Project MRV Tool Guidelines

Thailand Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action (RAC NAMA)

NAMA Facility
On behalf of: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
Department for Business, Energy & Industrial Strategy
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Department of Alternative Energy Development and Efficiency MINISTRY OF ENERGY
EGAT

As a federally owned enterprise, GIZ supports the German Government in achieving its objectives in the field of international cooperation for sustainable development.

Published by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices:
Bonn and Eschborn, Germany

Authors:
Irene Papst
Johanna Gloel

Editors:
Denise Andres

Design:
Jettanat Tripetch

GIZ is responsible for the content of this publication.

Printing and distribution:
Bangkok, July 2021

CONTENT

Abbreviations

AC
Air Conditioning or Air Conditioner

AR
Assessment Report

BL
Baseline

BTR
Biennial Transparency Report

BUR
Biennial Update Report

CO2
Carbon Dioxide

COP
Coefficient of Performance

CSPF
Cooling Season Performance Factor

DEDE
Department of Alternative Energy Development and Efficiency

DIW
Department of Industrial Works

EER
Energy Efficiency Ratio

EGAT
Electricity Generating Authority of Thailand

GHG
Greenhouse Gas

GIZ
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GWP
Global Warming Potential

HEPS
High Energy Performance Standard

IPCC
Intergovernmental Panel on Climate Change

IPPU
Industrial Processes and Product Use

MA
Market Average

MEPS
Minimum Energy Performance Standard

MRV
Monitoring, Reporting and Verification

NAMA
Nationally Appropriate Mitigation Action

NDC(s)
Nationally Determined Contribution(s)

ONEP
Office of Natural Resources and Environmental Policy and Planning

RAC
Refrigeration and Air Conditioning

SEER
Seasonal Energy Efficiency Ratio

UNFCCC
United Nations Framework Convention on Climate Change

About the Project MRV Tool

These guidelines explain the use of the Project MRV Tool (Package) for the project Thailand Refrigeration and Air Conditioning Nationally Appropriate Mitigation Action (RAC NAMA). It contains a theoretical guide for the parameters, baselines, and calculations used in the tool as well as a practical guide for its application.

0 Background

The project Thailand "RAC NAMA" or Refrigeration and Air Conditioning – Nationally Appropriate Mitigation Action aims to support Thailand in initiating a sustainable transformation in the cooling sector by promoting climate-friendly and energy-efficient cooling technologies. The project is funded by the NAMA Facility[1] and is implemented by GIZ together with the Office of Natural Resources and Environmental Policy and Planning (ONEP), the Department of Alternative Energy Development and Efficiency (DEDE) and the Electricity Generating Authority of Thailand (EGAT).

Aiming to promote the market introduction of green cooling technologies, the RAC NAMA Fund was established in 2018 together with EGAT as the host and project fund manager. With EUR 8.3 million, the fund launched financing mechanisms for targeted beneficiaries, especially: local producers, consumers, trainings and testing facilities. Specifically with the support provided to local producers and consumers, greenhouse gas (GHG) emission reductions are achieved. As a project, RAC NAMA has reporting obligations to the donors regarding its results (incl. targeted and achieved emission reductions). And as part of Thailand's Nationally Determined Contributions (NDCs), RAC NAMA's mitigation results can be included in the country's reporting to the UNFCCC – for example, in the context of the Biennial Update Report (BUR)/Biennial Transparency Report (BTR).

More information on the RAC NAMA project, visit: www.racnama.org

[1] NAMA Facility is a multi-donor facility that provides tailor-made support for the implementation of highly ambitious and transformational NAMAs in developing countries. The Facility conducts competitive calls and selects the most ambitious and promising NAMA Support Projects for funding. For more information, visit: https://www.nama-facility.org/

1 Project MRV System

A monitoring, reporting and verification (MRV) scheme of greenhouse gas (GHG) emissions can be designed for and implemented on different levels: project, sectoral, and national. The Project MRV Scheme illustrated below (Fig.1) focuses on the direct and indirect emission reductions achieved through the RAC NAMA project, more specifically through the different financing mechanisms launched by the RAC NAMA Fund[2] for different target groups. . Annex I provides more information on the financing schemes launched by the RAC NAMA Fund.

