TOOL31

Methodological tool

Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings

Version 01.1

United Nations
Framework Convention on
Climate Change

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1. Introduction

1.1. Background

1. This tool provides a methodological framework for the development of standardized baselines for energy-efficiency measures in residential, commercial and institutional buildings.

2. Scope, applicability, and entry into force

2.1. Scope

2. This tool provides a methodological procedure to standardise the specific CO_2 emissions for whole buildings (hereinafter "buildings") in terms of tCO_2/m^2 of floor area of building, taking into account the geographical scope and availability of historical data.

2.2. Applicability

3. This tool covers the determination of specific CO_2 emissions of baseline buildings, associated with the consumption of electricity, fuel and chilled/hot water by buildings. The tool does not cover emissions associated with replacement of refrigerants.

4. This tool is only applicable to determine the specific CO_2 emissions of baseline buildings based on survey.[1]

5. The standardize baseline developed through this tool may be applied in conjunction with any of the following methodologies[2]:

   (a) "AM0091: Energy efficiency technologies and fuel switching in new and existing buildings";

   (b) "AMS-II.E: Energy efficiency and fuel switching measures for buildings";

   (c) "AMS-II.Q: Energy efficiency and/or energy supply projects in commercial buildings";

   (d) "AMS-III.AE: Energy efficiency and renewable energy measures in new residential buildings".

6. When using this tool, relevant provisions from the latest approved versions of the following documents shall be applied:

   (a) "Guideline: Quality assurance and quality control of data used in the establishment of standardized baselines";

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[1] Stakeholders may propose amendments to this tool to include additional approaches (e.g. specific CO_2 emissions for different building categories based on information in regional or international building energy codes or certification systems) following the procedure "Development, revision and clarification of baseline and monitoring methodologies and methodological tools".

[2] Some of these methodologies will require revisions to be compatible with this tool. The MP has requested a mandate from the Board to undertake this work as reflected in the cover note.

(b)   "Procedure: Development, revision, clarification and update of standardized baselines";

(c)   "Standard: Determining coverage of data and validity of standardized baselines";

(d)   "Standard: Sampling and surveys for CDM project activities and programme of activities".

7.   The specific emissions shall be determined for new buildings and/or for existing buildings. The buildings shall:

(a)   Be classified into different categories. Proponents of the standardized baseline can define their own categories or use some or all of the categories listed in the Appendix;

(b)   Belong to the same geographical scope, defined by the proponents of the standardized baseline based on their own criterion[3], taking into account:

(i)   The climatic zones; and

(ii)   The social-economic conditions of the area where the buildings are located.

2.3. Entry into force

8.   The date of entry into force is the date of the publication of the EB 100 meeting report on 31 August 2018.

3.   Definitions

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

10.   In addition, for the purpose of this tool, the following definitions apply:

(a)   **Building unit –** distinct space in a building allotted to a specific user, which can be either a tenant or owner. If a building has more than one tenant/owner, a building unit is defined as a subordinate structure of a building rented by one tenant or used by an owner. If a building is used by a single tenant/owner, the building unit is equal to the entire building;

(b)   **Gross floor area (GFA) –** area occupied by internal walls and partitions of a building unit. If a building unit contains common service areas in its physical boundary (meeting rooms, corridors, lift wells, plant and machinery, etc.), include GFA of the common service areas. Otherwise, GFA of the common service areas shall be excluded;

(c)   **Chilled water system –** comprises all components needed to provide the cooling services by chilled water. It comprises one or several chillers plus ancillary equipment such as pumps for circulating chilled water and the condensing water and the fans to be used for circulating the cooling air in the condenser, associated piping, and the fans used to facilitate cooling at the cooling tower;

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[3] The proponents of the standardized baseline can further expand the definition of geographical scope provided proper justifications and evidences.

(d) **Chilled water –** water or water mixture that circulates through an evaporator unit, where it is cooled by a refrigerant as the latter evaporates. The chilled water in turn circulates to the applications that need to be cooled (e.g. space in buildings), where it exchanges heat, and is re-circulated back to the evaporation unit;

(e) **Hot water system –** a hot water system comprises all components needed to provide hot water. It consists of heat sources, water treatment apparatus, water heaters, pipelines to transport the hot water, and devices to regulate and control the water's temperature;

(f) **Data coverage period –** the period for which activity data on the operation of the buildings (i.e. electricity consumed, fuel consumed and hot/chilled water consumed) is collected for the establishment or update of a standardized baseline. The following provisions apply[4]:

  (i) By default, activity data of three years are required;

  (ii) Exceptionally, one year of activity data may be used when the related conditions specified under section "4.1. Constant standardized baselines" of the "Standard: Determining coverage of data and validity of standardized baselines" are met.

