Verified Carbon Standard

VCS Tool

VT0010

EMISSIONS FROM ELECTRICITY CONSUMPTION AND GENERATION

Version 1.0

27 November 2024

Version 1.0 of this tool was developed by Verra.

CONTENTS

1 SUMMARY DESCRIPTION

This tool provides procedures to calculate emissions from electricity consumption and generation in VCS projects. It is intended to be used when required by a VCS methodology. It applies to:

- Electricity consumption in the baseline, project, and associated with leakage, and
- Grid-connected electricity generation in the project that displaces baseline generation.

Various electricity supply scenarios are included in the scope of this tool including grid-connected electricity, Purpose-Built Wheeling Arrangements, Shared Power Plants (Localized Grids and Hybrid), and Dedicated Power Plants (Off-grid and Back-up).

2 SOURCES

This tool is based on:

- *CDM TOOL05 Baseline, Project and/or Leakage Emissions from Electricity Consumption and Monitoring of Electricity Generation, v3.0*

The tool uses the most recent versions of the following tools and methodologies:

- *VT0011 Emission Factors for Electricity Systems*
- *CDM ACM0002 Grid-connected electricity generation from renewable sources*
- *CDM TOOL03 Tool to Calculate Project or Leakage CO_2 Emissions from Fossil Fuel Combustion*
- *CDM TOOL07 Tool to Calculate the Emission Factor for an Electricity System*
- *CDM TOOL09 Tool to Determine the Baseline Efficiency of Thermal or Electric Energy Generation Systems*
- *CDM TOOL14 Project and Leakage Emissions from Anaerobic Digesters*
- *CDM TOOL16 Project and Leakage Emissions from Biomass*

3 DEFINITIONS

In addition to the definitions set out in the *VCS Program Definitions*, the following definitions apply to this tool.

Directly connected power plant

A power plant that supplies electricity directly to a consumer in the baseline, project or associated with leakage, and not through the national or regional grid. This supply can be through direct connection or a localized grid and thus may serve a dedicated load or be shared with other consumers, depending on the connection. The power plant may be co-located with project activities or remote.

Grid-connected electrical load

An electricity consumer that is directly connected to the regional or national grid and may also have a supply of electricity wheeled through the regional or national grid using purpose-built wheeling arrangements (PBWAs – see definition below), a connection to a shared power plant(s), or a connection to a dedicated power plant(s).

Localized grid

An electricity system operating independently of a national or regional grid. It includes one or more power sources, and one or more consumers, for example, within an industrial complex or defined geographic area. It does not have a connection to the regional or national grid. This includes mini-grids, micro-grids, and isolated grids that meet the aforementioned conditions.

Low-carbon power plant

A power plant that generates electricity with minimal or zero carbon emissions specifically by avoiding fossil fuel combustion. It may be one of two types:

- Type 1: Zero carbon emission sources that do not require accounting for emissions associated with power production. These include solar power (photovoltaic or thermal) with or without battery storage, wind power with or without battery storage, nuclear power, and hydropower (run-of-river, new plant on existing reservoir with no change in the volume of the reservoir, or new plant with power density greater than 10 W/m^2).
- Type 2: Low-carbon sources that require accounting for emissions associated with power production. These include geothermal power, biomass combustion using renewable biomass (including biomass residues) derived through sustainable land management practices, hydropower (new projects with power density greater than 4 W/m^2 and less than or equal to 10 W/m^2), and biogas from organic waste, manure, or wastewater treatment. Mixed waste incineration or other mixed fuels are excluded (pure streams of biomass residues are not excluded) .

Low-carbon power plant phase

A set of generation facilities that are developed and constructed in different stages over time but that share a similar energy source, design, and operational control. For example, a wind farm power plant may be developed in multiple phases, where each phase includes a specific area of land or a new set of turbines, but all phases have similar operating parameters and contribute to the overall plant's capacity.

Power plant operator
The entity responsible for directing operations at a power plant that also has the authority and control to market future electrical energy from the plant and execute power purchase agreements on behalf of the power plant or a power plant phase.

Proxy measurement
A measurement taken of a quantity or variable that is correlated with the variable of interest.

Purpose-built wheeling arrangement (PBWA)
An arrangement (enforced through a legally binding agreement) between a power plant operator and a project proponent that enables the supply of electricity from the power plant to the project activity through the national or regional grid.

Start of construction
The date on which the first placement of permanent structure occurs (e.g., foundations for a power plant), including first piling or pouring cement foundations and footings. It does not include site clearing and preparation, staff mobilization, excavation, site offices, cribbing, formwork, or other temporary structures.