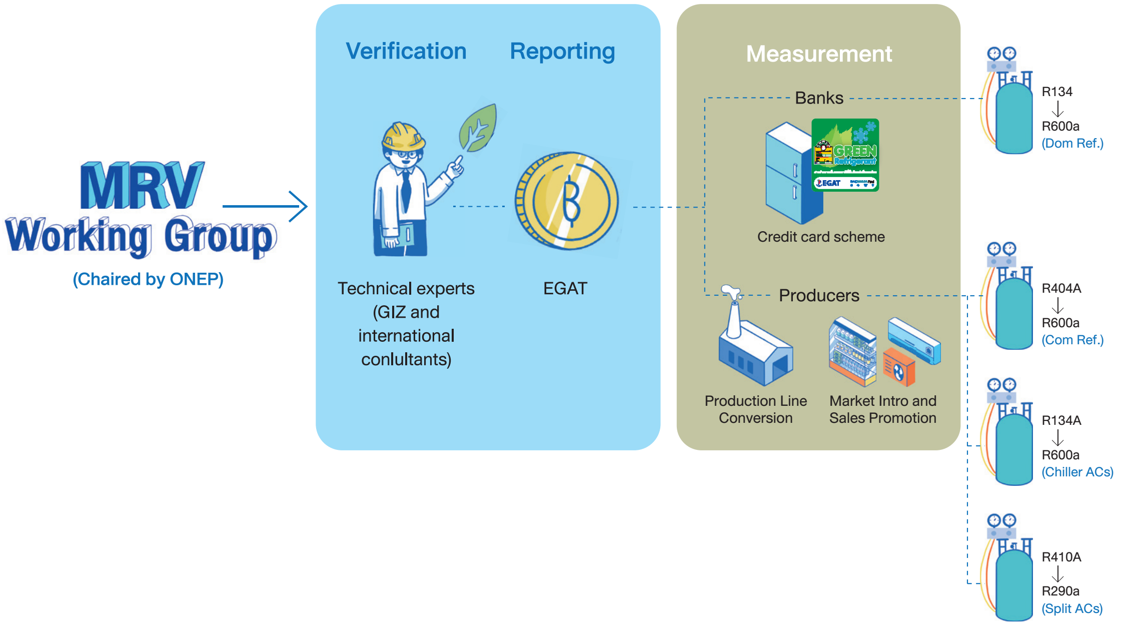


Figure 1 - Current Project MRV Scheme for RAC NAMA Emission Reductions

There are four targeted subsectors for which the RAC NAMA Fund made financing mechanisms available – each subsector is shortly described in Table 1 below. The fund supported banks in operating a credit card scheme for consumers of domestic refrigerators that natural refrigerants, and are highly energy efficient. Further, the fund supported producers of commercial refrigerators, ACs (split-type and portable), and chillers through (sub-)grants and credit lines for the production line conversion, market introduction and sales promotion of green cooling technologies.

[2] The RAC NAMA Fund was established in 2018 together with EGAT as the host and project fund manager. With EUR 8.3 million, the fund launched financing mechanisms for targeted beneficiaries, especially: local producers, consumers, trainings and testing facilities. Funding was awarded based on competitive bidding; RAC NAMA Fund beneficiaries have contractual obligations to report to EGAT including (but not limited to) data essential for estimating emissions reductions.

