TOOL TO CALCULATE EMISSIONS FROM ELECTRICITY CONSUMPTION

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1 SOURCES

This tool is based on the following tool:

- *CDM TOOL05 Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation, v3.0*

The tool uses the latest versions of the following tools and 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 Standardized Baselines*[1]
- *IFI List of harmonized GHG accounting standards/approaches and guidelines developed*[2]

2 SUMMARY DESCRIPTION OF THE TOOL

This tool provides procedures to calculate baseline, project, and/or leakage emissions due to electricity consumption. It provides uncertainty estimation procedures according to the *VCS Methodology Requirements* and additional estimation options for small or insignificant electricity consumption. It also provides guidance for project activities that consume power from greenfield power plants that generate electricity with lower GHG emission intensity.

This tool builds on the procedures in *CDM TOOL05 Baseline, project and/or leakage emissions from electricity consumption, and monitoring of electricity generation, v3.0*.

3 DEFINITIONS

Biomass
Dead wood residues (including foliage) left on the forest floor after timber removal.

[1] https://cdm.unfccc.int/methodologies/standard_base/index.html

[2] List of harmonized GHG accounting standards/approaches and guidelines developed

Captive power plant

A power plant that is not connected to the grid – though it may be directly connected to neighboring electricity consumers or supply electricity to a mini-grid or equivalent – and that supplies electricity to a project activity or in the baseline scenario. Project proponents directly control captive power plant emissions through their electricity consumption. It may include any backup power generators at a project site.

Dedicated captive power plant

A captive power plant that supplies all its net generated electricity to project or baseline scenario by a dedicated, direct connection. It may be on-site or remote.

Duty cycle

The proportion of time for which an electric load consumes power, expressed as a percentage of the crediting period or year

Low-carbon power plant

A power plant that generates electricity using one of the following energy sources:

- Solar power (PV or thermal) with or without battery storage
- Wind power with or without battery storage
- Hydropower (run-of-river or existing reservoir with no change in the volume of the reservoir; or new projects with power density greater than 4W/m^2). The hydropower plant must not lead to ecosystem loss.
- Power generation with renewable biomass-derived through sustainable land management practices (excluding waste incineration or other mixed fuels)
- Geothermal power
- Nuclear power

Low-carbon power plant phase

A well-defined set of generation facilities that may be developed, financed, constructed, and operated separately but that are associated with a low-carbon power plant by similarities in energy source, design, construction, and operatorship. For example, a wind power plant may include multiple phases, where each phase includes a specific area of land or set of turbines that are built and operated separately from other phases, but that have similar design and operating parameters as the rest of the low-carbon power plant.

Proxy measurement

A measured variable that is correlated with electricity consumption.

Purpose-built wheeling arrangements

An arrangement between a low-carbon power plant operator and a project proponent that allows the development of new low-carbon electricity generation with the intention of supplying the project activity with power delivered through a national/regional grid.

Start of construction
The date on which the first placement of permanent structure occurs, typically being 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 provides procedures to calculate baseline, project, and/or leakage emissions due to electricity consumption.

4.1 This tool is applicable under the following conditions:

1) Baseline, project, and/or leakage emissions result from one or a combination of the following scenarios:

   a) **Scenario A: Grid electricity consumption**

      The national or regional grid supplies electricity for consumption.

   b) **Scenario B: Electricity consumption from on-site power plant(s) or dedicated captive power plant(s)**

      An on-site, grid-connected power plant delivers some or all its net electricity generated, or a captive power plant delivers all net electricity generated for consumption.

   c) **Scenario C: Electricity consumption from shared captive power plant(s)**

      A captive power plant delivers some of its net electricity generated for consumption.

   d) **Scenario D: Purpose-built wheeling arrangements**

      An off-site, grid-connected power plant (or power plant phase) that meets the eligibility conditions in Applicability Condition 2 is constructed and delivers its net electricity generated through the grid to the project activity (i.e., wheeling).

4.2 Purpose-built wheeling arrangements are eligible where they comply with all of the following conditions (2) to (6):

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

   a) The PPA is signed between the project proponent and a power plant operator for the supply of electricity from a new low-carbon power plant or new low-carbon power plant phase;

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

c) The PPA commits the power plant operator to supply electricity from the low-carbon power plant to the project for at least the project crediting period;

d) The PPA covers at least 50 percent of the power plant's anticipated annual net generation (considering local climate and resource potential) and

e) The PPA includes provisions to avoid double counting by forbidding the transfer or claim of GHG emission reductions by the PPA counterparty or any other parties.

