Point of origin/supply. Point of origin/supply is the site at which power generation occurs, such as power plants.

Point of receipt. Point of receipt is referred to as the point at which power is received by consumer of power or interconnection point in grid from the '**Point of origin/Supply**'.

Right-of-way. Right-of-way is a strip of land that is used to construct, operate, maintain and repair transmission line and its facilities. A transmission line is usually centred in the right-of-way. The width of a right-of-way depends on the voltage of the line and the height of the transmission towers.

Station losses. Station losses are the losses that take place in the equipment installed at the substations and converter stations . These include losses in transformers, filters and converters (rectifiers and inverters), as applicable.

Substation spacing in an HVAC power transmission system**.** Substation spacing in an HVAC power transmission system is the distance between the following:

(a) Point of supply/origin and a substation (if applicable);

(b) Two substations (if applicable);

(c) Substation and point of receipt (if applicable).

Technical losses. Technical losses are the summation of station losses and transmission line losses.

Transmission Line Losses. Transmission line losses are the losses that take place in the transmission line itself. These include losses due to passage of current in the conductors in the line, due to skin effect, due to proximity effect and due to corona effect. These do not include losses that take place in the equipment installed at the sub-stations/converter stations.

Applicability

The methodology is applicable to following project activities.

- Installation of Greenfield HVDC power transmission line/s for transmission of power from point of origin/supply to the point of receipt; or
- Replacement of existing alternating current power transmission line by a new HVDC power transmission line.

The above project activities are restricted to following two situations:

- The electricity is transferred using a HVDC transmission line from a specific power plant to a specific captive user; or
- The electricity is transferred using a HVDC transmission line from a specific power plant to an interconnection point in an existing grid.

The methodology is applicable under the following conditions:

- The site specific conditions and/or regulations shall not mandate the implementation of the HVDC power transmission technology identified as the project activity.
- Project participants shall invest in setting up a HVDC power transmission line and utilize it.
- Project participant shall demonstrate through verifiable data that the right-of-way requirement for the project activity is lesser than that for the baseline activity. The project participants shall use one of the following documents as "verifiable" data for this purpose:
    - Project documents submitted to government authorities for implementation approval;
    - Project documents submitted to financial institutions for appraisal;
    - Project documents certified by chartered engineers.
- In case the project activity is the replacement of an existing alternating current transmission line by a new HVDC transmission line, the existing line should also have supplied electricity between the same point of origin/supply and point of receipt, that the HVDC line installed under the CDM project activity will supply;
- In addition, the applicability conditions included in the tools referred to above apply.

This methodology is not applicable to:

- Project activities that seek to expand or retrofit existing grids by the construction of a new piece of HVDC transmission line :
- Project activities where the site specific conditions and/or regulations prohibit the implementation of HVDC transmission line.

II. BASELINE METHODOLOGY PROCEDURE

Identification of the baseline scenario

Project participants shall identify the most plausible baseline scenario and demonstrate additionality using the latest approved version of the "Combined tool to identify the baseline scenario and demonstrate additionality".

In applying Step 1 of the tool, the realistic and credible alternatives for the project activity are:

B1: Implementation of power transmission technology identical to the project activity without considering CDM

This alternative may be considered when the project participant proposes to implement an energy efficient technology such as a HVDC transmission lines for power transmission from the point of origin/supply to the point of receipt.

B2: Implementation of power transmission technology based on the current trends/practices in the region or country

This alternative may be considered when, in absence of CDM, the project participant proposes to implement a technology which is being commonly practiced in the country/region. For example, high voltage alternating current (HVAC) transmission from point of origin/supply to the point of receipt.

The project participant shall assess and consider all prevailing technologies and designs for power transmission in the region/country. The technologies and designs considered shall comprise those which are capable of meeting the technical requirements of the project scenario.

B3: Continuation of power transmission using existing alternating current transmission line

This baseline alternative is available for CDM projects where an existing alternating transmission line is replaced by a HVDC transmission line, and where in absence of CDM the existing transmission line would have continued supplying the electricity without any modification. The point of origin/supply and point of receipt will remain the same.

B4: Power transmission using the national or regional electricity grid.

This alternative may be realistic and credible if the grid for transmission is available at a comparative cost.

The methodology is applicable only if the most plausible baseline scenario identified using “Combined tool to identify the baseline scenario and demonstrate additionality” is B2 or B3.

Additionality

The latest approved version of the “Combined tool to identify the baseline scenario and demonstrate additionality” should be applied to assess the additionality of the proposed project activity as mentioned above.

This following provides additional guidance on “common practice”, as per . the latest version of the “Combined tool to identify the baseline scenario and demonstrate additionality”.