Subsector	Description	Parameter Considerations
Domestic refrigeration: Refrigerator/freezer	Household refrigerators and freezers as well as refrigerator-freezer combinations.	Leakage rates during operation are usually low because systems are built under factory conditions, hermetically sealed and tested. Product lifetimes are long.
Commercial refrigeration: Stand-alone units	Plug-in units with an integrated condensing unit (self-contained refrigeration systems), such as vending machines, ice cream freezers and beverage coolers	Leakage rates during operation are usually low, because systems are built under factory conditions, hermetically sealed and tested. Product lifetimes are long.
Unitary air conditioning: Split air-conditioners (duct-less)	Single split systems (one indoor unit is connected to one condensing unit.) The systems consist of two elements: (1) the condenser unit containing the compressor mounted outside the room, and (2) the indoor unit (evaporator) supplying cooled air to the room.	Leakage rates during operation are usually high because systems are built on site and this depends on the skill of the individual installer. Product lifetimes are shorter.
Chillers, air-conditioning	Air-conditioning chillers to cool a liquid (usually water), which is then distributed to air-handling units within the building AC chillers are mainly applied for commercial and light industrial purposes.	Leakage rates during operation are usually high because systems are built on site, which depends on the skill of the individual installer. Product lifetimes are long due to high investment costs.
Unitary air conditioning: Monoblock and Mini Chiller	This refers to proposed equipment types that do not match standard parameters attributed to the 4 subsectors. Monoblock units combine condenser and evaporator in one housing, which is located outside of the cooled space. An air-duct is used to transport the cooled air into the room. Mini Chillers also combine condenser and evaporator in one housing, that is located outdoors. Instead of cooled air, a mini chiller supplies cooled water.	Leakage rates during operation vary depending whether the systems can be factory sealed or piping is completed on site. For the MRV, we expect similar emission factors as for Split ACs. Product lifetimes are medium (between refrigerators and split ACs.

Table 1 - Targeted RAC Subsectors

The beneficiaries (i.e., banks and producers) have a contractual obligation to report to EGAT based on the agreed terms, which include necessary figures and technical data for the Project MRV System / Tool. While the credit card scheme already finished in 2018, participating producers still have reporting obligations to EGAT.

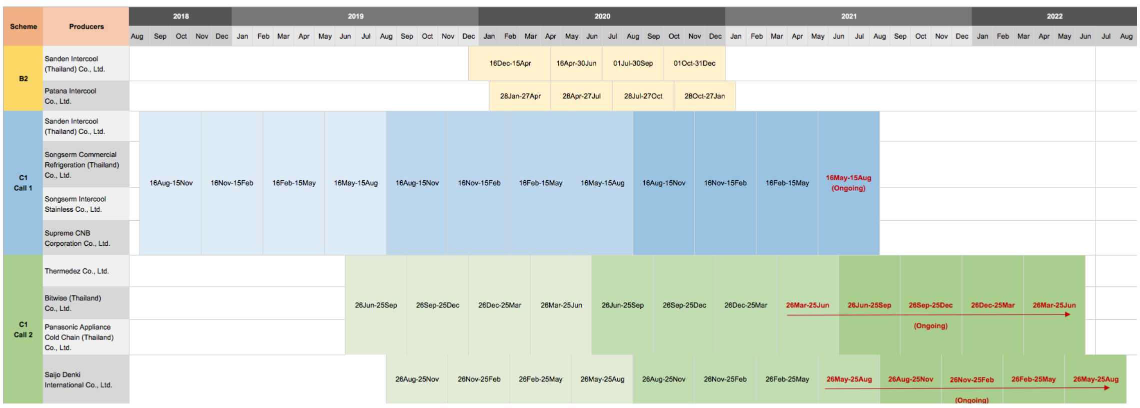


Figure 2 - Reporting Timeline of Producers

2 Methodology and Application

Emissions from the RAC sector arise from direct and indirect emissions, from refrigerant use and electricity consumption respectively, which are attributed to the IPPU and energy sectors under the IPCC 2006 Guidelines (IPCC 2006). The project MRV adheres to the Tier 2 Methodology under the IPCC 2006 guidelines[3], following the subsector[4] categories provided and collecting data at equipment level. The product specific data needed to be collected are specified below:

Direct emissions / refrigerant use	**Indirect emissions / energy consumption**
- refrigerant type	- cooling capacity
- refrigerant charge	- COP / (S)EER[5]
- manufacturing emissions	- average runtime hours
- in-use / operating emissions	- compressor type (fixed speed or inverter)
- disposal emissions	- energy consumption based on standard testing method (if available)
- estimated lifetime	

Non-product specific parameters are the global warming potential of the refrigerants and the Thai grid emission factor.

