Joint Crediting Mechanism Approved Methodology TH_AM016
"Introduction of high energy efficient and high colour rendering LED downlight/spotlight in indoor facilities"

A. Title of the methodology

Introduction of high energy efficient and high colour rendering LED downlight/spotlight in indoor facilities, Version 01.0

B. Terms and definitions

Terms	Definitions
LED light	LED light is a lighting fixture using a light-emitting diode (LED), a semiconductor device that emits visible light when an electric voltage is applied in the forward direction.
Luminous flux	Luminous flux is the measure of the perceived power of the total amount of light energy radiated from a light source in a certain direction. The SI unit of luminous flux is the lumen (lm).
Luminous efficiency	Luminous efficiency is the capacity of light flux per watt, which is calculated with the formula below. Luminous efficiency [lm/W] = Luminous flux [lm] ÷ Rated power consumption [W]
Colour rendering index (CRI)	CRI is an index used to quantitatively measure light source's ability to render the true colours of the object compared to a natural light source. The index is measured from 0 to 100, with a perfect 100 indicating that colours under the light source appear the same as they would under natural sunlight.
Downlight/Spotlight	Downlight is downward lighting directly embedded in ceiling. Spotlight is downward lighting attached to ceiling-mounted wiring ducts.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	This methodology applies to the project that aims for saving energy by introducing LED downlight/spotlight in indoor facilities where high performance in colour rendering property is required.
Calculation of reference emissions	Reference emissions are GHG emissions from using reference lighting, calculated with power consumption of project lighting, ratio of luminous efficiency of project/reference lighting and CO_2 emission factor for consumed electricity.
Calculation of project emissions	Project emissions are GHG emissions from using project lighting, calculated with power consumption of project lighting and CO_2 emission factor for consumed electricity.
Monitoring parameters	Total power consumption of project lighting and/or opening days of facilities where project lighting is installed

D. Eligibility criteria

This methodology is applicable to projects that satisfy all of the following criteria.

Criterion 1	LED lighting is installed in indoor facilities.
Criterion 2	The installed LED lighting is a downlight or spotlight type LED whose colour rendering index is equal to or higher than 85, and luminous efficiency is equal to or higher than the corresponding threshold value set in the table below.

Rated power consumption [W]	$0 \leq x < 40$	$x \geq 40$
Luminous efficiency of reference lighting [lm/W]	73.6	78.0

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Power consumption by reference lighting	CO_2
Project emissions	
Emission sources	GHG types

Power consumption by project lighting	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated with power consumption of project lighting, ratio of luminous efficiency of project/reference lighting and CO_2 emission factor for consumed electricity.

The luminous efficiency of reference lighting is conservatively set *ex ante* in the following manner to ensure the net emission reductions.

1. In Thailand, conventional High Intensity Discharge (HID) lighting is commonly chosen as lighting equipment in case that high performance in colour rendering property is required. However, LED lighting, which is more efficient than HID lighting, is adopted as reference lighting in this methodology for conservativeness.
2. The average luminous efficiency value of LED downlight/spotlight commercially available in the global market is defined as η_{RE} in each rated power consumption range, as described in Section I.

F.2. Calculation of reference emissions

$$\boldsymbol{RE_p = \sum_{i,j}\left(EC_{PJ,i,j,p} \times \frac{\eta_{PJ,i,j}}{\eta_{RE,i,j}}\right) \times EF_{elec,i}}$$

RE_p	:	Reference emissions during the period p [tCO_2/p]
i	:	Identification number of the facility
j	:	Identification number of the group of project lighting of the same model
$EC_{PJ,i,j,p}$	:	Power consumption of project lighting for group j in the facility i during the period p [MWh/p]
$\eta_{PJ,i,j}$	:	Luminous efficiency per unit of project lighting for group j in the facility i [lm/W]
$\eta_{RE,i,j}$	:	Luminous efficiency per unit of reference lighting for group j in the facility i [lm/W]
$EF_{elec,i}$	:	CO_2 emission factor for consumed electricity in the facility i [tCO_2/MWh]

$EC_{PJ,i,j,p}$ is calculated as described below (Option 1 or 2).