(g) **Data currentness –** the time gap between the end of the data coverage period and the complete submission of the standardized baseline. The following provisions apply[4]:

  (i) The most recent data available shall be used, and the data currentness shall be no more than two years; or

  (ii) Exceptionally, the data currentness may be up to five years when the related conditions specified under section "5. Data currentness" of the "Standard: Determining coverage of data and validity of standardized baselines" are met.

(h) **Cohort of existing buildings** – buildings that have finalized the construction more than five years before the end of the data coverage period;

(i) **Cohort of new buildings** – buildings that have finalized the construction within the five years before the end the data coverage period;

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[4] These requirements are derived from the standard "Determining coverage of data and validity of standardized baselines"

Figure 1.   Example on how to determine the cohort of new and existing buildings and the allowed data currentness for a SBL submitted in 2018
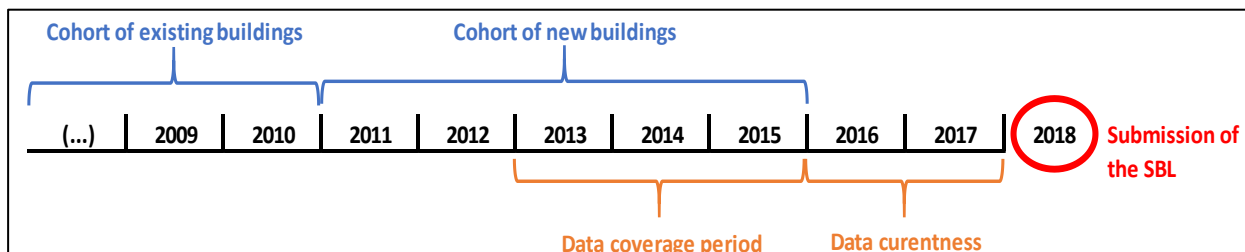
4.   Determination of the specific CO_2 emissions in buildings

11.   The specific CO_2 emissions are determined based on benchmark using the top-20% best performing buildings. Under this approach, a survey is conducted separately for new and for existing buildings through a sample of similar building units that:

(a)   Belong to the same building category; and

(b)   Are located in the same geographical scope.

12.   Data from existing official surveys[5] may be used if the requirements on data currentness, specified in Section 3 above, are met. Data from the buildings is collected either through a census of all the building units or through a survey using a sampling approach. If sampling is used the requirements from the "Standard: Sampling and surveys for CDM project activities and programme of activities" shall be complied with.

13.   The information related to the electricity, fuel and chilled/hot water consumption for new and existing buildings shall be collected following the requirements of data coverage period as specified in Section 3 above.

14.   The average specific CO_2 emissions from the top-20% best performing buildings under the building category i over the applicable data coverage period for new and existing buildings is determined following the equation below:

$$SE_{CO2,Top20\%,i} = \frac{\sum_j SE_{CO2,Top20\%,j,i,BL}}{J_{i,BL}}$$

Equation (1)

Where:

$SE_{CO2,Top20\%,i}$	=	Average specific CO_2 emissions of the top 20 per cent performing building units in building unit category i included in the sample over the applicable data coverage period ($tCO_2/(m^2.year)$)
$SE_{CO2,Top20\%,j,i,BL}$	=	Specific CO_2 emissions of building unit j in the top 20% performing building units in building unit category i included in the sample over the relevant data coverage period ($tCO_2/(m^2. year)$)

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[5] For example, surveys conducted by national authorities.