Collect information on transmission line projects undertaken or implemented in the relevant geographical area during the last five years preceding the start date of the proposed CDM project activity using government data or third party studies (in case government published data is not available). Relevant geographical area is the host country by default, however project participants, with proper justification, may propose a region in the host country if they find it more appropriate.

The information shall comprise of transmission lines that carry amount of power similar to that in the project activity (within +/-50% threshold of the power supplied by HVDC transmission line constructed under CDM project activity) , over a distance similar (within +/-50% threshold of the distance for which HVDC transmission line constructed under CDM project activity) to that in the project activity, and within an investment and regulatory environment as that of the project activity. After collection and analysis of data, the project participants shall have a set of transmission line projects that are similar to the proposed CDM project activity.

If no activities similar to the proposed CDM project activity are found in a period of five years preceding the project activity, the project participants can refer to a ten year data vintage for analysis. If no similar project activities are found in the ten year data as well, the project participants can conclude that the project is not a common practice in the geographical region.

Project boundary

The **spatial extent** of the project boundary encompasses the transmission line from the point of origin/supply to the point of receipt including all the equipments connected to it. Converter stations connected between the terminals are also a part of the project boundary. Point of origin/supply or the power distribution system which occurs after point of receipt will not be a part of the project boundary. The dotted lines in the figures below show the physical delineation of project boundary.

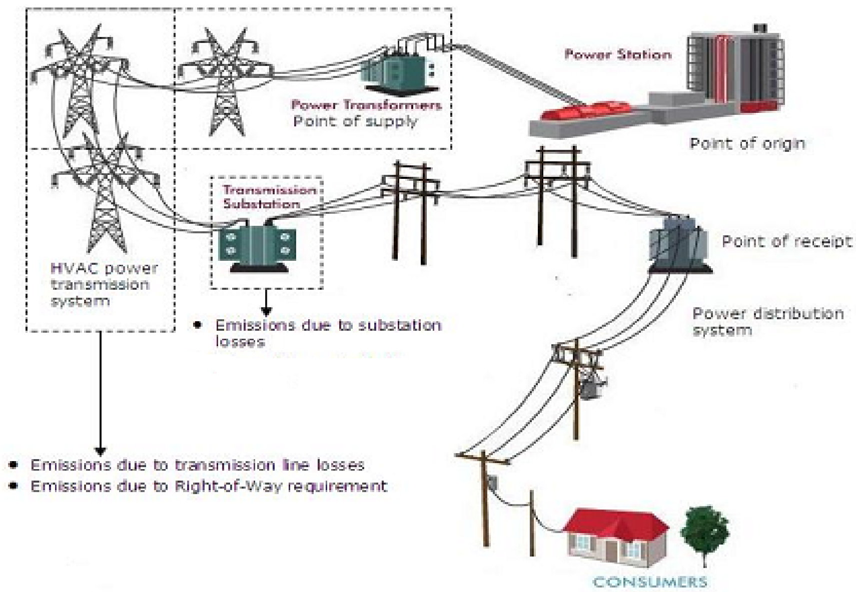


Figure 1: Project boundary in Baseline Scenario

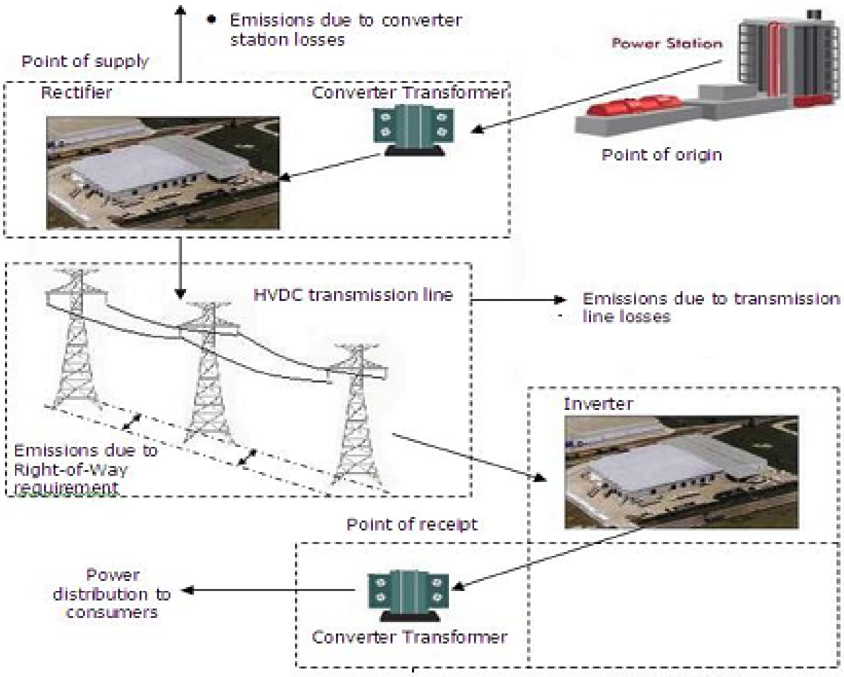


Figure 2: Project Boundary in Project Scenario

The greenhouse gases included in or excluded from the project boundary are shown in Table 1.

