Joint Crediting Mechanism Approved Methodology ID_AM008
"Installation of a separate type fridge-freezer showcase by using natural refrigerant for grocery store to reduce air conditioning load inside the store"

A. Title of the methodology

Installation of a separate type fridge-freezer showcase by using natural refrigerant for grocery store to reduce air conditioning load inside the store, version 32.0

B. Terms and definitions

Terms	Definitions
Separate type fridge-freezer showcase	Refrigeration or freezer system with natural refrigerant of which condensing unit and showcase unit are separated and the condensing unit is located outside the store. The system includes the following: • Reach-in type fridge showcase or freezer 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)
Natural refrigerant	Natural refrigerant refers to naturally occurring substances with refrigeration capacity and with zero ozone depletion potential (ODP) (e.g., CO_2 and NH_3).
Built-in type showcase	Refrigeration or freezer system of which condensing unit and showcase unit are built in one unit.
Coefficient of Performance (COP)	Coefficient of Performance (COP) is the cooling capacity per rated power consumption of the air conditioning system. The values of cooling capacity and rated power consumption are defined under specific temperature stated in ISO 5151:2010.
Energy efficiency	For the purpose of this methodology, energy efficiency of the fridge-freezer showcase is defined as the rated volume (L)

	divided by the rated electricity consumption (W) or the rated cooling capacity (W) divided by the rated electricity consumption (W).

C. Summary of the methodology

Items	Summary
GHG emission reduction measures	This methodology applies to the project that aims for saving total energy of in-store showcase and air conditioning system by introducing a separate type natural refrigerant fridge-freezer showcase for grocery store in Indonesia, which leads to GHG emission reductions, through the reduction of air conditioning electricity load demand by not releasing waste heat inside the store.
Calculation of reference emissions	Reference emissions are GHG emissions from both the reference built-in type fridge-freezer showcase and the reference air conditioning system. [Built-in type fridge-freezer showcase] Reference emissions from the reference fridge-freezer showcase are calculated with: • Electricity consumption of the project fridge-freezer showcase; • Energy efficiency of the project fridge-freezer showcase; • Energy efficiency of the reference fridge-freezer showcase; and • CO_2 emission factor for consumed electricity. [Air conditioning system] Reference emissions from the reference air conditioning system due to waste heat from the reference fridge-freezer showcase are calculated with: • Electricity consumption of the project fridge-freezer showcase; • Energy efficiency of the project fridge-freezer showcase in terms of the cooling capacity; • Energy efficiency of the project fridge-freezer showcase in terms of the volume;

	• Energy efficiency of the reference fridge-freezer showcase; • COP of the reference air conditioning system; and • CO_2 emission factor for consumed electricity.
Calculation of project emissions	[Separate type natural refrigerant fridge-freezer showcase] Project emissions are calculated with power consumption of installed separate type natural refrigerant fridge-freezer showcase and CO_2 emission factor for consumed electricity.
Monitoring parameters	● Electricity consumption of the project fridge showcase ● Electricity consumption of the project freezer showcase

D. Eligibility criteria

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

Criterion 1	The project is to install a separate type fridge-freezer showcase by using natural refrigerant or replacing the existing at a grocery store which is equipped with wall mounted type and/or ceiling cassette type air conditioning system and whose selling area is less than 400 (four hundred) m^2.
Criterion 2	In the case of replacing the existing fridge-freezer showcase with the project fridge-freezer showcase, the existing one is a built-in type showcase.
Criterion 3	A plan for not releasing refrigerant used for project fridge-freezer showcase is prepared. In the case of replacing the existing fridge-freezer showcase with the project fridge-freezer showcase, a plan is prepared in which refrigerant used in the existing fridge-freezer showcase is not released to the air e.g. re-use of the refrigerant. Execution of the prevention plan is checked at the time of verification, in order to confirm that refrigerant used for the existing one replaced by the project is not released to the air.