$J_{i,BL}$	=	Total number of the top 20 per cent performing building units of building unit category i in each of the years of the applicable data coverage period, calculated as the product of the number of baseline building units in building category i included in the sample and 20 per cent, rounded up to the next integer if it is decimal[6]

15. The specific emissions of baseline building unit j in building unit category i included in the sample over the applicable data coverage period are determined following the equation below:

$$SE_{j,i,BL} = \frac{BE_{electricity,j,i,BL} + BE_{fuel,j,i,BL} + BE_{water,j,i,BL}}{GFA_{j,i,BL}} \qquad \text{Equation (2)}$$

Where:

$SE_{j,i,BL}$	=	Specific CO_2 emissions of baseline building unit j in building unit category i included in the sample over the applicable data coverage period $(tCO_2/(m^2 \cdot year))$
$BE_{electricity,j,i,BL}$	=	Baseline emissions from electricity consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period $(tCO_2/year)$
$BE_{fuel,j,i,BL}$	=	Baseline emissions from fossil fuel consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period $(tCO_2/year)$
$BE_{water,j,i,BL}$	=	Baseline emissions from chilled/hot water consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period $(tCO_2/year)$
$GFA_{j,i,BL}$	=	GFA of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (m^2)

4.1.1. Average baseline emissions from electricity consumption

16. The emissions associated with the consumption of electricity are determined based on the specific electricity consumption from different sources by the building unit j under the building category i (new or existing) included in the sample over the applicable data coverage period, multiplied by the emission factor of the source providing electricity to the building unit j, as follows:

$$BE_{electricity,j,i,BL} = \left(EC_{grid,j,i,BL} \times EF_{grid,j,i}\right) \qquad \text{Equation (3)}$$
$$+ \left(EC_{captive,j,i,BL} \times EF_{captive,j,i,BL}\right)$$

Where:

$BE_{electricity,j,i,Bl}$	=	Baseline emissions from electricity consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period $(tCO_2/year)$

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[6] For example, if the sample size is 22, the number of building units that will comprise the top-20% is 22 x 20% = 4.4, which is rounded up to 5.

$EC_{grid,j,i,BL}$	=	Grid electricity consumed by the baseline building unit j in building unit category i included in the sample over the applicable data coverage period (MWh/year)
$EF_{grid,j,i}$	=	Emission factor of the electric grid supplying electricity to the baseline building unit j in building unit category i (tCO₂e/MWh), determined applying the "TOOL07: Tool to calculate the emission factor for an electricity system", using the most recent data available
$EC_{captive,j,i,BL}$	=	Captive electricity consumption by the baseline building unit j in building unit category i included in the sample over the applicable data coverage period (MWh/year)
$EF_{captive,j,i}$	=	Emission factor of the captive power plant(s) supplying electricity to the baseline building unit j in building unit category i (tCO₂e/MWh)

4.1.2. Average baseline emissions from fossil fuel consumption

17. The emissions associated with the consumption of different types of fuel are determined based on the sum of the amounts of fuel type k consumed by the building unit $j,$ under building category i (new or existing) included in the sample over the applicable data coverage period, multiplied by the fuel's net calorific value and CO_2 emission factor, as follows:

$$BE_{fuel,j,i,BL} = \sum_k FC_{k,j,i,BL} \times NCV_k \times EF_{CO2,k}$$

Equation (4)

Where:

$BE_{fuel,j,i,BL}$	=	Baseline emissions from fossil fuel consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (tCO₂/year)
$FC_{k,j,i,BL}$	=	Amount of fossil fuel type k consumed by the building unit j in building unit category i included in the sample over the applicable data coverage period (mass or volume units/year)
NCV_k	=	Net calorific value of the fossil fuel type k (GJ/mass or volume units)
$EF_{CO2,k}$	=	CO₂ Emission factor of the fuel type k (tCO₂/GJ)

4.1.3. Average baseline emissions from chilled/hot water consumption

18. The emissions associated with the consumption of chilled/hot water are determined based on the energy required to produce the chilled/hot water and on the distribution losses of the water distribution network, as follows:

$$BE_{water,j,i,BL} = \frac{WC_{j,i,BL} \times EF_{WP,j,i,BL}}{1 - \eta_{dist,s,BL}}$$

Equation (5)

Where:

| $BE_{water,j,i,BL}$ | = | Baseline emissions from chilled/hot water consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (tCO₂/year) |

$WC_{j,i,BL}$	=	Energy content of the chilled/hot water consumption in baseline building unit j in building unit category i included in the sample over the applicable data coverage period (GJ/year)
$EF_{WP,j,i,BL}$	=	Emission factor for production of chilled/hot water that is supplied to baseline building unit j in building unit category i included in the sample over the applicable data coverage period (tCO_2/GJ)
$\eta_{dist,s,BL}$		Average technical distribution losses of the chilled/hot water system s network serving baseline building unit j in building unit category i included in the sample over the applicable data coverage period (GJ of technical thermal energy losses in the chilled/hot water distribution network divided by GJ of thermal energy supplied to the building units)