3) The power plant is in the same country as the project activity;

4) The project activity, the power plant, and the national/regional grid are connected such that electricity may be transmitted from the power plant to the project;

5) The power plant capacity is in addition to jurisdictional renewable portfolio requirements or is otherwise excluded from the requirements that exist at the time of the PPA's execution and

6) The project proponent and the PPA counterparties do not transfer or sell Renewable Energy Credits (RECs) or other instruments representing the environmental attributes associated with the electricity consumed by the project.

4.3 This tool does not cover:

1) Project activities related to upgrades or fuel switches at power plants (e.g., the project activity is efficiency improvements at a power plant).

2) Project activities that consume both electricity and heat and/or cooling from shared captive co-generation power plants.

5 PROCEDURES

Project proponents must apply the following equations to determine project, baseline, and leakage emissions from electricity consumption.

$$PE_{EC} = \sum_i (EC_{PE,i} \times EF_i \times (1 + TDL_i)) \quad (1)$$

$$BE_{EC} = \sum_i (EC_{BE,i} \times EF_i \times (1 + TDL_i)) \quad (2)$$

$$LE_{EC} = \sum_i (EC_{LE,i} \times EF_i \times (1 + TDL_i)) \quad (3)$$

Where:

PE_{EC}	=	Project emissions from electricity consumption (t CO_2e)
BE_{EC}	=	Baseline emissions from electricity consumption (t CO_2e)
LE_{EC}	=	Leakage emissions from electricity consumption (t CO_2e)
$EC_{PE,i}$	=	Electricity consumption in the project from instance *i* during the reporting period (MWh)
$EC_{BE,i}$	=	Electricity consumption in the baseline from instance *i* during the reporting period (MWh)
$EC_{LE,i}$	=	Electricity consumption related to leakage from instance *i* during the reporting period (MWh)
EF_i	=	Emission factor for electricity consumption for instance *i* (t CO_2e/MWh)
TDL_i	=	Transmission and distribution losses related to instance *i* (percent)
i	=	Instance of electricity consumption in the project, baseline, or associated with leakage

For power plants in Scenario B that are newly installed as part of the project activity, the project emissions must be determined by calculating the CO_2e emissions from all fuel combustion using the latest approved version of CDM *TOOL03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*. Determining the electricity consumed and an emission factor may still be necessary to estimate baseline emissions, as described in Section 5.3.

5.1 Determining Electricity Consumed ($EC_{PE,i}$, $EC_{BE,i}$, $EC_{LE,i}$)

5.1.1 Measurement Approaches

Electricity consumed (*EC*) must be determined using one or a combination of the measurement approaches described below.

1) **Direct measurement of electricity consumed**

The quantity of electricity consumed by the project, or associated with leakage, is directly and continuously monitored. This is the preferred approach. For project activities that consume electricity from shared captive power plants with a grid connection (Scenario C) and purpose-built wheeling arrangements (Scenario D), the electricity consumption must be determined using direct measurement.

2) **Estimation of electricity consumed**

The quantity of electricity consumed in the baseline may be estimated for some or all electrical loads without restriction.

The quantity of electricity consumed in the project, or associated with leakage, may be estimated for some or all electrical loads where the emissions from estimated electricity consumption are less than five percent of the total estimated emission reduction or removals of the project.

The electricity consumption is estimated with one of the following options:

a) **Proxy measurements:** The proponent must demonstrate in the project description that the proxy process correlates well and reliably with the electricity consumption. This may be shown using an analytical approach or a statistical analysis of empirical data. A minimum R^2 (coefficient of determination) of 0.75 must be achieved when using a regression model in statistical analysis.

The quantity in MWh of electricity consumed must be determined using the correlation between electricity consumption and the proxy process for the reporting period.

b) **Duty cycle correlations:** The proponent must determine the quantity in MWh of electricity consumed by assuming the electrical loads operate at either their rated (maximum) capacity or at a rate determined by proxy measurements (meeting the requirements described above) for the intervals of time (duty cycles) that are directly measured during the reporting period.

c) **Rated capacity and full duty:** The electricity consumption of the load(s) to be estimated in the project or as leakage is the quantity in MWh of electricity consumed when the loads are operated at full capacity and continuously for the reporting period.