E. Emission Sources and GHG types

Reference emissions	
Emission sources	GHG types
Electricity consumption of the reference fridge showcase	CO_2
Electricity consumption of the reference freezer showcase	CO_2
Electricity consumption of the reference air conditioning system	CO_2

Project emissions	
Emission sources	GHG types
Electricity consumption of the project fridge showcase	CO_2
Electricity consumption of the project freezer showcase	CO_2

F. Establishment and calculation of reference emissions

F.1. Establishment of reference emissions

Reference emissions are GHG emissions from electricity consumption by both the reference built-in type fridge-freezer showcase and the reference air conditioning system used for cooling the exhaust heat from the reference fridge showcase.

Net emission reductions in this methodology are achieved by setting default values of "COP of the reference air conditioning system" in a conservative manner, and also achieved by not including "leakage of HFCs from the reference fridge-freezer showcase" when calculating emission reductions.

[COP of the reference air conditioning system]
The default values of COP of the reference air conditioning system are set in line with the approved JCM methodology ID_AM004 ~~Ver1.0.~~

If the air conditioning system equipped in the project store has higher COP values compared to the table below within the respective cooling capacity range, the COP value of the air conditioning system installed at the project store is used.

If multiple types of air conditioning system with different cooling capacity rage shown in the table below are found in the project site, the highest value of COP is selected and applied to calculate reference emissions in a conservative manner.

Cooling Capacity[kW]	Reference COP
2.6＜x≤5.6	3.83
5.6＜x≤6.8	3.61
6.8＜x≤12.5	3.29
12.5＜x≤14.1	3.01

Cooling Capacity [kW]	Reference COP
2.5 < x ≦ 4.1	4.00
4.1 < x ≦ 5.3	3.59
5.3 < x ≦ 7.1	2.96
7.1 < x ≦ 14.2	2.85

The default COP values may be revised as to the revision of the approved JCM methodology ID_AM004 to maintain conservativeness.

[Energy efficiency of the reference fridge-freezer showcase]
The default values of rated electricity consumption of the reference fridge and freezer showcase are set *ex ante* in the table below.

The reference fridge showcase
-Reach-in showcase

Range of volume (L)	Energy efficiency (L/W)
z < 900	1.271.18
900 ≦ z < 1,200	1.941.07
1,200 ≦ z	2.432.24

-Open showcase

Range of volume (L)	Energy efficiency (L/W)
z < 900	0.540.50
900 ≦ z < 1,200	0.680.65
1,200 ≦ z	0.610.73

The reference freezer showcase
-Reach-in showcase

Range of volume (L)	Energy efficiency (L/W)
z < 900	0.540.70
900 ≦ z < 1,200	0.820.70
1,200 ≦ z	0.841.01

Correspondence between project fridge-freezer showcase and reference fridge-freezer showcase:

Pattern	Project fridge-freezer showcase	Reference fridge-freezer showcase
1	Reach-in type fridge showcase	Reach-in type fridge showcase

2	Open type fridge showcase	Open type fridge showcase
3	Walk-in type fridge showcase	Reach-in type fridge showcase
4	Reach-in type freezer showcase	Reach-in type freezer showcase

F.2. Calculation of reference emissions

$$\mathbf{RE_p = RE_{fridge,p} + RE_{freezer,p} + RE_{AC,add,fridge,p} + RE_{AC,add,freezer,p}}$$

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

$RE_{fridge,p}$: Reference emissions of the fridge showcase during the period *p* [tCO_2/p]

$RE_{freezer,p}$: Reference emissions of the freezer showcase during the period *p* [tCO_2/p]

$RE_{AC,add,fridge,p}$: Reference emissions of the air conditioning system caused by the electricity consumption due to exhaust heat from the reference fridge showcase during the period *p* [tCO_2/p]