19. The parameter $WC_{j,i,BL}$ can be calculated using heat meters or using mass flow-meters and temperature sensors as indicated in the equations below:

$$WC_{j,i,BL} = m_{j,i,BL} \times \Delta t_{j,i,BL} \times C_m \qquad \text{Equation (6)}$$

Where:

$m_{j,i,BL}$	=	Mass of chilled/hot water consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (kg/year)
$\Delta t_{j,i,BL}$	=	Average temperature difference between the outlet water and inlet water of the cooling/heating system used for the cooling/heating of building unit j in building unit category i included in the sample over the applicable data coverage period (K)
C_m	=	Specific heat capacity of the chilled/hot water (GJ/(kg$\cdot$ K))

20. If the amount of water is measured using volumetric flow-meters, the mass of water consumed is determined by multiplying the volumetric readings by the density of the water as indicated in the equation below:

$$m_{j,i,BL} = v_{j,i,BL} \times \rho_{H2O} \qquad \text{Equation (7)}$$

Where:

| $v_{j,i,BL}$ | = | Average chilled/hot water consumption (in volume) of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (m^3/year) |
| ρ_{H2O} | = | Density of the chilled/hot water (kg/m^3) |

21. The emission factor for chilled/hot water production ($EF_{WP,j,i,BL}$) shall be calculated for each centralised chilled/hot water system s that supplies the chilled/hot water to the respective building unit j in building unit category i included in the sample over the applicable data coverage period, according to the equation below:

$$EF_{WP,j,i,BL} \qquad \text{Equation (8)}$$

$$= \frac{\left(EC_{WP,s,BL} \times EF_{CO2,s,electricity}\right) + \left(\sum_f FC_{WP,k,s,BL} \times NCV_k \times EF_{CO2,k}\right)}{m_{s,BL} \times \Delta t_{s,BL} \times C_m}$$

Where:

$EC_{WP,s,BL}$	=	Electricity consumed to produce the chilled/hot water system s over the applicable data coverage period (MWh/year)
$EF_{CO2,s,electricity}$	=	CO_2 emission factor of power source to which the chilled/hot water system s is connected to (tCO2e/MWh). If the source is grid electricity, the monitoring provisions of the parameter $EF_{grid,j,i}$ shall apply; if the source is a captive power plant, the monitoring provisions of the parameter $EF_{captive,j,I}$ shall apply.
$FC_{WP,k,s,BL}$	=	Amount of fossil fuel type k consumed to produce the chilled/hot water system s over the applicable data coverage period (mass or volume unit/year)
NCV_k	=	Net calorific value of the fossil fuel k (GJ/mass or volume unit)
$EF_{CO2,k}$	=	CO_2 emission factor of the fossil fuel type k (tCO2/GJ)
$m_{s,BL}$	=	Mass of chilled/hot water production by chilled/hot water system s over the applicable data coverage period (kg/year)
$\Delta t_{s,BL}$	=	Average temperature difference between the outlet and inlet of the heat exchanger used for the chilled/hot water production in chilled/hot water system s over the applicable data coverage period (K)
C_m	=	Specific heat capacity of the chilled/hot water (GJ/(kg. K))

5. Fixed Parameters

Data / Parameter table 1.

Data / Parameter:	C_m
Data unit:	GJ/(kg·. K)
Description:	Specific heat capacity of the chilled/hot water
Source of data:	Engineering handbook E.g. "Water – Thermal Properties", <https://www.engineeringtoolbox.com/water-thermal-properties-d_162.html>.
Measurement procedures (if any):	-
Monitoring frequency:	-
QA/QC procedures:	-
Any comment:	-

Data / Parameter table 2.

Data / Parameter:	ρ_{H2O}
Data unit:	kg/m^3
Description:	Density of the chilled/hot water.
Source of data:	E.g. "Water – Thermal Properties", <https://www.engineeringtoolbox.com/water-thermal-properties-d_162.html>.
Measurement procedures (if any):	-
Monitoring frequency:	-

QA/QC procedures:	-
Any comment:	-

6. Monitored Parameters

Data / Parameter table 3.