- **Option 1.** If total power consumption of project lighting is measured for the facility i,

$$EC_{PJ,i,j,p} = EC_{PJ,i,total,p} \times \frac{P_{PJ,i,j} \times n_{PJ,i,j}}{P_{PJ,i,total}}$$

$$P_{PJ,i,total} = \sum_{j} \left(P_{PJ,i,j} \times n_{PJ,i,j} \right)$$

$EC_{PJ,i,total,p}$: Total power consumption of project lighting in the facility i during the period p [MWh/p]

$P_{PJ,i,total}$: Total rated power consumption in the facility i [W]

$P_{PJ,i,j}$: Rated power consumption per unit of project lighting for group j in the facility i [W]

$n_{PJ,i,j}$: Number of the unit of project lighting for group j in the facility i

- **Option 2.** Otherwise,

$$EC_{PJ,i,j,p} = P_{PJ,i,j} \times n_{PJ,i,j} \times 10^{-6} \times h_i \times D_{i,p}$$

h_i : Daily opening hours of the facility i [hour/day]

$D_{i,p}$: Opening days of the facility i during the period p [day/p]

G. Calculation of project emissions

$$PE_p = \sum_{i,j} EC_{PJ,i,j,p} \times EF_{elec,i}$$

PE_p : Project emissions during the period p [tCO_2/p]

$EC_{PJ,i,j,p}$: Power consumption of project lighting for group j in the facility i during the period p [MWh/p]

$EF_{elec,i}$: CO_2 emission factor for consumed electricity in the facility i [tCO_2/MWh]

H. Calculation of emissions reductions

$$ER_p = RE_p - PE_p$$

ER_p : Emission reductions during the period p [tCO_2/p]

RE_p : Reference emissions during the period p [tCO_2/p]

PE_p : Project emissions during the period p [tCO_2/p]

I. Data and parameters fixed *ex ante*

The source of each data and parameter fixed *ex ante* is listed as below.

Parameter	Description of data	Source
$EF_{elec,i}$	CO_2 emission factor for consumed electricity in the facility *i* [tCO_2/MWh]. When project LED consumes only 1) grid electricity, 2) captive electricity or 3) electricity directly supplied from other sources (e.g. independent power producer (IPP), small power producer (SPP) and very small power producer (VSPP)) to the project site, the project participant applies the CO_2 emission factor respectively. When project LED may consume electricity supplied from more than 1 electric source, the project participant applies the CO_2 emission factor with the lowest value. [CO_2 emission factor] **Case 1) Grid electricity** The most recent value available from the source stated in this table at the time of validation **Case 2) Captive electricity including cogeneration system** $EF_{elec,i}$ is determined based on the following options: a) Calculated from its power generation efficiency ($\eta_{cap,i}$ [%]) obtained from manufacturer's specification The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $EF_{elec,i} = 3.6 \times \frac{100}{\eta_{cap,i}} \times EF_{fuel,cap,i}$	**Case 1)** [Grid electricity] The most recent value available at the time of validation is applied and fixed for the monitoring period thereafter. The data is sourced from "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization unless otherwise instructed by the Joint Committee. **Case 2)** [Captive electricity **including cogeneration system**] For the option a) Specification of the captive power generation system connected to the facility *i*, provided by the manufacturer ($\eta_{cap,i}$ [%]). CO_2 emission factor of the fuel consumed by the captive power generation system connected to the facility *i* ($EF_{fuel,cap.i}$ [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier; 2) measurement by the project participants; 3) regional or national default values; 4) IPCC default values

b) Calculated from measured data

The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{cap,i,p}$) and the amount of electricity generated ($EG_{cap,i,p}$) in the facility i during the period p is applied. The measurement is conducted with the monitoring equipment to which calibration certificate is issued by an entity accredited under national/international standards;

$$EF_{elec,i} = FC_{cap,i,p} \times NCV_{fuel,cap,i} \times EF_{fuel,cap,i} \times \frac{1}{EG_{cap,i,p}}$$

Where:

$NCV_{fuel,cap,i}$: Net calorific value of consumed fuel [GJ/mass or volume]

Note:

In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to $EF_{elec,i}$ depending on the consumed fuel type.