4 APPLICABILITY CONDITIONS

This tool applies when a methodology references it to quantify emissions from electricity consumption or those associated with electricity displaced by new generation. One or more of the following electricity supply scenarios apply:

1) **Scenario A Grid Electricity System[1]:** The national or regional grid supplies/receives electricity.
2) **Scenario B Purpose-Built Wheeling Arrangements (PBWA)[2]:** A new, off-site, low-carbon power plant (or phase) is constructed and connected to the national or regional grid to supply electricity to a project activity. All of the following conditions apply:
    a) The low-carbon power plant (or phase) is in the same country as the project activity;
    b) The project activity and the power plant (or phase) are connected through the national or regional grid(s) such that electricity may be transmitted from the power plant to the project, and the connection is metered;

[1] For guidance only: CDM ACM0002 (5), AMS-I.D 2(a), AMS-I.F 2(a) describe activities similar to Scenario A.

[2] For guidance only: CDM AMS-I.D 2(b) and ACM00123 describe activities similar to Scenario B but differ because Scenario B only applies to electricity use in conjunction with a separate project activity (e.g., biochar production). By contrast, the CDM methodologies credit the renewable energy generation as the project activity.

c) The low-carbon power plant (or phase) capacity used in a PBWA is in addition to jurisdictional renewable portfolio requirements or is otherwise excluded from those requirements; and

d) A power purchase agreement (PPA) is established and complies with all of the following conditions:

i) The PPA is mutually executed by both the project proponent (or project proponent representative) and the power plant operator before the start of construction of the low-carbon power plant (or phase);

ii) The PPA commits the power plant operator to supply a quantity of electrical energy to the national or regional grid, and the low-carbon beneficial claim related to consuming that quantity is afforded to the project proponent;

iii) The term of the PPA, including any updates or modifications, corresponds to at least the first project crediting period (i.e., 7 years, 10 years, or as otherwise specified in the methodology, and depending on the crediting period type); and

iv) The PPA forbids the project proponent and the PPA counterparties from generating, transferring, or selling renewable energy credits (RECs) or other instruments representing the low-carbon benefits of the energy to others for the quantity of energy supplied to the project through the agreement.

3) **Scenario C Shared Power Plant(s):** Directly connected power plant(s) supply some or all of their net electricity generated to activities in the baseline, in the project, or associated with leakage. The project description indicates that shared power plant(s) supply electricity (including the sub-scenario), depicts the electricity system configuration, and describes operations. One of the following sub-scenarios applies:

a) **Scenario C1 Localized Grid**[3]: The electricity consumer is connected to only a localized grid, supplied by a directly connected power plant(s). This localized grid supplies electricity to project activities and potentially other consumers but is isolated from the regional and national grid.

b) **Scenario C2 Hybrid**[4]**:** The electricity consumer is connected to both the national or regional grid (Scenario A or B) and directly connected power plant(s) (by direct connection, or via a localized grid), or is connected to a mini-grid that is also connected to a national or regional grid. The connections to directly connected power plant(s) and the national or regional grid are metered separately. The consumer draws electricity from both directly connected power plant(s) and the regional or national grid based on availability or operational needs during the

[3] For guidance only: CDM AMS-I.F 2(c) and AMS-I.A (stand-alone mini-grids) describe activities similar to Sub-scenario C1

[4] For guidance only: CDM AMS-I.F 2(b) describe activities similar to Sub-scenario C2.

monitoring period. The shared power plant may be designed and operated to export electricity to the grid.

4) **Scenario D Dedicated Power Plant:** Directly connected power plant(s) supply all their net electricity generated to activities in the baseline, in the project, or associated with leakage. Unlike shared power plants in supply Scenario C, dedicated power plants do not supply electricity to other consumers. The project description indicates that dedicated power plant(s) supply electricity (including the sub-scenario), depicts the electricity system configuration, and describes operations. One of the following sub-scenarios applies:

   a) **Scenario D1 Off-grid[5]:** The electricity consumer is directly connected to the power plant and there is no connection to a regional or national grid.

   b) **Scenario D2 Back-up Generation:** The electricity consumer is connected to both the national or regional grid (Scenario A or B) and directly connected power plant(s). The connection to the national or regional grid is metered. The power plant supplies all its net electricity generation to the electricity consumer as a "back-up" to grid electricity.

This tool does not apply where:

5) Project activities are upgrades or fuel switches at power plants (e.g., the project activity is efficiency improvements at a power plant). Capacity additions and refurbishments to extend the life of a power plant that is at end-of-life are not upgrades.