Table 1: Emissions sources included in or excluded from the project boundary

Source		Gas	Included?	Justification/Explanation
Baseline	Transmission losses in the power transmission technology identified in the baseline scenario	CO_2	Yes	Major source of emissions
		SF_6	No	These emissions cancel out each other under baseline and project scenario
		CH_4	No	No resulting CH_4 emissions
		N_2O	No	No resulting N_2O emissions
Project activity	Transmission losses in the power transmission technology identified in the project scenario	CO_2	Yes	Major source of emissions
		SF_6	No	These emissions cancel out each other under baseline and project scenario.
		CH_4	No	No resulting CH_4 emissions
		N_2O	No	No resulting N_2O emissions

Project emissions

Project emissions are calculated as follows:

The emissions generated from the project activity are due to technical losses occurring in the power transmission technology employed in the project activity. These losses shall be calculated on the basis of the amount of the gross electrical energy evacuated from the point of origin/supply and the net electrical energy received at the point of receipt of the transmission line. The project emissions will then be calculated as the product of the power transmission losses and the emission factor for the system during the year.

$$PE_y = (E_{evacuated,p,y} - E_{received,p,y}) \bullet EF_{EL,y} \quad \textbf{(1)}$$

Where:

PE_y	=	Emissions due to transmission of electricity using HVDC transmission line (t CO_2)
$E_{evacuated,p,y}$	=	Gross electricity evacuated from the point of origin/supply during year y using the HVDC transmission line built under the project activity (MWh)
$E_{received,p,y}$	=	Net electricity received at the point of receipt of the transmission line during year y (MWh)
$EF_{EL,y}$	=	Emission factor of the electricity supplied through transmission line during year y (t CO_2/MWh)

Baseline emissions

Baseline emissions are calculated as follows.

The baseline emissions are on account of the technical losses occurring in the power transmission system identified as the baseline scenario (scenario B2 and B3) . These will include losses taking place in the transmission line (referred as transmission line loss) and substations which are located between the point of supply and point of receipt (referred as station loss).

The following procedure for calculating baseline emissions shall be adopted.

$$BE_y = \sum_H P_{L,BL,H} \bullet EF_{EL,y} \quad \textbf{(2)}$$

Where:

BE_y	=	Baseline Emissions for the year y t CO_2
$P_{L,BL,H}$	=	Technical losses in the baseline scenario during the hour H of year y (MW)
H	=	Each operational hour in year y.
$EF_{EL,y}$	=	Emission factor of the electricity supplied through transmission line during year y (t CO_2/MWh)

Technical loss in the baseline scenario is calculated as:

$$P_{L,BL,H} = P_{Line,BL,H} + P_{Station,BL,H} \quad \textbf{(3)}$$

Where:

$P_{Line,BL,H}$	=	Losses in the transmission line in the baseline scenario during the hour H of year *y* (MW)
$P_{Station,,BL,H}$	=	Station losses in the baseline scenario during the hour H of year *y* (MW)
$P_{L,BL,H}$	=	Transmission line losses in the baseline scenario during the hour H of year *y* (MW)

Determination of $P_{Station,,BL,H}$ and $P_{L,BL,H}$

For the purpose of an ex-ante estimate for the PDD, the project participant shall calculate station losses and transmission line losses mentioned in equation (3) above as per the simulation of the power transmission line identified as the baseline scenario, using credible assumptions on the loading of the transmission line during the crediting period.

Estimation of ex-post baseline emissions during the crediting period As a part of the proposed monitoring methodology, the project participants will be required to monitor the power evacuated using the transmission line on a continuous basis. The monitored quantum of power exported over a monitoring period will be used to construct the load curve of the dedicated power plant during the same period. The actual loading conditions of the transmission line in the project scenario during the monitoring period will be used for the determination of technical losses using simulation of the baseline transmission line during the same period. This will ensure that the same/actual loading conditions are used for computing transmission losses in both the project and the baseline scenarios.

The ex-post simulation of the baseline transmission line will factor in the losses that would have occurred in the baseline scenario had it been operated on the same load profile as the project transmission line. The simulation provides the value of the parameter $P_{L,BL,H}$ provided in the equation (3) above. The value of $P_{L,BL,H}$ will be calculated for each monitoring period and the value so obtained be used in the equation (2) to compute baseline emissions.