Data / Parameter:	$GFA_{j,i}$
Data unit:	m²
Description:	Gross Floor Area of baseline building unit j in building unit category i (three years or one year *average* of the data coverage period as determined following para 10 (f))
Source of data:	The following data sources may be used if the relevant conditions apply:<table><tr><th>Data Source</th><th>Conditions for using the data source</th></tr><tr><td>Building plan</td><td>Preferred source</td></tr><tr><td>On-site measurement</td><td>If the building plan is not available</td></tr></table>
Measurement procedures (if any):	-
Monitoring frequency:	N/A. This parameter is measured once for determining the SBL.
QA/QC procedures:	When determined through the building plan, confirm on-site that building geometry represented in the plan is accurate;
Any comment:	

Data / Parameter table 4.

Data / Parameter:	$EC_{grid,j,i,BL}$ / $EC_{captive,j,i,BL}$ / $EC_{WP,s,BL}$
Data unit:	MWh/year
Description:	$EC_{grid,j,i,BL}$: Grid electricity consumption by the baseline building unit j in building unit category i included in the sample. $EC_{captive,j,i,BL}$: Captive electricity consumption by the baseline building unit j in building unit category i included in the sample. $EC_{WP,s,BL}$: Electricity consumed to produce the chilled/hot water system for the baseline building unit j in building unit category i in the sample. Take average of the data from the coverage period (i.e., three or one year as determined following para 10 (f))
Source of data:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

Measurement procedures (if any):	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". When applying the tool, requirements for $EG_{PJ,grid,y}$ and/or $EG_{PJ,j,y}$ specified in the tool should apply to electricity consumed form the grid ($EC_{grid,j,i,BL}$)and electricity consumed by any the captive power plant ($EC_{captive,j,i,BL}$). $EC_{WP,s,BL}$ shall refer to $EG_{PJ,grid,y}$ and/or $EG_{PJ,j,y}$ depending on the source of electricity (i.e. grid electricity or captive power plant).
Monitoring frequency:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation"
QA/QC procedures:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation". The records shall be cross-checked against electricity purchase invoices.
Any comment:	If the electricity consumed is measured for the whole building and not individually for each building unit, this parameter shall be determined by multiplying the electricity consumed by the whole building by the ratio between the GFA of the building unit i and the GFA of the total building, as follows: $$EC_{grid,j,i,BL} = EC_{Bldg,BL} \times \frac{GFA_{j,i}}{GFA_{Bldg}}, \text{ where}$$ If the electricity is supplied by a captive power plant, $EC_{grid,j,i,BL}$ is replaced by $EC_{captive,j,i,BL}$; $EC_{Bldg,BL}$ = electricity consumed by the whole building, which baseline building unit j in building unit category i belongs to over the applicable data coverage period (MWh/year); GFA_{Bldg} = gross floor area of the whole building which baseline building unit j in building unit category i belongs to (m²)

Data / Parameter table 5.

Data / Parameter:	$EF_{grid,j,i}$
Data unit:	tCO_2e/MWh
Description:	Emission factor of the electric grid supplying electricity to the baseline building unit j in building unit category i
Source of data:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system".
Measurement procedures (if any):	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system".
Monitoring frequency:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system".
QA/QC procedures:	As per the latest version of the "TOOL07: Tool to calculate the emission factor for an electricity system".
Any comment:	This parameter is determined using the most recent data available.

Data / Parameter table 6.

Data / Parameter:	$EF_{captive,j,i}$
Data unit:	tCO_2e/MWh
Description:	Emission factor of the captive power plant(s) supplying electricity to the baseline building unit j in building unit category i (tCO_2e/MWh)
Source of data:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Measurement procedures (if any):	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Monitoring frequency:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
QA/QC procedures:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".
Any comment:	As per the latest version of the "TOOL05: Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation".

Data / Parameter table 7.

Data / Parameter:	$FC_{k,j,i,BL}$ / $FC_{WP,k,s,BL}$ / NCV_k / $EF_{CO2,k}$
Data unit:	As per the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"
Description:	$FC_{k,j,i,BL}$: amount of fossil fuel type k consumed by the building unit j in building unit category i included in the sample over the applicable data coverage period. $FC_{WP,k,s,BL}$: amount of fossil fuel type k consumed to produce the chilled/hot water system s over the applicable data coverage period. NCV_k: Net calorific value of the fossil fuel k. $EF_{CO2,k}$: CO_2 Emission factor of the fuel type k. Take average of the data from the coverage period (i.e., three or one year as determined following para 10 (f))
Source of data:	As per the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". When applying the tool, requirements for $FC_{i,j,y}$ should apply to the fossil fuel consumed by the building unit j in building unit category i ($FC_{k,j,i,BL}$) and to the amount of fossil k consumed by the chilled/hot water system over the applicable data coverage period ($FC_{WP,k,s,BL}$); requirements for NCV_k should apply for the net calorific value of the fossil fuel f; and requirements for $EF_{CO2,k}$ should apply for the CO_2 emission factor of the fossil fuel type f.
Measurement procedures (if any):	As per the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".