5 PROCEDURES

Apply the following equations to determine baseline, project, and leakage emissions from electricity consumption or baseline emissions associated to electricity displaced by new generation.

$$BE_{Elec} = BE_A + BE_C + BE_D \quad (1)$$

$$PE_{Elec} = PE_A + PE_B + PE_C + PE_D \quad (2)$$

$$LE_{Elec} = LE_A + LE_C + LE_D \quad (3)$$

Where:

BE_{Elec} = Baseline emissions from electricity consumption (t CO_2e)
PE_{Elec} = Project emissions from electricity consumption (t CO_2e)
LE_{Elec} = Leakage emissions from electricity consumption (t CO_2e)

[5] For guidance only: CDM AMS-I.A (individual households/users) describe activities similar to Sub-scenario D1.

$BE_{A,C,D}$ = Baseline emissions for scenarios A, C or D respectively (tCO_2e)
$PE_{A,B,C,D}$ = Project emissions for scenarios A, B, C or D respectively (tCO_2e)
$LE_{A,C,D}$ = Leakage emissions for scenarios A, C or D respectively (tCO_2e)

5.1 Scenario A: Grid Electricity System

Identify each grid-connected electrical load. For clarity this includes loads that are directly connected to the regional or national grid (supply Scenario A) and includes those that also have:

1) a supply of electricity that is wheeled through the regional or national grid using PBWAs (supply Scenario B),

2) a connection to a shared power plant(s) (supply Scenario C2), or

3) a connection to a dedicated power plant(s) (supply Scenario D2).

For project activities that generate electricity and export it to the grid for consumption, include a grid-connected load corresponding to the quantity of electricity that is exported to the grid.

Categorize each load as a part of the baseline, project, or leakage in the following manner:

1) Baseline loads:

   a) electricity generation and export to the grid for consumption (i.e., baseline generation displacement),

   b) electricity consumption activities in the pre-project that would have continued in the absence of the project activities, or other electricity consumption activities that would have started in the absence of the project (i.e., baseline consumption).

2) Project loads: electricity consumption in the project boundary due to the implementation and operation of the project activity.

3) Leakage loads: electricity consumption activities outside the project boundary that are affected by, or related to, the project activities.

The option to account for multiple electricity generation or consumption activities as the same load may be used when they:

1) Share the same categorization (i.e., they are in the baseline together, project together, or associated with leakage together),

2) Share the same connection to electricity supply (e.g., several activities are connected to both the grid and a dedicated power plant), and

3) Are either measured together (i.e., the same meter measures their aggregate consumption), or are estimated together (i.e., a common estimation technique applies to the activities).

Apply each of the following equations to determine emissions using supply scenario A in the project, baseline, and associated with leakage respectively.

$$BE_A = \sum_l EC_{BE,A,l} \times EF_{BE,A,l} \times \left(1 + TDL_{BE,A,l}\right) \quad (4)$$

$$PE_A = \sum_l EC_{PE,A,l} \times EF_{PE,A,l} \times \left(1 + TDL_{PE,A,l}\right) \quad (5)$$

$$LE_A = \sum_l EC_{LE,A,l} \times EF_{LE,A,l} \times \left(1 + TDL_{LE,A,l}\right) \quad (6)$$

Where:

$EC_{BE,A,l}$, $EC_{LE,A,l}$,	=	Electricity consumption for each load *l* using supply scenario A in the baseline, and associated with leakage. This includes the electricity supplied by the regional or national grid to loads that also are connected to shared power plant(s) (supply Scenario C2) or dedicated power plant(s) (supply Scenario D2). (MWh)
$EC_{PE,A,l}$,	=	Electricity consumption for each load *l* using supply scenario A in the project, determined using Equation (7). (MWh)
$EF_{BE,A,l}$, $EF_{PE,A,l}$, $EF_{LE,A,l}$,	=	Emission factor for each load *l* using supply scenario A in the baseline, project, and associated with leakage (t CO_2e/MWh)
$TDL_{BE,A,l}$, $TDL_{PE,A,l}$, $TDL_{LE,A,l}$,	=	Average transmission and distribution losses related to supplying electricity to load *l* in the baseline, project, and associated with leakage (dimensionless)

5.1.1 Electricity Consumed ($EC_{PE,A,l}$)

Use the following equation to determine electricity consumption for loads connected to the national or regional grid for project activities.

$$EC_{PE,A,l} = EC_{Grid,l}\left(1 - \frac{EC_{PE,B}}{\sum_l EC_{Grid,l}}\right) \quad (7)$$

Where:

$EC_{Grid,l.}$	=	Electricity consumed for each grid-connected load *l* in the project. This includes electricity that is wheeled through the regional or national grid as established by a PBWA (supply Scenario B). This includes the electricity supplied by the regional

or national grid to loads that are also connected to shared power plant(s) (supply Scenario C2) or dedicated power plant(s) (supply Scenario D2). (MWh)

$EC_{PE,B}$ = Electricity consumed from PBWAs as determined using Equation (9) (MWh)

5.1.2 Emission Factor ($EF_{BE,A,l}$, $EF_{PE,A,l}$, $EF_{LE,A,l}$)

Use the most recent version of *VT0011 Emission Factors for Electricity Systems* to determine the emission factor for supply Scenario A.

5.2 Scenario B: Purpose-Built Wheeling Arrangements

Apply the following equation to determine emissions from electricity consumption using supply scenario B in the project.

$$PE_B = EC_{PE,B} \times EF_{PE,B} \times (1 + TDL_{PE,B}) \quad (8)$$

Where:

$EF_{PE,B}$ = Emission factor for electricity supplied using Scenario B (t CO_2e/MWh)

$TDL_{PE,B}$ = Average transmission and distribution losses related to supplying electricity in the project for supply scenario B (dimensionless)

5.2.1 Electricity Consumed ($EC_{PE,B}$)

Meter grid-connected electrical loads in projects that have PBWAs. To determine the electricity supplied by Scenario B, use the minimum of the total grid-connected electrical loads and the net generation from the low-carbon power plant delivered to the project boundary as shown in Equation (9). Use at most an annual reconciliation frequency[6], meaning the period over which both parameters are compared is either the monitoring period, or the calendar year, whichever is shorter.

$$EC_{PE,B} = MIN\left(\sum_l (EC_{Grid,l}) \;,\; \frac{EG_{PBWA}}{1 + TDL_{PE,B}}\right) \quad (9)$$

Where:

EG_{PBWA} = Quantity of electricity generated by low-carbon power plant(s) for the PBWA during the monitoring period or a year, whichever is shorter (i.e., annual reconciliation) (MWh)

[6] To encourage better temporal matching of clean energy with consumption, Verra will consider increasing the reconciliation frequency in future revisions.

5.2.2 Emission Factor for low-carbon power plants

For electricity supplied by Type 1 low-carbon power plants, the emission factor is 0 t CO_2e/MWh.

For electricity supplied with Type 2 low-carbon power plants, calculate the emission factors as follows:

1) Geothermal: account for direct CO_2 emissions from geothermal production using the procedures in *ACM0002*. Divide the emissions by the total net generation in MWh from the plant.
2) Biomass: use CDM *TOOL16* to account for upstream emissions from cultivation, processing, and transport of biomass. Divide the emissions by the total net generation in MWh from the plant. Direct emissions from combustion of renewable biomass or biomass residues under sustainable land management practices are 0 tCO_2e/MWh.
3) Hydropower: use 0.1 tCO_2e/MWh (only for new plants with a power density greater than 4 W/m^2 and less than or equal to 10 W/m^2).
4) Biogas: use CDM *TOOL14* to account for upstream emissions from biogas production (e.g., manure management, digestion, and transport). Divide the emissions by the total net generation in MWh from the plant.

5.3 Scenario C: Shared Power Plants

Apply each of the following equations to determine emissions from electricity consumption supplied by Scenario C in the project, baseline, or associated with leakage respectively.

$$BE_C = \sum_n (EC_{BE,SPP,n} \times EF_{BE,SPP,n}) \quad (10)$$

$$PE_C = \sum_n (EC_{PE,SPP,n} \times EF_{PE,SPP,n}) \quad (11)$$

$$LE_C = \sum_n (EC_{LE,SPP,n} \times EF_{LE,SPP,n}) \quad (12)$$

Where:

$EC_{BE,SPP,n}$, $EC_{PE,SPP,n}$, $EC_{LE,SPP,n}$	=	Electricity consumption from each shared power plant(s) *n* in the baseline, project, and associated with leakage (MWh). This quantity excludes the electricity supplied by the national or regional grid ($EC_{BE,A}$, EC_{Grid}, $EC_{LE,A}$) which is accounted using Section 5.1.
$EF_{BE,SPP,n}$ $EF_{PE,SPP,n}$ $EF_{LE,SPP,n}$	=	Emission factor for each shared power plant(s) *n* in the baseline, project, and associated with leakage (t CO_2e/MWh)

Where a shared power plant is also a cogeneration plant, emissions from heat production (e.g., steam) are not accounted for using this tool.