The estimated electricity consumption of the load(s) in the baseline is zero.

5.1.2 Purpose-Built Wheeling Arrangements

The quantity of electricity consumed from purpose-built low-carbon power plants must be determined based on an annual reconciliation (or by reporting period, whichever is shorter) of the quantity of electrical energy consumed by the project and electrical energy generated by the power plant, discounted for transmission and distribution losses as described by Equation (4).

Approach 1 (direct measurement) from Section 5.1.1 must be applied when determining electricity consumed using purpose-built wheeling arrangements.

$$EC_{PE,D} = MIN(EC_{PE}, \frac{EG_{PBWA}}{1 + TDL}) \quad (4)$$

Where:

$EC_{PE,D}$ = Quantity of electricity consumed by the project in the year or reporting period in Scenario D (MWh)

EC_{PE} = Electricity consumption in the project during the year or reporting period (MWh)

EG_{PBWA} = Quantity of electricity generated by the purpose-built wheeling arrangement power plant in the year or reporting period (MWh)

TDL = Average transmission and distribution losses during the year or the reporting period

For periods in which the electrical energy consumed by the project is greater than that delivered by the purpose-built low-carbon facility, the remainder must be determined as grid electricity consumption (Scenario A).

5.1.3 Uncertainty

The uncertainty for electricity consumption may be estimated according to Table 1 below.

Table 1: Uncertainty for Electricity Consumption

Measurement Approach	Uncertainty Estimation
Electricity measured	The uncertainty of this approach is based on 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.
Proxy	The uncertainty of estimated electricity consumed through the proxy measurement approach (proxy measurement alone or with duty cycle) is 30% (conservative default) or, as demonstrated by project-specific statistical analysis of the correlation error of proxy measurements and electricity consumption.
Duty cycle	The uncertainty of estimated electricity consumed in the project or as leakage through the duty cycle (without any proxy measurement) is high. • As the project scenario is a case of maximum conservativeness, uncertainty may be assumed to be zero. • In the baseline scenario, the uncertainty may be estimated as 50%. The uncertainty of estimated electricity consumed through the duty cycle (with proxy measurement) is the same as that for proxy measurements.
Rated capacity	The uncertainty of estimated electricity consumed in the project or as leakage through the rated capacity approach is high.

	• As the project scenario is a case of maximum conservativeness, uncertainty may be assumed to be zero. • In the baseline scenario, the uncertainty may be estimated as 50%.
Purpose-built wheeling arrangements	The uncertainty for electricity consumed from purpose-built wheeling arrangement plants is determined based on the uncertainty for $EC_{PE,D,}$ or EG_{PBWA}, whichever is used to determine electricity emissions.

5.2 Determining Transmission and Distribution Losses (TDL_i)

The average technical transmission and distribution losses (TDL_i) for providing electricity consumed must be determined using one of the following approaches:

- The annual average value is based on the most recent data available within the host country, mini-grid, or equivalent. The uncertainty for this option is 5 percent (applied to the absolute value of TDL emissions).
- A conservative default value of 20 percent in the project scenario and zero percent in the baseline may be used. The uncertainty for this option may be assumed to be zero because the value is already conservatively high. *TDL* should be estimated for the distribution and transmission networks of the electricity grid at the same voltage as the connection to which the project is connected. The technical distribution losses should not contain other grid losses (e.g., commercial losses, theft).

For instances where a power plant is on-site, *TDL* may be assumed to be zero. The uncertainty for this option is negligible.

5.3 Determining Emission Factor (EF_i)

The emission factors (EF_i) must be determined for each scenario as described below.

5.3.1 Scenario A: Grid Electricity Consumption

For grid electricity consumption, the following applies to determining EF_i:

1) The procedures in the latest version of CDM *TOOL07 Tool to calculate the emission factor for an electricity system* should be used (this is the preferred option):
   a) For projects that increase electricity consumption from the baseline to the project scenario (including leakage), use the combined margin EF of the grid.
   b) For projects that decrease electricity consumption from the baseline to the project scenario (including leakage), use the operating margin EF.
2) Where data for Option 1 are not available, proponents may use a contemporary national grid EF from CDM-approved standardized baselines.[3]

[3] Available at: https://cdm.unfccc.int/methodologies/standard_base/index.html

3) Where Options 1 and 2 are not available, proponents may use a contemporary national grid EF approved by the relevant National Authority or Designated National Authority (DNA) under CDM or the UNFCCC focal point where there is no DNA.

