Joint Crediting Mechanism Approved Methodology TH_AM014
"Installation of an inverter-controlled separate type fridge showcase for convenience store(s)"

A. Title of the methodology

Installation of an inverter-controlled separate type fridge showcase for convenience store(s) Version01.0

B. Terms and definitions

Terms	Definitions
Inverter-controlled separate type fridge showcase	Inverter-controlled separate type fridge showcase is a type of fridge showcase of which condensing unit and showcase unit are separated, and the condensing unit equipped with inverter to control the speed of the compressor motor in order to maintain the temperature is located outside the store. The system includes the following: • Reach-in type fridge showcase (a structure to interrupt display room from outside air by glass type door) • Open type fridge showcase (a structure to interrupt display room from outside air by air curtain) • Walk in type fridge showcase (a structure which people can go in and fill groceries from behind the display shelves)
Coefficient of Performance (COP)	Coefficient of Performance (COP) is the cooling capacity per rated power consumption of the fridge showcase.
Part Load Ratio	Ratio of the actual cooling capacity and rated cooling capacity.
Degradation coefficient	Measure of efficiency loss due to compressor switching on/off control by constant speed compressor.

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	This methodology applies to the project that aims for saving energy of in-store showcase by introducing an inverter-controlled separate type fridge showcase for convenience store(s).
Calculation of reference emissions	Reference emissions are GHG emissions from the reference fridge showcase, non-inverter-controlled fridge showcase. Reference emissions from the reference fridge showcase are calculated with: • Power consumption of the project fridge showcase • Ratio of COPs of reference and project fridge showcase • Part Load ratio of the showcase • Degradation coefficient • CO_2 emission factor for consumed electricity.
Calculation of project emissions	Project emissions are calculated with power consumption of installed inverter-controlled separate type fridge showcase and CO_2 emission factor for consumed electricity.
Monitoring parameters	● Power consumption of project fridge showcase ● Operating time of the project fridge showcase (if applicable)

D. Eligibility criteria

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

Criterion 1	Separate-type inverter-controlled fridge showcase is newly installed or installed to replace existing fridge showcase at convenience store(s).
Criterion 2	COP of project inverter-controlled separate type fridge showcase *i* under the standard temperature conditions* is more than the threshold COP values set in the table below. ("x" in the table represents cooling capacity per unit.) Cooling capacity [kW] | Reference COP $3.0 \leq x \leq 15.0$ | 2.20 $15.0 < x \leq 25.0$ | 1.83 *The standard temperature condition are as follows:

	Ambient temperature: 32 degrees Celsius Evaporative temperature: -10 degrees Celsius
Criterion 3	Ozone Depletion Potential (ODP) of the refrigerant used for project fridge show case is zero.
Criterion 4	A plan for prevention of releasing refrigerant used for project separate-type fridge showcase is prepared. In the case of replacing the existing showcase with the project showcase, a plan for prevention of releasing refrigerant used in the existing showcase to the air (e.g. re-use of the equipment) is prepared. Execution of this plan is checked at the time of verification, in order to confirm that refrigerant used for the existing one replaced by the project is prevented from being released to the air.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Power consumption of the reference fridge showcase	CO_2
Project emissions	
Emission sources	GHG types
Power consumption of the project fridge showcase	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are calculated by multiplying power consumption of project inverter-controlled separate type showcase, ratio of energy efficiency (COPs) of project/reference showcase, part load ratio of the showcase, Degradation coefficient (C_D), and CO_2 emission factor for consumed electricity.

In this methodology, energy saving effects through the inverter are conservatively calculated to ensure the net emission reductions.

- The value of C_D is conservatively set as a default value according to the survey on the standard of air conditioner.
- The effects of the improvement of efficiency in operation by inverter control in part load

conditions are not taken into account.

F.2. Calculation of reference emissions

For calculation of reference emissions, either Option 1 or Option 2 is selected.
If operating time of project fridge showcase can be measured, Option 2 may be selected.

Option 1

$$RE_p = \sum_i \sum_j \left[EC_{pj,i,j,p} \times \frac{COP_{pj,i,j}}{COP_{ref,i,j}} \right] \times EF_{elec}$$

RE_p	: Reference emissions of fridge showcase during the period p [tCO_2/p]
$EC_{pj,i,j,p}$	: Power consumption of the project fridge showcase j at the convenience store i during the period p [MWh/p]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
$COP_{pj,i,j}$	: COP of the project fridge showcase j at the convenience store i [-]
$COP_{ref,i,j}$	: COP of the reference fridge showcase j at the convenience store i [-]
i	: Identification number of the convenience store [-]
j	: Identification number of fridge showcase [-]

Option 2

$$\boldsymbol{RE_p = \sum_i \sum_j \left[EC_{pj,i,j,p} \times \frac{COP_{pj,i,j}}{COP_{ref,i,j}} \times \frac{1}{1 - C_D\left(1 - PLR_{i,j,p}\right)} \right] \times EF_{elec}}$$

Where, $\boldsymbol{PLR_{i,j,p} = \min\left(\frac{EC_{pj,i,j,p} \times 10^3}{t_{pj,i,j,p}} \times \frac{COP_{pj,i,j}}{Cap_{pj,i,j}}, 1\right)}$