5.3.1 Electricity Consumed ($EC_{BE,SPP,n}$, $EC_{PE,SPP,n}$, $EC_{LE,SPP,n}$)

Meter electricity consumption from shared power plants. For electricity supplied using Scenario C2, meter electricity consumption separately from the regional or national grid and shared power plant. Account for emissions from electricity supplied by the regional or national grid using Section 5.1 (Scenario A).

5.3.2 Emission Factor for shared power plants

5.3.2.1 Supply Scenario C1 – Localized Grids

For shared power plants that are low-carbon power plants, see Section 5.2.2.

For other shared power plants, use Equation (13) for each power plant *n* in each of the baseline, project, or associated with leakage:

$$EF_{BE,SPP,n}, EF_{PE,SPP,n}, EF_{LE,SPP,n} = \sum_f \left(\frac{Q_{n,f} \times NCV_f \times EF_{CO2,f}}{EG_n} \right) \times (1 - H_n) \quad (13)$$

Where:

$Q_{n,f}$	=	Quantity of fuel type *f* fired in power plant *n* (mass or volume unit)
NCV_f	=	Mean net calorific value of fuel type *f* used in the reporting period (GJ/mass or volume unit)
H_n	=	Fraction of heat at cogeneration system n (dimensionless)
$EF_{CO2,f}$	=	CO_2 emission factor of fuel type *f* (t CO_2/GJ)
EG_n	=	Quantity of net electricity generated in power plant *n* (MWh)

For plants with no cogeneration system, H_n = 0, otherwise for each plant *n*, use the following equation to determine heat fraction at a cogeneration system:

$$H_n = \frac{HG_n}{\sum_f (Q_{n,f} \times NCV_f) \times \eta_{cogen,n}} \quad (14)$$

Where:

HG_n	=	Quantity of heat cogenerated in power plant *n* (GJ)
$\eta_{cogen,n}$	=	Efficiency of cogeneration system *n* in which heat is generated (dimensionless)

For plants that have multiple fuel types, the baseline fuel mix must be:

1) the same as the fuel mix in the project or associated with leakage, or
2) a fuel mix that conservatively estimates emissions from power and heat production.

5.3.2.2 Supply Scenario C2 - Hybrid

Use the following steps to determine the emission factor for shared power plants:

1) Calculate the emission factor for the shared power plant ($EF_{BE,\ SPP,n}$, $EF_{PE,\ SPP,n}$, $EF_{LE,\ SPP,\ n}$) according to Section 5.3.2.1 if one of the following conditions is true throughout the monitoring period:
   a) The shared power plant operates in response to loads in the project, baseline, or leakage (e.g., by demand matching or direct dispatch), and at less than its maximum capacity (including ongoing capacity derates). This must be demonstrated using operational data or control system logs that show demand-matching or dispatch actions.
   b) The regional and national grid electricity consumption is zero.
   c) The electricity consumption from the regional or national grid is predefined and outside the project proponent's control (e.g., by capacity constraints, grid operator dispatching instructions, or similar). Evidence must be provided in the form of agreements with the grid operator or other documentation showing the project proponent does not control grid electricity consumption.
2) Otherwise (i.e., if none of the conditions in step 1 are true), calculate the emission factor for the shared power plant(s) ($EF_{BE,\ SPP,n}$, $EF_{PE,\ SPP,n}$, $EF_{LE,\ SPP,\ n}$) according to 5.3.2.1 (Supply Scenario C1) and the regional or national grid according to Section 5.1.2 (Supply Scenario A), and use the more conservative factor for that monitoring period (i.e., lower for baseline emissions, and higher for project or leakage emissions).

5.4 Scenario D: Dedicated Power Plants

5.4.1.1 Supply Scenario D1 – Off-grid

Account for emissions in Scenario D ($BE_{D,}$ $PE_{D,}$ $LE_{D,}$) from fossil fuel fired power plants using CDM *TOOL03*. For plants that have multiple fuel types, the baseline fuel mix must be:

1) the same as the fuel mix in the project or associated with leakage, or
2) a fuel mix that conservatively estimates emissions from power and heat production.

For electricity supplied by Type 1 low-carbon power plants in Scenario D, the emissions ($BE_{D,}$ $PE_{D,}$ $LE_{D,}$) are 0 t CO_2e.

For electricity supplied by Type 2 low-carbon power plants, calculate the emissions ($BE_{D,}$ $PE_{D,}$ $LE_{D,}$) as follows:

1) Geothermal: account for direct CO_2 emissions from geothermal production using the procedures in *ACM0002*.
2) Biomass: Use CDM *TOOL16* to account for upstream emissions from cultivation, processing, and transport of biomass. Assume direct emissions from combustion of

renewable biomass or biomass residues under sustainable land management practices are 0 t CO_2e.