4) Where Options 1, 2, and 3 are not available, proponents may use contemporary IFI emission factors[4] published on the UNFCCC website.

5.3.2 Scenario B: On-site and Dedicated Captive Power Plants

Project Emissions

For power plants in Scenario B that are newly installed as part of the project activity, the project emissions must be determined by calculating the CO_2e emissions from all fuel combustion using the latest approved version of CDM *TOOL03 Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion*. Determining the electricity consumed and an emission factor may still be necessary to estimate baseline emissions, described in the next sub-section.

For power plants in Scenario B that existed before the start of the project, or are otherwise in the baseline scenario, and continue operations into the project activity, the emission factor EF_i must be determined using one of the following:

(1) the simplified approach as described in Section 5.3.2.1, or

(2) using Equation (6), which determines the maximum emission factor of the power plant and grid, as shown below:

$$EF_{i,B} = MAX(EF_{plant}, EF_{i,A}) \quad (5)$$

Where:

$EF_{i,B}$	=	Emission factor for electricity consumption in Scenario B (t CO_2/MWh)
EF_{plant}	=	Emission factor for electricity generation based on plant specific fuel consumption using Equation (6) (t CO_2/MWh)
$EF_{i,A}$	=	Grid emission factor in scenario A in Section 5.3.1. (t CO_2/MWh)

The following equation gives the emission factor for electricity generation based on plant specific fuel consumption.

$$EF_{plant} = \frac{\sum_n \sum_f Q_{n,f} \times NCV_f \times EF_{CO2,f}}{\sum_n EG_n} \quad (6)$$

[4] Available at: https://unfccc.int/climate-action/sectoral-engagement/ifis-harmonization-of-standards-for-ghg-accounting/ifi-twg-list-of-methodologies

Where:

EF_{plant} = Emission factor for electricity generation based on plant specific fuel consumption (t CO_2/MWh)

$Q_{n,f}$ = Quantity of fuel type *f* fired in captive power plant *n* (mass or volume unit)

NCV_f = Average net calorific value of fuel type *f* (GJ/mass or volume unit)

$EF_{CO2,f}$ = Average CO_2 emission factor of fuel type *f* (t CO_2/GJ)

EG_n = Quantity of electricity generated in captive power plant *n* (MWh)

f = Index value denoting fuel type

n = Index value denoting captive power plant

Baseline Emissions

For power plants in Scenario B that existed before the start of the project, or are otherwise in the baseline scenario, the emission factor EF_i must be determined using the following:

1. For power plants that continue operations into the project, the same emission factor as the project,
2. For power plants that don't continue operations into the project, use Equation (6), or as described in Section 5.3.2.1.

5.3.2.1 Simplified Approaches

Project proponents may choose to use the following simplified approach to determine the emission factor for fossil fuel power plants in Scenarios B or C:

1) A default value of 1.3 t CO_2/MWh for:
   a) the project or leakage; or
   b) the baseline where consumption increases in the project scenario.
2) A default value of 0.4 t CO_2/MWh for:
   a) the baseline; or
   b) the project scenario where it decreases compared to the baseline.

5.3.3 Scenario C: Shared Captive Power Plant

5.3.3.1 Off-grid Shared Captive Power Plant

For off-grid captive power plants that deliver electricity to the project activity and neighboring consumers through direct connection or mini-grids, determine the *EF* using Equation (6).

5.3.3.2 Co-generation Captive Power Plant

In the case of a co-generation (or combined heat and power plant), a captive plant is used to generate electricity together with steam, heat, and/or cooling.