$RE_{AC,add,freezer,p}$: Reference emissions of the air conditioning system caused by the electricity consumption due to exhaust heat from the reference freezer showcase during the period *p* [tCO_2/p]

$$\mathbf{RE_{fridge,p}} = \sum_{\mathbf{i}} \left(\mathbf{EC_{PJ,fridge,i,p}} \times \frac{\eta_{\mathbf{PJ,fridge,i}}}{\eta_{\mathbf{RE,fridge,i}}} \right) \times \mathbf{EF_{elec}}$$

$RE_{fridge,p}$: Reference emissions of the fridge showcase during the period *p* [tCO_2/p]

$EC_{PJ,fridge,i,p}$: Electricity consumption of the project fridge showcase *i* during the period *p* [MWh/p]

$\eta_{PJ,fridge,i}$: Energy efficiency of the project fridge showcase *i* in terms of the volume [L/W]

$\eta_{RE,fridge,i}$: Energy efficiency of the reference fridge showcase *i* in terms of the volume [L/W]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

i : Identification number of the fridge showcase [-]

$$\mathbf{RE_{freezer,p}} = \sum_{\mathbf{j}} \left(\mathbf{EC_{PJ,freezer,j,p}} \times \frac{\eta_{\mathbf{PJ,freezer,j}}}{\eta_{\mathbf{RE,freezer,j}}} \right) \times \mathbf{EF_{elec}}$$

$RE_{freezer,p}$: Reference emissions of the freezer showcase during the period *p* [tCO_2/p]

$EC_{PJ,freezer,j,p}$: Electricity consumption of the project freezer showcase *j* during the period *p* [MWh/p]

$\eta_{PJ,freezer,j}$: Energy efficiency of the project freezer showcase *j* in terms of the volume [L/W]

$\eta_{RE,freezer,j}$: Energy efficiency of the reference freezer showcase *j* in terms of the volume [L/W]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

j : Identification number of the freezer showcase [-]

$$\mathbf{RE_{AC,add,fridge,p} = EC_{RE,AC,add,fridge,p} \times EF_{elec}}$$

$$\mathbf{EC_{RE,AC,add,fridge,p} = \sum_{i} EH_{RE,fridge,i,p} \times \frac{1}{\eta_{RE,AC}}}$$

$$\mathbf{EH_{RE,fridge,i,p} = HG_{RE,fridge,i,p} + EC_{RE,fridge,i,p}}$$

$$\mathbf{HG_{RE,fridge,i,p} = HG_{PJ,fridge,i,p}}$$

$$\mathbf{HG_{PJ,fridge,i,p} = EC_{PJ,fridge,i,p} \times \eta_{PJ,fridge,cap,i}}$$

$$\mathbf{EC_{RE,fridge,i,p} = EC_{PJ,fridge,i,p} \times \frac{\eta_{PJ,fridge,i}}{\eta_{RE,fridge,i}}}$$

$RE_{AC,add,fridge,p}$: Reference emissions of the air conditioning system caused by the electricity consumption due to exhaust heat from the reference fridge showcase during the period *p* [tCO_2/p]

$EC_{RE,AC,add,fridge,p}$: Electricity consumption of the reference air conditioning system due to exhaust heat from the reference fridge showcase during the period *p* [MWh/p]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

$EH_{RE,fridge,i,p}$: Amount of exhaust heat from the reference fridge showcase *i* during the period *p* [MWh/p]

$\eta_{RE,AC}$: COP of the reference air conditioning system [-]

$HG_{RE,fridge,i,p}$: Amount of cooling energy generated by the reference fridge showcase *i* during the period *p* [MWh/p]

$HG_{PJ,fridge,i,p}$: Amount of cooling energy generated by the project fridge showcase *i* during the period *p* [MWh/p]

$EC_{RE,fridge,i,p}$: Electricity consumption of the reference fridge showcase *i* during the period *p* [MWh/p]

$EC_{PJ,fridge,i,p}$: Electricity consumption of the project fridge showcase *i* during the period *p* [MWh/p]

$\eta_{PJ,fridge,cap,i}$: Energy efficiency of the project fridge showcase *i* in terms of the cooling capacity [W/W]