3) Hydro: Multiply 0.1 tCO_2/MWh by the total net generation in MWh from the plant.

4) Biogas: Use CDM *TOOL14* to account for upstream emissions from biogas production (e.g., manure management, digestion, and transport).

5.4.1.2 Supply Scenario D2 – Back-up Generation

For back-up generation power plants, do not account for an emission reduction benefit to a project when excess generation from a dedicated power plant displaces grid generation, either intentionally or unintentionally. Therefore, do not prorate electricity generation based on how much excess was supplied to the grid, and do not account for the displacement of baseline grid generation. All emissions from dedicated power plants must be accounted for, including those arising from periods of excess generation. Account for emissions from dedicated power plants that serve as back-up generation power to the grid using Section 5.4.1.1 (Supply Scenario D1 – Off-grid).

6 DATA AND PARAMETERS

6.1 Data and Parameters Available at Validation

Data/Parameter	$\eta_{cogen,n}$
Data unit	percent
Description	Efficiency of cogeneration system n in which heat is generated plant *n*
Equations	(14)
Source of data	As per the procedures specified in CDM *TOOL09*
Value applied	Project specific
Justification of choice of data or description of measurement methods and procedures applied	As per the procedures specified in CDM *TOOL09*
Purpose of data	Calculation of baseline and project emissions
Comments	This is only applicable to projects or baseline activities where CO_2 emissions from cogeneration are allocated to heat and power. Efficiency is expressed as a decimal equivalent (i.e., 20% is expressed as 0.20).

6.2 Data and Parameters Monitored

Data/Parameter	$EC_{BE,A,I}$, $EC_{LE,A,I}$, $EC_{Grid,I}$, $EC_{BE,SPP,n}$, $EC_{PE,SPP,n}$, $EC_{LE,SPP,n}$
Data unit	MWh
Description	Electricity consumption in the baseline, project, and related to leakage
Equations	(4), (5), (6), (7), (10), (11), (12)
Source of data	Direct measurement or estimation
Description of measurement methods and procedures to be applied	Direct measurement is required as indicated: 1. project activities that generate electricity and export it to the regional or national grid, 2. projects in which a PBWA is established (supply Scenario B), 3. both connectios for loads that are both grid-connected and connected to a shared power plant (supply Scenario C2), 4. grid connections for loads that are both grid-connected and connected to a dedicated power plant for back-up (supply Scenario D2), or 5. the maximum power consumption of the load exceeds 100kW. Where direct measurement is not required, the quantity of electricity consumed by the load may be estimated. Demonstrate that the estimate meets one of the following criteria: 1. Conservative: consider whether the consumption is project, baseline, or associated with leakage, and how it changes from the baseline to project (increases or decreases). Physical limits such as maximum equipment capacity, continuous operation (24/7), or zero are appropriate. 2. Statistically significant: use proxy measurements, correlations, models, or another analytical technique. The estimate must also quantify uncertainty. Discount the estimate using the uncertainty to be conservative (less emissions in the baseline, more in the project and leakage) and justify the extent of conservativeness in the project description.
Frequency of monitoring/recording	Monitor continuously, aggregate data at least monthly. Perform estimates for at least monthly intervals.
QA/QC procedures to be applied	Regularly test and calibrate the meters as per utility or national requirements and manufacturer specifications. Cross-check with receipts/invoices from utilities or suppliers where applicable. Where invoices from utilities and suppliers provide the grid-electricity consumed $(EC_{PE,A},)$ and the PBWA electricity consumed $(EC_{PE,B})$ separately (i.e., the invoices state disaggregated electricity consumption for each source) proponents may use this information directly as a QA/QC. Propagate uncertainty according to instructions specific to the methodology used. For uncertainty of direct measurement, use the actual metering uncertainty specified by the error from the last calibration event or by

	the meter manufacturer where information from a previous calibration event is not available. For uncertainty of estimates, use zero for conservative estimates and a project-specific uncertainty for statistically significant estimates.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	For cumulative electricity meters, use the difference between initial and final readings and record the dates of each reading. Use linear interpolation where meter reading dates do not align with the monitoring period. Where historical data are used in the baseline, do one of the following: 1) Follow methodology specific guidance, 2) Use at least three years of the most recent records, 3) Justify why previous data are more appropriate, or 4) Justify why a shorter data period is appropriate.
Comments	Where direct measurement is required but temporarily not feasible due to technical or logistical constraints (e.g. lack of access to monitoring equipment, maintenance, remote, or hazardous project locations), the project proponent may use estimation methods. This must be accompanied by justification and a demonstration that the constraint is temporary and the chosen estimation method is conservative.