Monitoring frequency:	As per the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion".
QA/QC procedures:	As per the latest version of the "TOOL03: Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion". The amount of fuel consumed is to be cross-checked against fuel purchase receipts.
Any comment:	If the fuel consumed is measured for the whole building and not individually for each building unit, this parameter shall be determined by multiplying the fuel consumed by the whole building by the ratio between the GFA of the building unit i and the GFA of the total building, as follows: $$FC_{k,j,i,BL} = FC_{k,Bldg,BL} \times \frac{GFA_{j,i}}{GFA_{Bldg}}, \text{ where}$$ $FC_{k,Bldg,BL}$ = annual average amount of fossil fuel type k consumed in the whole building, which baseline building unit j in building unit category i included in the sample belongs to, over the applicable data coverage period (mass or volume unit/year); GFA_{Bldg} = gross floor area of the whole building which baseline building unit j in building unit category i belongs to (m^2)

Data / Parameter table 8.

Data / Parameter:	$m_{j,i,BL}$ / $m_{s,BL}$
Data unit:	kg/year
Description:	$m_{j,i,BL}$: mass of chilled/hot water consumption of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (kg/year). $m_{s,BL}$: mass of chilled/hot water production by chilled/hot water system s over the applicable data coverage period (kg/year). Take average of the data from the coverage period (i.e., three or one year as determined following para 10 (f)).
Source of data:	(a) Utility billing records or (b) On-site measurements.
Measurement procedures (if any):	(a) As per the utility metering; (b) Use mass meters.
Monitoring frequency:	(a) As per the utility metering; (b) Continuously, aggregated at least annually.
QA/QC procedures:	Check consistency of the monitored records with the records from previous monitoring intervals.
Any comment:	Applicable only if a mass flow meter is installed for monitoring of chilled/hot water consumption.

Data / Parameter table 9.

Data / Parameter:	$\Delta t_{j,i,BL}$ / $\Delta t_{s,BL}$
Data unit:	K

Description:	$\Delta t_{j,i,BL}$: Average temperature difference between the outlet and inlet of the heat exchanger used for the cooling/heating of building unit j in building unit category i included in the sample over the applicable data coverage period. $\Delta t_{s,BL}$: Average temperature difference between the outlet and inlet of the heat exchanger used for the chilled/hot water production in chilled/hot water system s over the applicable data coverage period (K).
Source of data:	The following data sources may be used if the relevant conditions apply: <table><tr><th>Data Source</th><th>Conditions for using data source</th></tr><tr><td>(c) Readings taken from temperature meters installed at pipeline of inlet and outlet of the heat exchanger used for the chilled/hot water supply</td><td>This is the preferred source</td></tr><tr><td>(d) Specification of the manufacturer of the chilled/hot water system</td><td>If (a) is not available</td></tr></table>
Measurement procedures (if any):	(a) Readings taken from temperature meters installed at pipeline of inlet and outlet of the heat exchanger; (b) Not applicable.
QA/QC procedures:	-
Any comment:	The temperature meter readings should be installed at the immediate inlet and outlet point of the heat exchanger of the chilled/hot water system.

Data / Parameter table 10.

Data / Parameter:	$v_{j,i,BL}$
Data unit:	m³/year
Description:	Annual average chilled/hot water consumption (in volume) of baseline building unit j in building unit category i included in the sample over the applicable data coverage period (m³/year). Take average of the data from the coverage period (i.e., three or one year as determined following para 10 (f)).
Source of data:	On-site measurements.
Measurement procedures (if any):	Use volume flow-meters
QA/QC procedures:	-
Any comment:	Applicable only if a volume flow meter is installed for monitoring of chilled/hot water production.

Data / Parameter table 11.