Calculation of station losses and transmission losses using simulation software:[1]

The **station losses** for the HVDC transmission line that would have been implemented in absence of project transmission line, comprise the following two types of losses:

- **Transformer losses** (two components):
  - Core loss. Core losses are again comprised of hysteresis losses and eddy current losses. Hysteresis loss is energy lost by reversing the magnetic field in the core as the magnetizing Alternating Current (AC) rises and falls and reverses direction. Eddy current loss is a result of induced current circulating in the core;
  - Winding loss. The winding loss is a result of the resistance of the windings and is proportional to the square of the current through the transformer.
- **Conductor losses.** The conductor loss in the transmission line is also directly proportional to the square of the amount of current carried by the conductors in the line.

[1] Refer Annex I for the general guidance on simulation software package.

The **transmission line losses** for the AC transmission line that would have been implemented in absence of project transmission line, comprise the following losses:

Please provide definitions of these losses.

Ohmic losses. The passage of current through the conductors (of a transmission line) results in power losses due to resistance of the conductors. This loss is referred to as the ohmic losses.

Reactance losses. Reactive Power Losses refer to those losses which occur as a result of flow of reactive power in a system. The flow of reactive power results in the reduction of the power factor of the system, which in turn results in reduction of transmission of real power. Thus, the term reactive power loss refers to this reduction in transmission of real power.

The simulation software as described in Annex I shall be chosen in order that the following parameters are used to compute station losses and transmission line losses:

(a) **Rated power transformer voltage.** The voltage assigned to be applied, or developed at no-load, between the terminals of an untapped winding, or of a tapped winding connected on the principal tapping. For a three-phase winding it is the voltage between line terminals. This parameter is the key design parameter of a transformer, which in addition to the kVA rating is used to calculate the rated current of the transformer, and therefore, the losses that would occur during the course of operation of the equipment.

(b) **Rated power transformer kVA.** The kVA rating of a transformer is the apparent power handling capability of the transformer. This is a conventional value of apparent power assigned to a winding which, together with the rated voltage of the winding, determines its rated current, which affects the losses that occur in the transformer during course of operation.

(c) **Power transformer ratio.** The power transformer ratio is the ratio of the number of turns in primary winding and secondary winding. This is same as the ratio of primary voltage and secondary voltage.

(d) **Percent exciting current.** The percent exciting current is the value (expressed as percentage of the rated current) of current which primary winding of the transformer draws to develop the magnetic flux sufficient to reach the rated voltage, secondary of the transformer being open circuited.

(e) **Percent impedance .** Short-circuit impedance of a pair of windings is the percentage ratio of "voltage applied to primary winding to maintain rated current in the short circuited secondary winding" and the rated voltage of primary winding.,

Relevance of parameters under points a, b, c, d and e above. All these design parameters are the characteristics of a transformer, and transformer no load and load losses are dependent upon these design parameters. The transformer no-load and load copper losses comprise the total losses that take place in the transformer connected at the sub-station. Further, the transformer losses comprise the bulk of the losses that occur in a substation. The parameters listed above are required to compute the transformer losses at any point the transmission line is in operation.

(f) **No load iron test loss (Watts).** The no load iron test losses are the power losses which are caused due to the hysteresis and eddy currents in the iron core of the transformer. These loads are always present in the transformer when energized irrespective of the loading.

Relevance. These losses are present all the time; this has direct bearing on the terminal station losses.

(g) **Full load copper test loss (Watts).** These are the power losses which occur due to the flow of current in the copper winding and are proportional of the square of the current.

Relevance. These losses vary with respect to the loading on the transformer, and have a direct bearing on the terminal station losses.

(h) **Resistance and reactance per unit length.** The resistance of the transmission line is the ohmic resistance of the line per unit of line length. This is evaluated after considering the proximity and skin effect. This is responsible for the power losses in the line and voltage drop across the line. The resistance is inversely proportional to the area of the conductor and directly proportional to the resistivity of the conductor.