Data/Parameter	$EF_{BE,A,l}$, $EF_{PE,A,l}$, $EF_{LE,A,l}$, ,
Data unit	t CO_2e/MWh
Description	Emission factor for electricity consumption
Equations	(4), (5), (6)
Source of data	As per *VT0011 Emission Factors for Electricity Systems*
Description of measurement methods and procedures to be applied	As per *VT0011 Emission Factors for Electricity Systems*
Frequency of monitoring/recording	As per *VT0011 Emission Factors for Electricity Systems*
QA/QC procedures to be applied	For grids, follow QA/QC procedures in *VT0011 Emission Factors for Electricity Systems*. Deduct uncertainty according to instructions specific to the methodology used.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	N/A
Comments	None

Data/Parameter	$TDL_{BE,A,I}$, $TDL_{PE,A,I}$, $TDL_{LE,A,I}$, $TDL_{PE,\ B}$
Data unit	Percent
Description	Mean technical transmission and distribution losses for providing electricity consumed in the project boundary
Equations	(4), (5), (6), (8), (9)
Source of data	Estimate
Description of measurement methods and procedures to be applied	Estimate *TDL* using: 1) the most recent data available from the electricity grid to which the project is connected within the host country, region, or equivalent, or 2) the following default values: a) 20% for high TDL in project and leakage calculations, or when electricity consumption increases from baseline to project activities, and b) 3% for low TDL in baseline calculations, or when electricity consumption decreases from baseline to project activities. Estimate TDL_{load} for the distribution and transmission networks of the electricity grid at the same voltage as the connection to the project. The technical distribution losses should not contain other grid losses (e.g., commercial losses, theft). The distribution losses may be either calculated by project proponents or based on references from utilities, network operators, or other official documentation.
Frequency of monitoring/recording	Annually. Where data from the relevant year are not available, use the most recent available values.
QA/QC procedures to be applied	Deduct uncertainty according to instructions specific to each methodology. Assume 5% uncertainty for values published by national or regional governments, utilities, network operators, or multinational institutions and propagate as per IPCC guidance.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	N/A
Comments	*TDL* is expressed as a decimal equivalent (i.e., 20% is expressed as 0.20).

Data/Parameter	EG_{PBWA}, EG_n
Data unit	MWh
Description	Total quantity of electricity generated by the power plant (either associated to the wheeling arrangement in the PPA, or a shared power plant n respectively) in the monitoring period

Equations	(9), (13)
Source of data	Direct measurement
Description of measurement methods and procedures to be applied	Measure net electricity generation using calibrated meters
Frequency of monitoring/recording	Continuous, aggregated and recorded at least monthly.
QA/QC procedures to be applied	Cross-check generation data with receipts/invoices from utilities or suppliers where applicable. Regularly test and calibrate the meters.
Purpose of data	To determine the electricity generated in the project Calculation of baseline, project, and leakage emissions
Calculation method	For cumulative electricity meters, use the difference between initial and final readings and record the dates of each reading. Use linear interpolation where meter reading dates do not align with the monitoring period. Where historical data are used in the baseline, do one of the following: 1) Use at least three years of the most recent records, 2) Justify why previous data are more appropriate, or 3) Justify why a shorter data period is appropriate.
Comments	None

Data/Parameter	$Q_{n,f}$
Data unit	Mass or volume unit at reference conditions
Description	Quantity of fuel type *f* fired in power plant *n*
Equations	(13)
Source of data	Direct measurements
Description of measurement methods and procedures to be applied	Use either mass or volume meters. Accessories such as transducers, sonar, and piezo-electronic devices are acceptable where they are correctly calibrated and receive maintenance per manufacturer specifications.
Frequency of monitoring/recording	Continuous, aggregated at least annually
QA/QC procedures to be applied	Cross-check the consistency of metered fuel consumption quantities with an annual energy balance based on purchased quantities and stock changes.