$\eta_{PJ,fridge,i}$: Energy efficiency of the project fridge showcase *i* in terms of the

	volume [L/W]
$\eta_{RE,fridge,i}$	: Energy efficiency of the reference fridge showcase *i* in terms of the volume [L/W]
i	: Identification number of the fridge showcase [-]

$$\mathbf{RE_{AC,add,freezer,p}} = \mathbf{EC_{RE,AC,add,freezer,p}} \times \mathbf{EF_{elec}}$$

$$\mathbf{EC_{RE,AC,add,freezer,p}} = \sum_{\mathbf{j}} \mathbf{EH_{RE,freezer,j,p}} \times \frac{\mathbf{1}}{\eta_{\mathbf{RE,AC}}}$$

$$\mathbf{EH_{RE,freezer,j,p}} = \mathbf{HG_{RE,freezer,j,p}} + \mathbf{EC_{REfreezer,j,p}}$$

$$\mathbf{HG_{RE,freezer,j,p}} = \mathbf{HG_{PJ,freezer,j,p}}$$

$$\mathbf{HG_{PJ,freezer,j,p}} = \mathbf{EC_{PJ,freezer,j,p}} \times \eta_{\mathbf{PJ,freezer,cap,j}}$$

$$\mathbf{EC_{RE,freezer,j,p}} = \mathbf{EC_{PJ,freezer,j,p}} \times \frac{\eta_{\mathbf{PJ,freezer,j}}}{\eta_{\mathbf{RE,freezer,j}}}$$

$RE_{AC,add,freezer,p}$	: Reference emissions of the air conditioning system caused by the electricity consumption due to exhaust heat from the reference freezer showcase during the period *p* [tCO_2/p]
$EC_{RE,AC,add,freezer,p}$	: Electricity consumption of the reference air conditioning system due to exhaust heat from the reference freezer showcase during the period *p* [MWh/p]
EF_{elec}	: CO_2 emission factor for consumed electricity [tCO_2/MWh]
$EH_{RE,freezer,j,p}$	: Amount of exhaust heat from the reference freezer showcase *j* during the period *p* [MWh/p]
$\eta_{RE,AC}$	: COP of the reference air conditioning system [-]
$HG_{RE,freezer,j,p}$	: Amount of cooling energy generated by the reference freezer showcase *j* during the period *p* [MWh/p]
$HG_{PJ,freezer,j,p}$	: Amount of cooling energy generated by the project freezer showcase *j* during the period *p* [MWh/p]
$EC_{RE,freezer,j,p}$	: Electricity consumption of the reference freezer showcase *j* during the period *p* [MWh/p]
$EC_{PJ,freezer,j,p}$	: Electricity consumption of the project freezer showcase *j* during the period *p* [MWh/p]
$\eta_{PJ,freezer,cap,j}$	: Energy efficiency of the project freezer showcase *j* in terms of the cooling capacity [W/W]
$\eta_{PJ,freezer,j}$	: Energy efficiency of the project freezer showcase *j* in terms of the volume [L/W]
$\eta_{RE,freezer,j}$	: Energy efficiency of the reference freezer showcase *j* in terms of the

volume [L/W]

j : Identification number of the freezer showcase [-]

G. Calculation of project emissions

$$\mathbf{PE_p = PE_{fridge,p} + PE_{freezer,p}}$$

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

$PE_{fridge,p}$: Project emissions of the fridge showcase during the period *p* [tCO_2/p]

$PE_{freezer,p}$: Project emissions of the freezer showcase during the period *p* [tCO_2/p]

$$\mathbf{PE_{fridge,p} = \sum_i \left(EC_{PJ,fridge,i,p}\right) \times EF_{elec}}$$

$PE_{fridge,p}$: Project emissions of the project fridge showcase during the period *p* [tCO_2/p]

$EC_{PJ,fridge,i,p}$: Electricity consumption of the project fridge showcase *i* during the period *p* [MWh/p]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

i : Identification number of the fridge showcase [-]

$$\mathbf{PE_{freezer,p} = \sum_j \left(EC_{PJ,freezer,j,p}\right) \times EF_{elec}}$$

$PE_{freezer,p}$: Project emissions of the project freezer showcase during the period *p* [tCO_2/p]

$EC_{PJ,freezer,j,p}$: Electricity consumption of the project freezer showcase *j* during the period *p* [MWh/p]

EF_{elec} : CO_2 emission factor for consumed electricity [tCO_2/MWh]

j : Identification number of the freezer showcase [-]

H. Calculation of emissions reductions

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

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.