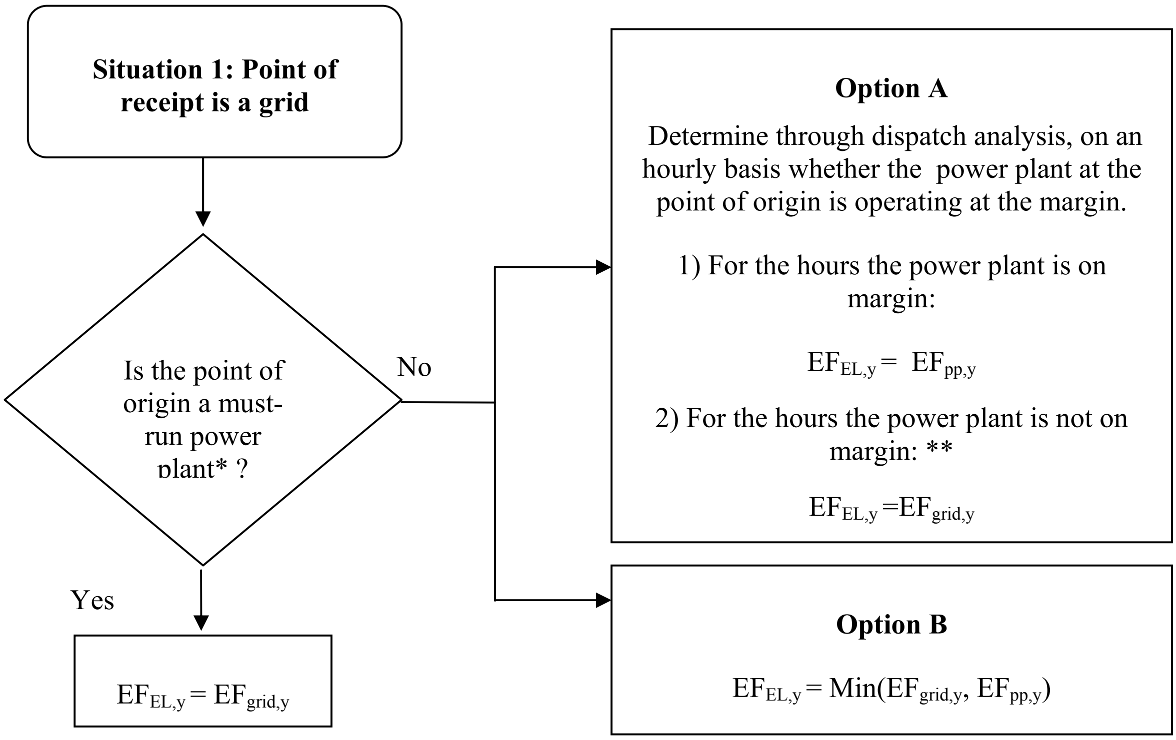
The reactance of the line in combination with the resistance, contributes to the voltage drop across the transmission line.

Relevance. Ohmic losses are directly proportional to the resistance of the power transmission line. This forms major part of the transmission losses. Reactance contributes to voltage drop in the transmission line and is only indirectly related to the loss calculation.

Therefore, the parameters listed above allow for the calculation of losses that occur at the various stages of a power transmission system. i.e. substation and transmission line. The station losses and transmission line losses together represent the technical losses that occur during the transmission phase.

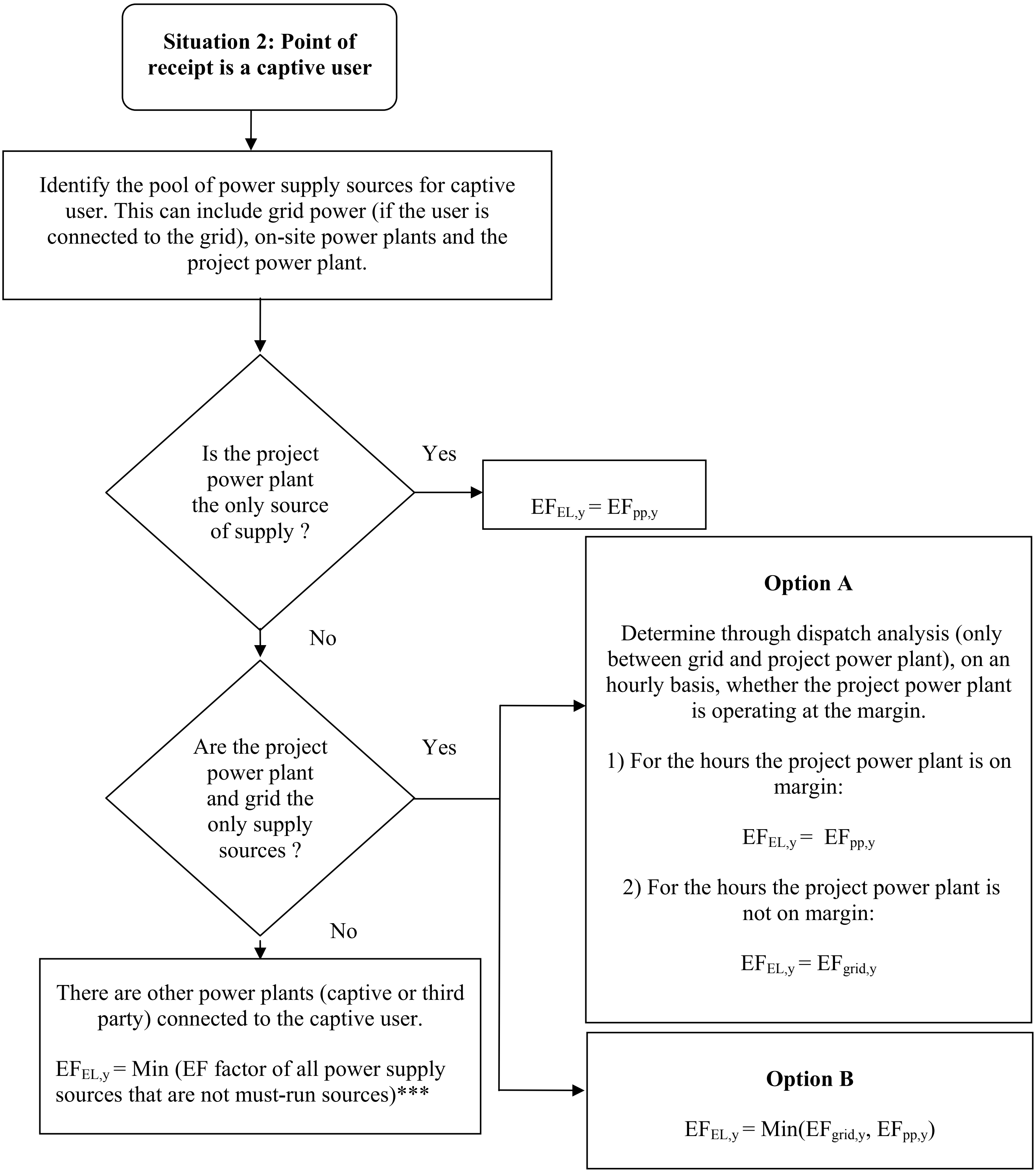
Determination of emission factor of electricity $EF_{EL,y}$