- The system is non-renewable generation system
- Electricity generation capacity of the system is less than or equal to 15 MW

Fuel type	Diesel fuel	Natural gas
$EF_{elec,i}$	0.8 *1	0.46 *2

*1 The most recent value at the time of validation is applied.

*2 The value is calculated with the equation in the option a) above. The lower value of default effective CO_2 emission factor for natural gas (0.0543tCO_2/GJ), and the most

provided in table 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied

For the option b)

Generated and supplied electricity by the captive power generation system connected to the facility i ($EG_{cap,i,p}$ [MWh/p]).

Fuel amount consumed by the captive power generation system connected to the facility ($FC_{cap,i,p}$ [mass or volume/p]).

Net calorific value ($NCV_{fuel,cap,i}$ [GJ/mass or volume]) and CO_2 emission factor of the fuel ($EF_{fuel,cap,i}$ [tCO_2/GJ]) in order of preference:

1) values provided by the fuel supplier;

2) measurement by the project participants;

3) regional or national default values;

4) IPCC default values provided in tables 1.2 and 1.4 of Ch.1 Vol.2 of 2006 IPCC Guidelines on National GHG Inventories. Lower value is applied.

[Captive electricity with diesel fuel]

CDM approved small scale

	efficient value of default efficiency for off-grid gas turbine systems (42%) are applied. **Case 3) Electricity directly supplied from other sources including cogeneration system** $EF_{elec,i}$ is determined based on the following options: a) The value provided by the SPP with the evidence; b) The value calculated in the same manner for the option a) of 2) captive electricity as instructed above; c) The value calculated in the same manner for the option b) of 2) captive electricity as instructed above; When project LED may consume electricity supplied from more than 1 electric source, the project participant applies the CO_2 emission factor with the lowest value.	methodology: AMS-I.A. [Captive electricity with natural gas] 2006 IPCC Guidelines on National GHG Inventories for the source of EF of natural gas. CDM Methodological tool "Determining the baseline efficiency of thermal or electric energy generation systems version02.0" for the default efficiency for off-grid power plants. **Case 3)** [Electricity directly supplied from other sources including cogeneration system] <u>For option a)</u> The evidence stating information relevant to the value of emission factor (e.g. data of power generation, type of power plant, type of fossil fuel, period of time).
$\eta_{PJ,i,j}$	Luminous efficiency per unit of project lighting for group *j* in the facility *i* [lm/W].	Information prepared by manufacturer (e.g. catalogs, specifications, or quotations)
$\eta_{RE,i,j}$	Luminous efficiency per unit of reference lighting for group *j* in the facility *i* [lm/W]. The default values for reference luminous efficiency are set in the table below, corresponding to the rated power consumption of project lighting.	Value derived from the result of survey. The default value should be revised, if necessary.

	<table><tr><th>Rated power consumption [W]</th><th>Reference luminous efficiency [lm/W]</th></tr><tr><td>0 ≤ x < 40</td><td>73.6</td></tr><tr><td>x ≥ 40</td><td>78.0</td></tr></table>	
$P_{PJ,i,j}$	Rated power consumption per unit of project lighting for group *j* in the facility *i* [W].	Information prepared by manufacturer (e.g. catalogs, specifications, or quotations)
$n_{PJ,i,j}$	Number of the unit of project lighting for group *j* in the facility *i*.	Information prepared by project participant (e.g. ledger, inventory or management record etc.)
h_i	Daily opening hours of the facility *i* [hour/day]. When the facility has more than one pattern of opening hours, the shortest one is applied conservatively.	Information on the facility where project lighting is installed.

History of the document

Version	Date	Contents revised
01.0	17 June 2022	Electronic decision by the Joint Committee Initial approval.