Joint Crediting Mechanism Approved Methodology VN_AM003
"Improving the energy efficiency of commercial buildings by utilization of high efficiency equipment"

A. Title of the methodology

Improving the energy efficiency of commercial buildings by utilization of high efficiency equipment, Version 01.1

B. Terms and definitions

Terms	Definitions
High efficiency equipment	Building facility equipment listed in Table 1 of the eligibility criterion 1.
Reference equipment	Equipment whose output is replaced/substituted by the project.
Coefficient of Performance (COP)	For the purpose of this methodology, COP is defined as a ratio of heat supplied to the amount of energy consumed by a chiller or heat pump, and it is defined by using following formula: COP = Q/W Where: Q: Amount of heat supplied by a chiller or a heat pump W: Electric power consumed by a chiller or a heat pump

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	Reduction of electricity and fossil fuel consumed by existing facilities is achieved by replacing or substituting these facilities with high efficiency equipment defined in Table 1 of the eligibility criterion 1.
Calculation of reference emissions	Reference emissions are calculated by multiplying electricity and fossil fuel consumption of the project by the ratio of

	efficiency of reference and project equipment, and emission factors of electricity and fossil fuel. For the installation of high efficiency lighting, reference emissions are calculated using rated electricity consumption of the lighting multiplied by operation hours.
Calculation of project emissions	Project emissions are calculated based on monitored electricity and fossil fuel consumption in the project.
Monitoring parameters	Electricity and fossil fuel consumption of the high efficiency equipment Operating hours of the high efficiency equipment and auxiliary equipment, where applicable

D. Eligibility criteria

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

Criterion 1

The project involves implementation of one or more energy efficiency measures categorized in Table 1 by using high efficiency equipment at an existing facility.

Projects involving installation of high efficiency lighting need to be coupled with another energy saving measure(s) in order to be eligible under this methodology.

High efficiency equipment introduced by the project replaces the existing equipment or substitutes the output of the existing equipment, and it is included in the applicable technologies as shown in Table 1:

Table 1 Applicable Technologies

No	Energy efficiency measures	Applicable technologies and their criteria
1	Energy efficiency improvement by reducing fossil fuel consumption	High efficiency boiler with the following features: - Energy efficiency is greater or equal to 93% (e.g. small once -through boiler); - Equipped with automatic unit number control device; and - Individual performance test report is provided.
2	Fuel switch to electricity and/or efficiency improvement	Heat recovery heat pump using electricity, which generates both cooling and heating energy (temperature of hot water ≥80°C) and uses non-HFC refrigerant with zero Ozone Depletion Potential (ODP)
3	Installation of high efficiency lighting	LED lighting

Criterion 2

If the existing equipment is a chiller containing CFCs, HFCs, or HCFCs and is removed due to the project, a plan to prevent release of refrigerant used for the existing chiller into the atmosphere is prepared. Execution of the prevention plan is checked at the time of verification, in order to confirm that the refrigerant used for the existing chiller is not released to the air.

Criterion 3

High efficiency equipment in the project guarantees a better performance than the reference equipment for a minimum of one year.

The performance level can be confirmed by comparing the efficiency or rated electricity consumption between the high efficiency equipment and the reference equipment, with an evidence of either a manufacturer's performance guarantee or energy saving company's (ESCO) energy saving guarantee of high efficiency equipment. Where such evidence is not available for the reference equipment, high efficiency equipment in the project guarantees a better performance than the default efficiency values provided in the methodology.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Fossil fuel consumption by the reference equipment	CO_2
Electricity consumption by the reference equipment	CO_2
Project emissions	
Emission sources	GHG types
Fossil fuel consumption by the high efficiency equipment	CO_2
Electricity consumption by the high efficiency equipment	CO_2
Electricity consumption by the auxiliary equipment for the high efficiency equipment	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated by multiplying electricity and fossil fuel consumption of the project by the ratio of efficiency of reference and project equipment, and emission factors of electricity and fossil fuel. Individual electricity and fossil fuel consumption are derived from monitored fuel and electricity consumption by the high efficiency equipment. Below are typical examples of reference equipment replaced or substituted by high efficiency equipment.