Determination of emission factor $EF_{EL,y}$ depends upon the following two situations:



* Low-cost/must-run plants are defined as power plants with low marginal generation costs or power plants that are dispatched independently of the daily or seasonal load of the grid. They typically include hydro, geothermal, wind, low-cost biomass, nuclear and solar generation. If coal is obviously used as must-run, it is also to be analysed.

** If in the baseline a transmission line with a higher loss would have been built, the project power plant would have operated more hours to compensate for the power loss if it would have been at the margin. If it would not have operated at the margin it can be assumed that other power plants connected to the grid would have supplied the additional electricity to compensate for the loss.



*** Grid is not considered as a must-run supply source and therefore should be included.

Leakage

Leakage is not considered.

Emission reductions

Emission reductions are calculated as follows:

$$ER_y = BE_y - PE_y \tag{4}$$

Where:

ER_y	=	Emission reductions in year y (t CO_2e)
BE_y	=	Baseline emissions in year y (t CO_2e)
PE_y	=	Project emissions in year y (t CO_2e)

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

The requirements of the latest approved version of “Tool to assess the validity of the original/current baseline and to update the baseline at the renewal of a crediting period” shall apply.

Data and parameters not monitored

In addition to the parameters listed in the tables below, the provisions in the section “parameters not monitored” in the tools referred to in this methodology apply.

Data / Parameter:	$V_{TL, BL}$
Data unit:	kV
Description:	Voltage level of the power transmission line as the baseline scenario
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$L_{TL,BL}$
Data unit:	Km
Description:	Length of the power transmission line identified as the baseline scenario
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$H_{TL,BL}$
Data unit:	Henry/meter
Description:	Inductance of the power transmission line identified as the baseline scenario
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	$C_{TL,BL}$
Data unit:	Farad/meter
Description:	Capacitance of the power transmission line identified as the baseline scenario
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	-

Data / Parameter:	SS
Data unit:	km
Description:	Sub-station spacing
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	-

III. MONITORING METHODOLOGY

All data collected as part of monitoring should be archived electronically and be kept at least for 2 years after the end of the last crediting period. 100% of the data should be monitored if not indicated otherwise in the tables below. All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

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

Data and parameters monitored

Data / Parameter:	$E_{evacuated,p,y}$
Data unit:	MWh
Description:	Gross electricity evacuated from the point of supply during year *y* using the HVDC transmission line built under the project activity
Source of data:	Measured by the project participant
Measurement procedures (if any):	Electricity meter installed at the input side of the rectifier
Monitoring frequency:	Continuously
QA/QC procedures:	Accuracy Class: 0.2% Calibration frequency: Annual
Any comment:	-

Data / Parameter:	$E_{received,p,y}$
Data unit:	MWh
Description:	Net electricity received at the point of receipt of the transmission line during year *y*
Source of data:	Measured by the project participant
Measurement procedures (if any):	Electricity meter installed at the output side of the inverter
Monitoring frequency:	Continuously
QA/QC procedures:	Accuracy Class: 0.2% Calibration frequency: Annual
Any comment:	-