<table>
<tr><th>Parameter</th><th>Description of Data</th><th>Source</th></tr>
<tr><td>$\eta_{RE,fridge,i}$</td><td>Energy efficiency of the reference fridge showcase i in terms of the volume.

-Reach-in showcase
<table>
<tr><th>Range of volume (L)</th><th>Energy efficiency (L/W)</th></tr>
<tr><td>z < 900</td><td>1.27~~1.18~~</td></tr>
<tr><td>900 ≦ z < 1,200</td><td>1.94~~1.07~~</td></tr>
<tr><td>1,200 ≦ z</td><td>2.43~~2.24~~</td></tr>
</table>
-Open showcase
<table>
<tr><th>Range of volume (L)</th><th>Energy efficiency (L/W)</th></tr>
<tr><td>z < 900</td><td>0.54~~0.50~~</td></tr>
<tr><td>900 ≦ z < 1,200</td><td>0.68~~0.65~~</td></tr>
<tr><td>1,200 ≦ z</td><td>0.61~~0.73~~</td></tr>
</table>
When multiple types of showcases (Reach-in, Open, and Walk-in) are connected to a condensing unit, the energy efficiency of Reach-in showcase above is selected according to the total sum of rated cooling capacity (watt) of all showcases connected corresponding to the “Range of volume” in the table.</td><td>Nominal value available on product catalogs, specification documents or websites.

The default values are derived from the result of survey on energy efficiency of fridge showcase from manufacturers well known in the market. The default values should be revised if necessary from survey result which is conducted by JC or project participants~~ every three years~~.</td></tr>
<tr><td>$\eta_{RE,freezer,j}$</td><td>Energy efficiency of the reference freezer showcase j in terms of the volume.

-Reach-in showcase
<table>
<tr><th>Range of volume (L)</th><th>Energy efficiency (L/W)</th></tr>
<tr><td>z < 900</td><td>0.54~~0.70~~</td></tr>
</table></td><td>Nominal value available on product catalogs, specification documents or websites.</td></tr>
</table>

	900 ≦ z < 1,200 | 0.820.70 1,200 ≦ z | 0.841.01	The default values are derived from the result of survey on energy efficiency of fridge showcase from manufacturers well known in the market. The default values should be revised if necessary from survey result which is conducted by JC or project participants ~~every three years~~.
$\eta_{PJ,fridge,cap,i}$	Energy efficiency of the project fridge showcase *i* in terms of the cooling capacity. The value of rated cooling capacity (watt) and rated electricity consumption (watt) used in calculation of energy efficiency prepared by manufacturer is applied. When multiple showcases are connected to a condensing unit, the energy efficiency is calculated as a ratio between the total sum of rated cooling capacity (watt) of all showcases connected and the rated electricity consumption (watt) of condensing unit.	The specifications of the project fridge showcase and condensing unit for quotation or the factory acceptance test data by manufacturer.
$\eta_{PJ,fridge,i}$	Energy efficiency of the project fridge showcase *i* in terms of the volume. The value of rated volume (liter) and rated electricity consumption (watt) used in calculation of energy efficiency prepared by manufacturer is applied. When multiple showcases are connected to a condensing unit, the energy efficiency is calculated as a ratio between the total sum of rated volume (liter) of all showcases connected and the rated electricity consumption (watt) of condensing unit.	The specifications of the project fridge showcase and condensing unit for quotation or the factory acceptance test data by manufacturer.