	Energy efficiency measures	Project equipment	Typical examples of reference equipment
1	Energy efficiency improvement by reducing fossil fuel consumption	High efficiency boiler	Boiler
2	Fuel switch to electricity and/or efficiency improvement	Heat recovery heat pump	Boiler Chiller
3	Installation of high efficiency lighting	LED lighting	Halogen Fluorescent

The methodology ensures net emission reductions by the followings:

1) Adopting conservative default efficiency values for calculation of reference emissions

- Boilers: applying CDM default efficiency for new boilers;

- Chillers: design efficiency of models sold by dominant manufacturers in the chiller market in Vietnam

2) Implementation of multiple measures

Among the three measures introduced in this methodology, one measure (installation of high efficiency lighting) may have a possibility where the calculation result will not demonstrate net emission reductions due to the way the equation is formulated. In order to ensure the net emission reductions, the methodology requires to implement together with other energy efficiency measure(s) stated in table 1 under the eligibility criteria.

F.2. Calculation of reference emissions

Reference emissions are calculated by the following equation:

$$RE_p = \frac{\sum_i EC_{REF,i,p}}{1{,}000} \times EF_{CO2,ELEC} + \sum_i \left(FC_{REF,i,p} \times EF_{CO2} \right) \quad (1)$$

Where

RE_p	Reference emissions during the period p [tCO_2/p]
$EC_{REF,i,p}$	Electricity consumed during the period p by reference equipment corresponding to measure i introduced in the project [kWh/p]
$EF_{CO2,ELEC}$	CO_2 emission factor of electricity consumed [tCO_2/MWh]
$FC_{REF,i,p}$	Fossil fuel consumed during the period p by reference equipment, corresponding to measure i introduced in the project [L/p].
EF_{CO2}	CO_2 emission factor of fossil fuel [tCO_2/L]
i	Type of measure

Measure 1: High efficiency boiler

$$FC_{REF,1,p} = \sum_i FC_{PJ1,i,p} \times \frac{\eta_{PJ1,i}}{\eta_{REF1,i}} \quad (2)$$

Where

$FC_{REF,1,p}$	Total fossil fuel that would have been consumed during the period p by the reference equipment, replaced/substituted by the high efficiency equipment introduced in the project categorized as measure 1 [L/p]
$FC_{PJ1,i,p}$	Fossil fuel consumed during the period p by the high efficiency equipment i

introduced in the project categorized as measure 1 [L/p]

$\eta_{PJ1,i}$ Energy efficiency of the equipment *i* introduced in the project [dimensionless]

$\eta_{REF1,i}$ Energy efficiency of the reference equipment, replaced/substituted by the equipment *i* introduced in the project [dimensionless]

Measure 2: Heat recovery heat pump

$$FC_{REF,2,p} = \sum_i \frac{EC_{PJ2,i,p}}{ECR_i} \times H_i \times DC_i \quad (3)$$

$$EC_{REF,2,p} = \sum_i \frac{EC_{PJ2,i,p}}{ECR_i} \times \frac{CH_i}{COP_i} \quad (4)$$

Where

$FC_{REF,2,p}$ Total fossil fuel that would have been consumed during the period *p* by the reference equipment, replaced/substituted by the high efficiency equipment in the project categorized as measure 2 [L/p]

$EC_{PJ2,i,p}$ Electricity consumed during the period *p* by the high efficiency equipment *i* in the project categorized as measure 2 [kWh/p]

ECR_i Rated electricity consumption of the high efficiency equipment *i* introduced in the project [kW]

H_i Rated heating capacity of the high efficiency equipment *i* in the project [kW]

DC_i Unit fuel consumption rate of the reference equipment that are replaced/substituted by the equipment *i* in the project [L/kWh]

$EC_{REF,2,p}$ Total electricity that would have been consumed during the period *p* by the reference equipment, replaced/substituted by the high efficiency equipment introduced in the project categorized as measure 2 [kWh/p]

CH_i Rated cooling capacity of the high efficiency equipment *i* introduced in the project [kW]

COP_i Efficiency of reference cooling equipment replaced/substituted by the equipment *i* introduced in the project [dimensionless]