Data / Parameter:	$\eta_{dist,s,BL}$
Data unit:	decimal
Description:	Average technical distribution losses of the chilled/hot water system network serving baseline building unit j in building unit category i included in the sample over the applicable data coverage period i.e. GJ of technical thermal energy losses in the chilled/hot water distribution network divided by GJ of thermal energy supplied to the building units. Take average of the data from the coverage period (i.e., three or one year as determined following para 10 (f)).
Source of data:	Monitoring records of thermal energy supply and demand or thermal energy loss measurement. A default value of 0 per cent may be used if no recent data are available or the data cannot be regarded accurate and reliable.
Measurement procedures (if any):	(a) Based on monitoring of thermal energy supply and demand; or (b) Measurement and estimation of surface thermal energy losses. Follow authentic engineering handbooks/ publications or national or international standards for calculation of the surface thermal energy losses.
QA/QC procedures:	-
Any comment:	-

Appendix. List of building units categories

1. This list provides examples of building unit categories eligible under this tool. The list categorizes building units based on two criteria: (i) type of a building unit; and (ii) height of a whole building that the building unit belongs to.

2. Definitions of building unit types eligible under this tool are provided below. Further, a low-rise building is defined as a building with three stories or fewer above grade, and a high-rise building with more than three stories above grade.

   (a) **Residential building units** - building units used for one of the following dwelling purposes:

      (i) **Single-family (low-rise or high-rise)** - this category includes constructions for a single family or household, such as bungalows, cottages, stand-alone houses, semi-detached houses, town houses and row houses;

      (ii) **Multi-family (low-rise or high-rise)** - this category includes apartments in a building that comprises of more than two apartments;

   (b) **Commercial building units** - building units used for one of the following activities focusing on the exchange of goods and/or services for a profit:

      (i) **Office (low-rise or high-rise)** - this category includes, for example, administrative and professional offices, government offices, and banks or other financial institutions;

      (ii) **Hotel (low-rise or high-rise)** - this category includes, for example, hotels, motels, and guest houses;

      (iii) **Warehouse & storage (low-rise or high-rise)** - this category includes, for example, distribution and shipping centers;

      (iv) **Mercantile & service (low-rise or high-rise)** - this category includes the following:

         a. **Retail** - this category includes, for example, shopping stores for furniture, cloths, drugs, books, or building supplies, rental centers for videos or vehicles, dealer shops or showrooms for vehicles, and studios or galleries;

         b. **Food sales** - this category includes, for example, grocery stores or food markets, gas stations with convenience stores, convenience stores, and beer, wine, liquor stores;

         c. **Service** - this category includes, for example, auto repair shops, post offices, photocopy center, beauty parlour or barber shop, gas stations without convenience stores, cleaning, and tanning salon;

d. **Other mercantile & service** - this category includes mercantile & service building units that belong to none of the above categories:

   i. **Food service (low-rise or high-rise)** - this category includes, for example, restaurants or cafeterias, fast foods, bars, reception halls, and catering services;

   ii. **Entertainment (low-rise or high-rise)** - this category includes, for example, cinemas, sports arenas, casinos, and night clubs;

(c) **Institutional building units** - building units used for one of the following activities focusing on not-for-profit services in the public's interest:

(i) **Education (low-rise or high-rise)** - this category includes, for example, preschools or day-care centers, elementary or middle schools, colleges or universities, adult education, career or vocational training, and religious education;

(ii) **Health care (low-rise or high-rise)** - this category includes the following:

   a. **Health care** - this category includes, for example, hospitals, clinics, and rehabilitation centers;

   b. **Nursing** - this category includes, for example, nursing homes, assisted living centers, or other residential care buildings;

   c. **Other health care** - this category includes health care building units that belong to none of the above categories;

(iii) **Public assembly (low-rise or high-rise)** - this category includes the following:

   a. **Social or meeting** - this category includes, for example, community centers, lodges, meeting halls, convention centers, senior centers, student activities centers, and parliamentary buildings;

   b. **Culture** - this category includes, for example, museums, theaters, operas, and concert halls;

   c. **Religious worship -** this category includes, for example, temples, mosques, and churches;

   d. **Recreation –** this category includes, for example, gymnasiums, indoor swimming pools, buildings to serve outdoor recreational facilities and outdoor swimming pools;

      i. **Other public assembly -** this category includes public assembly building units that belong to none of the above categories, such as police and fire stations, other public service stations for road and park maintenance, civil defence, jails, reformatories, and penitentiaries, courthouses and probation offices, other public order and safety, institutional lodging (low-rise or high-rise) such as retirement homes, convent or

monastery, shelters, orphanage, or children's homes, halfway houses, and military barracks.

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Document information

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