Data / Parameter:	$EF_{EL,y}$
Data unit:	t CO_2/MWh
Description:	Emission factor of the electricity supplied through transmission line during year *y* (t CO_2/MWh)
Source of data:	Calculated
Measurement procedures (if any):	Refer to the flow charts in baseline emissions section
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	$P_{Line,BL,H}$
Data unit:	MW
Description:	Transmission line losses in the baseline scenario during the hour H of year *y* (MW)
Source of data:	Transmission line simulation diagram

Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	Using load flow study by simulation software based on international standards.
Any comment:	-

Data / Parameter:	$P_{station,BL,H}$
Data unit:	MW
Description:	Station losses in the baseline scenario during the hour H of year *y* (MW)
Source of data:	Transmission line simulation diagram
Measurement procedures (if any):	-
Monitoring frequency:	Annually
QA/QC procedures:	Using load flow study by simulation software based on international standards.
Any comment:	-

Data / Parameter:	$P_{evacuated,p,H}$
Data unit:	MW
Description:	Gross power evacuated in the project activity from the point of supply in the hour H of year *y*
Source of data:	Measured by the project participant
Measurement procedures (if any):	Electricity meter
Monitoring frequency:	Continuously
QA/QC procedures:	Measurements equipments will be calibrated periodically for accuracy
Any comment:	This parameter, monitored continuously, will be used to generate load curve of transmission line, which is to be updated on an hourly basis during the year *y*

Data / Parameter:	$EF_{grid,y}$
Data unit:	t CO_2/MWh
Description:	Emission factor of the grid in year *y*
Source of data:	Calculated
Measurement procedures (if any):	As per the “Tool to calculate the emission factor for an electricity system”
Monitoring frequency:	As per the “Tool to calculate the emission factor for an electricity system”
QA/QC procedures:	As per the “Tool to calculate the emission factor for an electricity system”
Any comment:	-

Data / Parameter:	$EF_{pp,y}$;
Data unit:	t CO_2/MWh
Description:	Emission factor of the power plant at the point of supply;
Source of data:	Calculated
Measurement procedures (if any):	As per the “Tool to calculate the emission factor for an electricity system” using the equation for $EF_{EL,m,y}$.
Monitoring frequency:	As per the “Tool to calculate the emission factor for an electricity system”
QA/QC procedures:	As per the “Tool to calculate the emission factor for an electricity system”
Any comment:	Refer the guidance in “baseline emissions” section
Any comment:	-

Data / Parameter:	Emission factors for other power plants (captive or third party) connected to the captive user
Data unit:	t CO2/MWh
Description:	Emission factors for other power plants (captive or third party) connected to the captive user.
Source of data:	Calculated
Measurement procedures (if any):	As per the “Tool to calculate the emission factor for an electricity system” using the equation for $EF_{EL,m,y}$.
Monitoring frequency:	As per the “Tool to calculate the emission factor for an electricity system”
QA/QC procedures:	As per the “Tool to calculate the emission factor for an electricity system”
Any comment:	Refer the guidance in “baseline emissions” section

Data / Parameter:	H
Data unit:	hour
Description:	Each hour of operation of the power plant (at point of supply) connected to the transmission line during year *y*
Source of data:	Plant records
Measurement procedures (if any):	-
Monitoring frequency:	Daily, archived monthly
QA/QC procedures:	-
Any comment:	-

Data / Parameter:	Load Curve
Data unit:	-
Description:	Load curve for the project transmission line during year *y*
Source of data:	Monitored values of power evacuated
Measurement procedures (if any):	The power evacuated from the point of supply/origin shall be monitored on a continuous basis. Based on the power evacuated, the load curve for the year shall be developed
Monitoring frequency:	Annually
QA/QC procedures:	-
Any comment:	The load curve developed for the project case shall be used to compute the transmission losses, using simulation software, that would have occurred in the transmission line used in absence of CDM project. The process shall be repeated for every monitoring period

Data / Parameter:	Right-of-way
Data unit:	-
Description:	Right-of-way requirement for the transmission line under CDM project as well as under the most plausible baseline scenario.
Source of data:	One of the following sources shall be used as source: • Project documents submitted to government authorities for implementation approval; • Project documents submitted to financial institutions for appraisal; or • Project documents certified by chartered engineers
Measurement procedures (if any):	-
Any comment:	This monitored parameter is required in order to comply with the applicability condition that required project participants to demonstrate that the right-of-way requirement for the project activity is lesser than that for the baseline activity