Measure 3: LED lighting

$$EC_{REF,3,p} = \sum_i ECR_{REF3,i} \times t_{i,p} \quad (5)$$

Where

$EC_{REF,3,p}$ Total electricity that would have been consumed during the period *p* by the reference equipment, replaced/substituted by the high efficiency equipment

	introduced in the project categorized as measure 3 [kWh/p]
$ECR_{REF3,i}$	Rated electricity consumption of the reference equipment *i*, replaced by the high efficiency equipment *i* in the project categorized as measure 3 [kW]
$t_{i,p}$	Operating hours of the high efficiency equipment *i* during the period *p* in the project categorized as measure 3 [hr/p]

G. Calculation of project emissions

Project emissions are calculated as a sum of emissions from electricity and fossil fuel consumption in the project. The emission from electricity consumption is calculated by multiplying electricity consumed by the project ($EC_{PJ,i,p}$) by the CO_2 emission factor of electricity ($EF_{CO2,ELEC}$). The emission from fuel consumption is calculated by multiplying fuel consumed by the project ($FC_{PJ,i,p}$) by the emission factor of the fuel (EF_{CO2}).

$$PE_p = \frac{\sum_i EC_{PJ,i,p}}{1{,}000} \times EF_{CO2,ELEC} + \sum_i \left(FC_{PJ,i,p} \times EF_{CO2} \right) \quad (6)$$

Where

PE_p	Project emissions during the period *p* [tCO_2/p]
$EC_{PJ,i,p}$	Total electricity consumed by the high efficiency equipment by measure *i* introduced in the project during the period *p* [kWh/p]
$EF_{CO2,ELEC}$	CO_2 emission factor of the electricity consumed [tCO_2/MWh]
$FC_{PJ,i,p}$	Total fossil fuel consumed by the high efficiency equipment by measure *i* introduced in the project during the period *p* [L/p]
EF_{CO2}	CO_2 emission factor of fossil fuel[tCO_2/L]
i	Type of measure

Measure 1: High efficiency boiler

$$FC_{PJ,1,p} = \sum_i FC_{PJ1,i,p} \quad (7)$$

Where

$FC_{PJ,1,p}$	Total fossil fuel consumed during the period *p* by the high efficiency equipment introduced in the project categorized as measure 1 [L/p]
$FC_{PJ1,i,p}$	Fossil fuel consumed during the period *p* by the high efficiency equipment *i* introduced in the project categorized as measure 1 [L/p]

Measure 2: Heat recovery heat pump

$$EC_{PJ,2,p} = \sum_i \left(EC_{PJ2,i,p} + ECA_i \times t_p \right) \quad (8)$$

Where

$EC_{PJ,2,p}$	Total electricity consumed during the period p by the high efficiency equipment introduced in the project categorized as measure 2 [kWh/p]
$EC_{PJ2,i,p}$	Electricity consumed during the period p by the high efficiency equipment i introduced in the project categorized as measure 2 [kWh/p]
ECA_i	Capacity of auxiliary electric equipment that is installed due to the implementation of the high efficiency equipment i [kW]
t_p	Operating hours of auxiliary electric equipment during the period p [hr/p]

Measure 3: LED lighting

$$EC_{PJ,3,p} = \sum_i \left(EC_{PJ3,i} \times t_{i,p} \right) \quad (9)$$

Where

$EC_{PJ,3,p}$	Total electricity consumed during the period p by the high efficiency equipment introduced in the project categorized as measure 3 [kWh/p]
$EC_{PJ3,i}$	Rated electricity consumption of the high efficiency equipment i in the project categorized as measure 3 [kW]
$t_{i,p}$	Operating hours of the high efficiency equipment i introduced in the project during the period p categorized as measure 3 [hr/p]

H. Calculation of emissions reductions

Emission reduction is calculated by the following equation.