The emissions from fuel combustion in a shared co-generation captive power plant must be allocated when the project activities and neighboring consumers consume electricity, heat, or cooling power. The emission factor for the co-generation plant is thus determined by subtracting heat/cooling power as follows:

$$EF_{i,C} = \frac{\left(\sum_n \sum_f (Q_{n,f} \times NCV_f) - \frac{HG_n}{\eta_{boiler}}\right) \times EF_{CO2,n}}{\sum_n EG_n} \quad (7)$$

Where:

$EF_{i,C}$	=	Emission factor for electricity in the reporting period in scenario C (t CO_2/MWh)
$Q_{n,f}$	=	Quantity of fuel type *f* fired in captive power plant *n* (mass or volume unit)
NCV_f	=	Average net calorific value of fuel type *f* used in the reporting period (GJ/mass or volume unit)
HG_n	=	Quantity of heat co-generated in captive power plant *n* (GJ)
η_{boiler}	=	Efficiency of the boiler in which heat is generated in the co-generation plant
$EF_{CO2,n}$	=	Average CO_2e emission factor of the fuels fired in captive power plant *n* (t CO_2/GJ)
EG_n	=	Quantity of electricity generated in captive power plant *n* (MWh)
f	=	Index value denoting fuel type
n	=	Index value denoting captive power plant

5.3.4 Scenario D: Purpose-Built Wheeling Arrangement

For projects with purpose-built wheeling arrangements, the following applies:

1) Type 1: For electricity supplied by solar (thermal or PV), wind, run-of-river hydro, or nuclear power plants, the emission factor is 0 t CO_2/MWh.
2) Type 2: Project-specific emission factors must be demonstrated for reservoir hydro, dedicated thermal biomass, and geothermal.

5.3.5 Uncertainty

The uncertainty for each emission factor (EF_i) is provided in Table 2.

Table 2: Uncertainty for Emission Factor

Emission Factor Source	Uncertainty Estimation
Project-specific data obtained for the relevant regional or national grid	Propagate input value uncertainties as per *VCS Methodology requirements*[5]
Regional government, electric system operator-published values, or national government-published values for jurisdictions where the electricity system is operated nationally	Reference value applies to the reporting period: 2%

[5] Guidance on Uncertainty is available in the latest version of the VCS Methodology requirements

	Reference value does not apply to the reporting period: 10%
National government published values for jurisdictions where the electricity system is operated with distinct sub-regions or reference values from CDM standardized baseline, relevant National Authority, DNA, UNFCCC focal point, or IFI.	Reference value applies to the reporting period: 5% Reference value does not apply to the reporting period: 20%
Simplified approach using a default conservative value (where emission factor uncertainty is high, but the estimate is conservative)	Zero
Purpose-built wheeling arrangements	Type 1: Zero Type 2: Project-specific estimate required

6 DATA AND PARAMETERS

6.1 Data and Parameters Available at Validation

Data/Parameter	η_{boiler}
Data unit	percent
Description	Efficiency of the boiler in which heat is assumed to be generated in the absence of a co-generation plant
Equations	(7)
Source of data	Meter measurements
Description of measurement methods and procedures to be applied	Measurement of efficiency where a heat-only boiler is installed and in operation at the site of a captive power plant(s)
Frequency of monitoring/recording	At the start of the project
QA/QC procedures to be applied	Cross-check measurement results with records for heat sold and other energy measurements where relevant.
Purpose of data	Calculation of baseline and project emissions
Calculation method	Use national or international standards to determine the boiler efficiency, or in the absence of sufficient information, use manufacturer specifications.
Comments	This is only applicable to project or baseline activities where CO_2 emissions from co-generation 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*
Data unit	MWh
Description	Quantity of electricity consumed by the project in the reporting period
Equations	(1), (2), (3)
Source of data	Measured or estimated, see Section 5.1
Description of measurement methods and procedures to be applied	See Section 5.1
Frequency of monitoring/recording	Measured data must be monitored continuously. Estimates and monitored data are recorded monthly.
QA/QC procedures to be applied	Metered electricity consumption must be cross-checked with receipts/invoices from electricity bills where applicable. Deduct uncertainty according to instructions specific to the methodology used.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	See Section 5.1
Comments	None

Data/Parameter	*TDL*
Data unit	percent
Description	Average technical transmission and distribution losses for providing electricity consumed in the project boundary
Equations	(1), (2), (3)
Source of data	Estimated, see Section 5.2
Description of measurement methods and procedures to be applied	See Section 5.2
Frequency of monitoring/recording	Annually. Where data from the relevant year are not available, the most recent available values must be used.
QA/QC procedures to be applied	Deduct uncertainty according to instructions specific to each methodology.

Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	See Section 5.2
Comments	*TDL* is expressed as decimal equivalent (i.e., 20% is expressed as 0.20)

Data/Parameter	EF_i
Data unit	t CO_2e/MWh
Description	Emission factor for the source during the reporting period
Equations	(1), (2), (3), (6)
Source of data	Measured or estimated, see Section 5.3
Description of measurement methods and procedures to be applied	See Section 5.3
Frequency of monitoring/recording	• Once for each crediting period using the most recent three historical years for which data are available at the time of submission for validation (ex-ante option); or • Annually, during the reporting period
QA/QC procedures to be applied	For grids, cross reference other available sources of data for determining *EF* and justify the source used considering the quality of data, time period, and potential biases. For captive power plants, cross reference on-site meters with fuel invoices.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	See Section 5.3
Comments	None

Data/Parameter	*EG*
Data unit	MWh
Description	Total quantity of electricity generated in the captive power plant or purpose-built power plant in the reporting period
Equations	(4), (6), (7)
Source of data	Direct measurements
Description of measurement methods and procedures to be applied	Measured using calibrated meters at the site of generation. When used in the baseline, 3 years of historical records must be used.
Frequency of monitoring/recording	Continuously, aggregated at least annually.

QA/QC procedures to be applied	Cross-check measurement results with records for electricity sold, where relevant.
Purpose of data	Calculation of baseline, project, and leakage emissions
Calculation method	N/A
Comments	None

Data/Parameter	*Q*
Data unit	Mass or volume unit at reference conditions per year (in m^3, tonne, or L)
Description	Quantity of fuel type fired in the power plant.
Equations	(6), (7)
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 accepted where they are correctly calibrated and receive maintenance per manufacturer specifications.
Frequency of monitoring/recording	Continuously, aggregated at least annually.
QA/QC procedures to be applied	The consistency of metered fuel consumption quantities should be cross-checked with an annual energy balance based on purchased quantities and stock changes.
Purpose of data	Calculation of baseline and project emissions
Calculation method	When used in the baseline, 3 years of historical records must be used. Baseline volumes must be an average of the historical period.
Comments	None

Data/Parameter	*HG*
Data unit	GJ
Description	Total quantity of thermal energy co-generated in the power plant during the reporting period.
Equations	(7)
Source of data	Direct measurements
Description of measurement methods and procedures to be applied	Measurement of the inlet steam (or other heat transfer medium) flow and physical properties and, the feedwater return, and any condensate return flow and physical properties.

	The respective enthalpies should be determined based on the mass (or volume) flows, temperatures, and pressure in the case of superheated vapors.
Frequency of monitoring/recording	Continuously, aggregated at least annually.
QA/QC procedures to be applied	Cross-check measurement results with records for heat sold 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 co-generation are allocated to heat and power.

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	(6), (7)
Source of data	The following data sources may be used where the relevant conditions apply, listed in descending order of preference: 1) Values provided by fuel supplier in invoices. 2) Measurements by project proponents 3) Regional or national default values. These sources 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 percent confidence interval as provided in Table 1.2 of Chapter 1 of Vol. 2 (Energy) of the *IPCC Guidelines for National GHG Inventories*
Description of measurement methods and procedures to be applied	For (1) and (2): Measurements should comply with national or international fuel standards.

Frequency of monitoring/recording	For (1) and (2): The NCV should be obtained for each fuel delivery, from which weighted average 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), (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, collect additional information from the testing laboratory to justify the outcome or 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
Calculation method	When used in the baseline, 3 years of historical records must be used. Baseline value must be an average of the historical period.
Comments	None

Data/Parameter	EF_{CO2}
Data unit	t CO_2/GJ
Description	CO_2 emission factor of the fossil fuel type used in the reporting period
Equations	(6), (7)
Source of data	The following data sources may be used where the relevant conditions apply, listed in descending order of preference: 1) Values provided by fuel supplier in invoices. 2) Measurements by project proponents 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 percent confidence interval as provided in Table 1.4 of Chapter 1 of Vol. 2 (Energy) of the *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 average 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 *IPCC Guidelines for National GHG Inventories*. Where the values fall outside of this range, collect additional information from the testing laboratory to justify the outcome or conduct additional measurements.
Purpose of data	Calculation of baseline and project emissions
Calculation method	When used in the baseline, 3 years of historical records must be used. Baseline value must be an average of the historical period.
Comments	None

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.