Purpose of data	Calculation of baseline and project emissions where fossil fuel-based power plants are involved
Calculation method	Where used in the baseline, historical records of the three most recent years must be used. Baseline volumes must be correlated to plant activity, or if demonstrated to be conservative can be an extrapolated trend or the mean of the historical period.
Comments	None

Data/Parameter	NCV_f
Data unit	GJ/mass or volume unit
Description	Mean net calorific value of fossil fuel type *f* used in the reporting period
Equations	(13)
Source of data	The following data sources must be used in the specified order of priority with lower-ranked options considered only if higher-ranked sources are unavailable: 1) Values provided by fuel supplier in invoices or published 2) Measurements by project proponents in accredited laboratories 3) Regional or national default values: may only be used for liquid fuels and should be based on well-documented, reliable sources (such as national energy balances). 4) IPCC default values at the upper or lower limit (whichever is more conservative) 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 for National GHG Inventories*.
Description of measurement methods and procedures to be applied	For (1) and (2): Measurements must comply with national or international fuel standards (e.g., ASTM D5865-12, ISO 1928).

Frequency of monitoring/recording	For (1) and (2), obtain the NCV for each fuel delivery and calculate the weighted mean values for the monitoring period.
	For (3), review the appropriateness of the values annually.
	For (4), future revisions of the IPCC guidelines should be considered.

QA/QC procedures to be applied	Verify whether the values under (1), (2), and (3) are within the uncertainty range of the IPCC default values provided in Table 1.2, Vol. 2 of the *2006 IPCC Guidelines*. Where the values fall outside of this range, additional information from the testing laboratory should be collected to justify the outcome or to conduct additional measurements. The laboratories used as sources of data for Options (1), (2), and (3) should have ISO 17025 accreditation or justify that they are able to comply with similar quality standards.
Purpose of data	Calculation of baseline and project emissions from fuel combustion

Calculation method	Where used in the baseline, three years of historical records must be used. Baseline value must be the mean of the historical period.
Comments	None

Data/Parameter	EF_{CO2}
Data unit	t CO_2/GJ
Description	CO_2 emission factor of the fuels fired in power plant *n*
Equations	(13)
Source of data	The following data sources must be used in the specified order of priority with lower-ranked options considered only if higher-ranked sources are unavailable: 1) Values provided by fuel supplier in invoices or published 2) Measurements by project proponents in accredited laboratories. 3) Regional or national default values 4) IPCC default values at the upper or lower limit (whichever is more conservative) of the uncertainty at a 95% confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the *2006 IPCC Guidelines for National GHG Inventories*
Description of measurement methods and procedures to be applied	For (1) and (2): Measurements should be undertaken in line with national or international fuel standards. For (1), where the fuel supplier provides the NCV value and CO_2 emission factor on the invoice, and these two values are based on measurements for this fuel, this CO_2 factor should be used. Where another source for the CO_2 emission factor is used, or no CO_2 emission factor is provided, Options (2), (3), or (4) should be used.

Frequency of monitoring/recording	For (1) and (2): The CO_2 emission factor should be obtained for each fuel delivery, from which weighted mean values for the reporting period should be calculated.
	For (3): Review the appropriateness of the values annually.
	For (4): Any future revision of the IPCC guidelines should be considered.

QA/QC procedures to be applied	Verify whether the values under (1) and (2) are within the uncertainty range of the IPCC default values provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the *2006 IPCC Guidelines for National GHG Inventories*. Where the values fall outside of this range, additional information from the testing laboratory should be collected to justify the outcome or to conduct additional measurements.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Where used in the baseline, three years of historical records must be used. Baseline value must be the mean of the historical period.
Comments	None

Data/Parameter	HG_n
Data unit	GJ
Description	Quantity of heat cogenerated in power plant *n*
Equations	(14)
Source of data	Direct measurements
Description of measurement methods and procedures to be applied	Measure the steam (or other heat transfer medium) flow and physical properties, the steam, feedwater , and any condensate return flow and physical properties. Determine the respective enthalpies based on the temperatures, and pressure in the case of saturated or superheated vapors.
Frequency of monitoring/recording	Continuous monitoring, for parameters that are determined on an instantaneous basis, at least every 15 minutes, aggregated at least monthly.
QA/QC procedures to be applied	Cross-check measurement results with records for heat sold, fuel consumption records, and other energy measurements where relevant.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Steam tables or appropriate thermodynamic equations may be used to determine the enthalpy as a function of temperature and pressure. Use only well-established and published property tables for the enthalpy of steam (or other heat transfer medium).
Comments	This is only applicable to project activities where CO_2 emissions from cogeneration are allocated to heat and power.

7 REFERENCES

IPCC (2006). Chapter 1, Volume 2: Energy. In: *2006 IPCC Guidelines for National Greenhouse Gas Inventories*. Institute for Global Environmental Strategies (IGES).

IPCC (2019). *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories*. IPCC.

DOCUMENT HISTORY

Version	Date	Comment
v1.0	27 November 2024	Initial version