RE_p	: Reference emissions of fridge showcase during the period p [tCO_2/p]
$EC_{pj,i,j,p}$	: Power consumption of the project fridge showcase j at the convenience store i during the period p [MWh/p]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
$COP_{pj,i,j}$	: COP of the project fridge showcase j at the convenience store i [-]
$COP_{ref,i,j}$	: COP of the reference fridge showcase j at the convenience store i [-]
C_D	: Degradation Coefficient [-]
$PLR_{i,j,p}$	: Part Load ratio of the project fridge showcase j at the convenience store i during the period p [-]
$t_{pj,i,j,p}$	: Operating time of the project fridge showcase j at the convenience store

	i during the period p [hour]
$Cap_{pj,i,j}$	: Capacity of the project fridge showcase j at the convenience store i [kW]
i	: Identification number of the convenience store [-]
j	: Identification number of fridge showcase [-]

G. Calculation of project emissions

$$\boldsymbol{PE_p = \sum_{j}\sum_{i}\left[EC_{pj,i,j,p}\right] \times EF_{elec}}$$

PE_p	: Project emissions of the project fridge showcase during the period p [tCO_2/p]
$EC_{pj,i,j,p}$	: Power consumption of the project fridge showcase j at the convenience store i during the period p [MWh/p]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
i	: Identification number of the convenience store [-]
j	: Identification number of the project fridge showcase [-]

H. Calculation of emissions reductions

$$\boldsymbol{ER_p = RE_p - PE_p}$$

ER_p	: Emissions 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}	CO_2 emission factor for consumed electricity [tCO_2/MWh]. When the project fridge showcase consumes only 1) grid electricity, 2) captive electricity or 3) electricity directly supplied from other sources (e.g. independent power producer (IPP), small	**Case 1)** [Grid electricity] The most recent value available at the time of validation is applied and fixed for the monitoring

	power producer (SPP) and very small power producer (VSPP)) to the project site, the project participant applies the CO_2 emission factor respectively. When the project fridge showcase 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} is determined based on the following options: a) <u>Calculated from its power generation efficiency (η_{elec} [%]) obtained from manufacturer's specification.</u> The power generation efficiency based on lower heating value (LHV) of the captive power generation system from the manufacturer's specification is applied; $$EF_{gen} = 3.6 \times \frac{100}{\eta_{elec}} \times EF_{fuel}$$ <u>b) Calculated from measured data</u> The power generation efficiency calculated from monitored data of the amount of fuel input for power generation ($FC_{PJ,p}$) and the amount of electricity generated ($EG_{PJ,p}$) 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;	period thereafter. The data is sourced from "Grid Emission Factor (GEF) of Thailand", endorsed by Thailand Greenhouse Gas Management Organization (TGO) unless otherwise instructed by the Joint Committee. **Case 2)** [Captive electricity] <u>For Option a)</u> Specification of the captive power generation system provided by the manufacturer (η_{elec} [%]). CO_2 emission factor of the fossil fuel type used in the captive power generation system (EF_{fuel} [tCO_2/GJ]) <u>For Option b)</u> Generated and supplied electricity by the captive power generation system ($EG_{PJ,p}$ [MWh/p]). Fuel amount consumed by the captive power generation system ($FC_{PJ,p}$ [mass or volume/p]). Net calorific value (NCV_{fuel} [GJ/mass or volume]) and CO_2 emission factor of the fuel (EF_{fuel} [tCO_2/GJ]) in order of preference: 1) values provided by the fuel supplier;

	$EF_{elec} = FC_{PJ,p} \times NCV_{fuel} \times EF_{fuel} \times \frac{1}{EG_{PJ,p}}$ Where: NCV_{fuel} : 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} 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} / 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 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} is determined based on the following options: a) The value provided by the electricity supplier 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	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 version 02.0" 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

<table>
<tr><td></td><td>the option b) of 2) captive electricity as instructed above;
When the project fridge showcase may consume electricity supplied from more than 1 electric source, the project participant applies the CO_2 emission factor with the lowest value.</td><td>value of emission factor (e.g. data of power generation, type of power plant, type of fossil fuel, period of time).</td></tr>
<tr><td>$COP_{pj,i,j}$</td><td>COP of the project fridge showcase j at the convenience store i at the standard temperature*

*The standard temperature conditions are as follows:
Ambient temperature: 32 degrees Celsius
Evaporative temperature: -10 degrees Celsius</td><td>The specifications of the project fridge showcase and condensing unit for quotation or the factory acceptance test data by manufacturer.</td></tr>
<tr><td>$COP_{ref,i,j}$</td><td>COP of the reference fridge showcase j at the convenience store i is selected from the default COP values in the following table.

Table: COP for Reference fridge showcase ($COP_{ref,i,j}$)<table><tr><th>Cooling capacity [kW]</th><th>Reference COP</th></tr><tr><td>$3.0 \leq x \leq 15.0$</td><td>2.20</td></tr><tr><td>$15.0 < x \leq 25.0$</td><td>1.83</td></tr></table></td><td>The default values are derived from the result of survey on COP of constant speed type fridge showcase from manufacturers that have high market share.
The $COP_{ref,i,j}$ should be revised if necessary from survey result which is conducted by the JC or project participants.</td></tr>
<tr><td>$Cap_{pj,i,j}$</td><td>Capacity of the project fridge showcase j at the convenience store i at the standard temperature condition.
The value of capacity (kW) prepared by manufacturer is applied.

*The standard temperature conditions are as follows:
Ambient temperature: 32 degrees Celsius
Evaporative temperature: -10 degrees Celsius</td><td>Nominal value available on product catalogs, specification documents or websites.</td></tr>
<tr><td>C_D</td><td>Degradation Coefficient, as indicated in the Table below.</td><td>The default value is derived from the survey on the values of Degradation</td></tr>
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		Parameter	Value		Coefficient of air conditioning system.
		C_D	0.15		

History of the document

Version	Date	Contents revised
01.0	20 September 2021	Electronic decision by the Joint Committee Initial approval.