Data / Parameter:	$\Phi_{PE, TL, H}$
Data unit:	-
Description:	Power factor of the power at the point of origin/ supply and connected to the transmission line during the hour H of year *y*
Source of data:	Measured by the project participant before the rectifier, after being compensated by capacitors.
Measurement procedures (if any):	The power factor of the power at the point of origin shall be continuously measured
Monitoring frequency:	Continuously
QA/QC procedures:	-
Any comment:	The power factor measured shall be used as an input parameter for developing the simulation of the transmission line identified as the baseline scenario

IV. REFERENCES AND ANY OTHER INFORMATION

(1) International Electro-technical Commission (IEC);[2]

(2) The Institute of Electrical and Electronics Engineers (IEEE);[3]

(3) American National Standards Institute;[4]

(4) Verband der Elektrotechnik, Elektronik und Informationstechnik.[5]

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[2] <http://www.iec.ch>.

[3] <http://www.ieee.org>.

[4] <www.ansi.org>.

[5] <www.vde.com>.

Annex I: General guidance on simulation software package

Evaluation of transmission line models

The calculation methods using simulation models are applied for planning, designing and managing operations in electricity transmission and distribution networks as well as industrial networks. Companies assess simulation models of various designs of transmission lines as it is not possible to get existing data on the performance of the transmission lines exactly as per the desired configuration. Often, the software results form an important consideration for a company that is evaluating different configurations of transmission lines. The software is commonly used by companies to evaluate various models before the final decision is taken and therefore, as per CDM requirements, the software can be construed as one of the critical tools available with the management of a company at the time of investment decision. For the purpose of this methodology the project participants shall apply the Siemens PSS SINCAL simulation software or other software of similar accuracy as confirmed by third party chartered engineer. The software should meet at least one of the following standards.

- VDE[6] 0102/1.90 – IEC[7] 909;
- VDE 0102/2002 – IEC 909/2001;
- IEC 61363-1/1998;
- ANSI;[8]
- Engineering Recommendation G74.[9]

The baseline scenario shall be simulated by a balanced load flow study of the power transmission line. The balanced load flow study is an effective tool for calculating operating conditions in electrical power networks. This calculation method determines the power flow from the point of supply to the point of receipt. The conservative assumptions shall be taken into account while carrying out simulation of baseline transmission line e.g. no substation losses (except terminal substations) will be calculated for the estimation of baseline technical losses. The simulation results shall be confirmed by third party chartered engineer.

Software simulation is required to arrive at baseline emissions since the calculation of the power transferred from the point of supply to the point of receipt would involve a complex algorithmic approach. In addition, it will also require equations and procedures for calculations which will be very difficult to carry out manually. On the other hand, the simulation shall account for the losses that are otherwise difficult to quantify using calculation procedures.

[6] Verband der Elektrotechnik, Elektronik und Informationstechnik, <www.vde.com>.
[7] International Electrotechnical Commission, <www.iec.ch>.
[8] American National Standards Institute, <www.ansi.org>.
[9] ER G74 sets out a procedure which requires a more detailed assessment of short circuit currents with a fuller representation of system pre-fault conditions and taking account of dynamic load fault circuit contribution.

Criteria for the selection of simulation software

The simulation software must be in compliance with accepted International Standards in electrical power transmission industry and follow any of the following algorithms for performing the load flow study:

- Newton-Raphson method;
- Gauss-Seidel method.

Functional Characteristics

The functional characteristics of the software package should include:

- Load flow calculations should be able to handle more than one isolated network at the same time;
- Required number of in-feeders and generators should be supported;
- Voltage controllers should calculate the optimal tap position while automatically taking into account voltage ranges;
- Load flow should handle phase shifting transformers;
- Permissible operating ranges (P/Q) can be defined for generators and in-feeders. The software can also use a prescribed zone exchange power to calculate power transfer between different network areas;
- Establishment and shutdown dates shall be defined for any equipment considered by the load flow calculations;
- The software package load flow should support different load types.

The project participant shall use software that is reliable, is used by chartered engineers and is readily available.

Key input parameters for the software package

- Voltage level of the transmission line (kV).
- Length of the transmission line (km);
- Inductance of the transmission line (H/km);
- Capacitance of the transmission line (F/km);
- Expected transmission line loading (MW).
- Substation spacing (km);
- Power factor of the power at the point of origin/ supply and connected to the transmission line during the hour H of year y.

Since the software is standardized, the simulation need not be performed by any third party, it can be either carried out by the technology supplier or by the project participant themselves. But the operation of the simulation software should be explained to DOE and the actual software shall be shared with DOE during validation. The DOE shall verify that the software used by the project participant is in compliance with International Standards in power transmission technology and as per standard industry practices.

The project participant shall simulate the model of the power transmission line that was or would have been installed in the absence of the project activity.

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