$$ER_p = RE_p - PE_p \quad (10)$$

Where

ER_p	Emission reduction during the period p [tCO_2/p]
RE_p	Reference emission during the period p [tCO_2/p]
PE_p	Project emission 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
$\eta_{PJ1,i}$	Energy efficiency of the equipment *i* introduced in the project	Rated/provided by the technology supplier
$\eta_{REF1,i}$	Energy efficiency of the reference equipment replaced/substituted by the equipment *i* introduced in the project	Default values in the methodology
ECR_i	Rated electricity consumption of the high efficiency equipment *i* introduced in the project	Rated/provided by the technology supplier
H_i	Rated heating capacity of the high efficiency equipment *i* introduced in the project	Rated/provided by the technology supplier
DC_i	Unit fuel consumption rate of the reference equipment replaced/ substituted by the equipment *i* introduced in the project	Rated/provided by the technology supplier
CH_i	Rated cooling capacity of the high efficiency equipment *i* introduced in the project	Rated/provided by the technology supplier
COP_i	Efficiency of the reference equipment replaced/substituted by the equipment *i* introduced in the project	Default values in the methodology
$ECR_{REF3,i}$	Rated electricity consumption of the reference equipment *i* replaced by the high efficiency equipment *i* in the project categorized as measure 3	Rated/provided by the technology supplier or checked by the indication on the lighting *i*
ECA_i	Capacity of auxiliary electric equipment that is installed due to the implementation of the high efficiency equipment *i*	Rated/provided by the technology supplier
$EC_{PJ3,i}$	Rated electricity consumption of the high efficiency equipment *i* in the project categorized as measure 3	Rated/provided by the technology supplier
$EF_{CO2,ELEC}$	CO_2 emission factor of the electricity consumed When project equipment consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project equipment may consume both grid	[Grid electricity] Ministry of Natural Resources and Environment of Vietnam (MONRE), Vietnamese DNA for CDM unless otherwise instructed by

	electricity and captive electricity, the project participant applies the CO_2 emission factor with lower value. [CO_2 emission factor] For grid electricity: The most recent value available from the source stated in this table at the time of validation For captive electricity, it is determined based on the following options: a) Calculated from its power generation efficiency ($\eta_{elec,CG}$ [%]) 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; $$EF_{CO2,ELEC} = 3.6 \times \frac{100}{\eta_{elec,CG}} \times EF_{fuel,CG}$$ b) Calculated from measured data The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,CG,p}$) and the amount of electricity generated ($EG_{PJ,CG,p}$) during the monitoring 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; $$EF_{CO2,ELEC} = FC_{PJ,CG,p} \times NCV_{fuel,CG} \times EF_{fuel,CG} \times \frac{1}{EG_{PJ,CG,p}}$$ Where: $NCV_{fuel,CG}$: Net calorific value of fuel consumed by the captive power generation system [GJ/mass or volume]	the Joint Committee. [Captive electricity] For the option a) Specification of the captive power generation system provided by the manufacturer ($\eta_{elec,CG}$ [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system ($EF_{fuel,CG}$ [tCO_2/GJ]) For the option b) Generated and supplied electricity by the captive power generation system ($EG_{PJ,CG,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,CG,p}$ [mass or volume/p]). Net calorific value ($NCV_{fuel,CG}$ [GJ/mass or volume]) and CO_2 emission factor ($EF_{fuel,CG}$ [tCO_2/GJ]) of the fuel consumed by the captive power generation system in order of preference: 1) values provided by

<table>
<tr>
<td></td>
<td>Note:
In case the captive electricity generation system meets all of the following conditions, the value in the following table may be applied to $EF_{CO2,ELEC}$ 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

<table>
<tr><th>fuel type</th><th>Diesel fuel</th><th>Natural gas</th></tr>
<tr><td>EF_{elec}</td><td>0.8 *1</td><td>0.46 *2</td></tr>
</table>

*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 (0.0543 tCO_2/GJ), and the most efficient value of default efficiency for off-grid gas turbine systems (42%) are applied.</td>
<td>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 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.</td>
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</table>

EF_{CO2}	CO_2 emission factor of fossil fuel	Country specific data or IPCC default value from "2006 IPCC Guidelines for National Greenhouse Gas Inventories". Lower limit values of the default net calorific value and CO_2 emission factor are applied.

History of the document

Version	Date	Contents revised
01.1	10 October 2017	JC6 ● Revision of methods to determine CO_2 emission factor for consumed electricity in section I
01.0	14 January 2015	JC3, Annex 4 Initial approval.