$\eta_{PJ,freezer,cap,i}$	Energy efficiency of the project freezer showcase *j* in terms of the cooling capacity. The value of rated cooling capacity (watt) and rated electricity consumption (watt) used in calculation of energy efficiency prepared by manufacturer is applied. When multiple showcases are connected to a condensing unit, the energy efficiency is calculated as a ratio between the total sum of rated cooling capacity (watt) of all showcases connected and the rated electricity consumption (watt) of condensing unit.	The specifications of the project fridge showcase for quotation or the factory acceptance test data by manufacturer.
$\eta_{PJ,freezer,j}$	Energy efficiency of the project freezer showcase *j* in terms of the volume. The value of rated volume (liter) and rated electricity consumption (watt) used in calculation of energy efficiency prepared by manufacturer is applied. When multiple showcases are connected to a condensing unit, the energy efficiency is calculated as a ratio between the total sum of rated volume (liter) of all showcases connected and the rated electricity consumption (watt) of condensing unit.	The specifications of the project fridge showcase for quotation or the factory acceptance test data by manufacturer.
EF_{elec}	CO_2 emission factor for consumed electricity. When project air conditioning system consumes only grid electricity or captive electricity, the project participant applies the CO_2 emission factor respectively. When project air conditioning system may consume both grid 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	**[Grid electricity]** The data is sourced from "Emission Factors of Electricity Interconnection Systems", National Committee on Clean Development Mechanism (Indonesian DNA for CDM), based on data obtained by Directorate General of Electricity, Ministry of

<table>
<tr>
<td></td>
<td>For captive electricity: 0.8* [tCO_2/MWh]
*The most recent value available from CDM approved small scale methodology AMS-I.A at the time of validation is applied.</td>
<td>Energy and Mineral Resources, Indonesia, unless otherwise instructed by the Joint Committee.

[Captive electricity]
CDM approved small scale methodology AMS-I.A</td>
</tr>
<tr>
<td>$\eta_{RE,AC}$</td>
<td>Default COP values of the reference air conditioning system.
If multiple types of air conditioning system with different cooling capacity, which means different COP values, are found in the project site, the highest value of COP is selected.
When an air conditioning system with higher COP value than that of the reference COP with corresponding cooling capacity set in the table is installed at the project site, $\eta_{RE,AC}$ is revised to the COP value of installed one.

Default COP[1] of Reference
Air Conditioning System ($\eta_{RE,AC}$)
<table>
<tr><th>Cooling Capacity [kW]</th><th>Reference COP</th></tr>
<tr><td>2.5 < x ≦ 4.1</td><td>4.00</td></tr>
<tr><td>4.1 < x ≦ 5.3</td><td>3.59</td></tr>
<tr><td>5.3 < x ≦ 7.1</td><td>2.96</td></tr>
<tr><td>7.1 < x ≦ 14.2</td><td>2.85</td></tr>
</table>
<table>
<tr><th>Cooling Capacity[kW]</th><th>Reference COP</th></tr>
<tr><td>2.6＜x≦5.6</td><td>3.83</td></tr>
<tr><td>5.6＜x≦6.8</td><td>3.61</td></tr>
<tr><td>6.8＜x≦12.5</td><td>3.29</td></tr>
<tr><td>12.5＜x≦14.1</td><td>3.01</td></tr>
</table>
[1] The default COP values may be revised as to the revision of the approved JCM methodology ID_AM004.</td>
<td>The latest version of approved JCM methodology ID_AM004</td>
</tr>
</table>

History of the document

Version	Date	Contents revised
03.0	TBD	TBD
02.0	10 November 2015	Revisions to: ● Change the description of Criterion 3 in Section D; and ● Change the description of "Measurement methods and procedures" for the electricity consumption of the project fridge showcases and the project freezer showcases in the Monitoring Spreadsheet.
01.0	18 May 2015	JC4, Annex 3 Initial approval.