Direct emissions over the lifetime of the equipment unit are calculated based on the following formula:

$$EM_{dir,LT} = \frac{IC \cdot GWP \cdot (EF_{manu} + EF_{serv} \cdot LT + EF_{disp})}{1000}$$

- $EM_{dir,LT}$ → Direct Emission over Lifetime of Equipment [t CO_2eq]
- IC → Initial Refrigerant Charge of Equipment [kg]
- GWP → Global Warming Potential of Refrigerant
- EF_{manu} → Emission Factor during Manufacture [% of initial charge]
- EF_{serv} → Emission Factor during Operation/Servicing [% of initial charge], applied annually
- EF_{disp} → Emission Factor during Disposal [% of initial charge]
- LT → Lifetime of Equipment [years]

Emission factors are dependent on circumstances and can be different for two units of the same model. For example, the refrigerant leakage during the operation of a split AC unit is directly dependent on the skill of the installing technician. As this is impossible to monitor, averages are applied.

Manufacture and disposal emissions calculated at the time they occur. Manufacture emissions in the first year, disposal emission after the last year of operation.

[3] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/3_Volume3/V3_7_Ch7_ODS_Substitutes.pdf

[4] RAC subsectors are unitary air-conditioners (self-contained, split, split ducted, rooftop and multi-split/VRV units), chillers (AC and process), mobile air-conditioners (passenger cars and large vehicles), domestic refrigeration, commercial refrigeration (stand-alone systems, condensing units, centralised systems), industrial refrigeration (integral systems, condensing units, centralised systems) and transport refrigeration.

[5] Seasonal energy efficiency ratio/ Energy efficiency ratio

Direct emission in the first year

$$EM_{dir,fy} = \frac{IC * GW * (EF_{manu} + EF_{serv})}{1000}$$

$EM_{dir,fy}$ → Direct Emission of Equipment in the first year [tCO2eq]

Direct emission during operation (annually between 2nd year of operation and year of disposal):

$$EM_{dir,operation} = \frac{IC * GWP * EF_{serv}}{1000}$$

$EM_{dir,operation}$ → Direct Emission of Equipment during each year of operation [tCO2eq]

Direct emission at disposal

$$EM_{dir,disposal} = \frac{IC * GWP * EF_{disp}}{1000}$$

The emissions during disposal occur in the year of disposal. For our above example (LT=8 years), the disposal emissions of units sold in 2020 occur in 2028.

$EM_{dir,disposal}$ → Direct Emission of Equipment during disposal [tCO2eq]

Annual indirect emissions are calculated by multiplying the annual energy consumption with the national grid emission factor.

$$EM_{(ind,annual)} = \frac{EM_{annual} \bullet EF_{grid}}{1000}$$

$EM_{ind,annual}$ → Indirect Emission of Equipment during one year [t CO2eq]
EC_{annual} → Annual Electricity Consumption of Equipment for one year [kWh/year]
EF_{grid} → Emission Factor of Electricity Grid [kg CO2/kWh]

The energy consumption is determined based on available data, favorably using measured data under standard testing conditions. Details will be described on a subsector basis below.

The emission reduction is calculated by subtracting the emissions originating from the unit positively affected by the RAC NAMA project from the emissions originating from a baseline unit.

$$ER = EM_{baseline} - EM_{project}$$

ER → Emission Reduction [t CO_2eq]
$EM_{baseline}$ → Emission from the Use of Baseline Equipment [t CO_2eq]
$EM_{project}$ → Emission from the Use of Project Equipment [t CO_2eq]

In case the reported baseline refrigerant is an HCFC, i.e. R22, which is not classified as a GHG that is to be reduced under the UNFCCC (and thus not part of a GHG inventory or accountable mitigation), the baseline refrigerant for calculation is the most likely HFC refrigerant, which would have been used in absence of the project activity.

2.1 Implementation of Calculation in the Tool

Emission reductions are determined on a per unit basis and are first summed up over all units of the same model and then over all models to derive the total emission reduction.

The **direct emission reduction** per equipment is calculated as follows:
1) All baseline (default) parameters are described on a subsector basis. All technical data of project and baseline units are entered in the tool in the database sheets. They are retrieved and spelled out in the output sheet (Initial charge of baseline and project equipment, refrigerant used and related GWP).

2) From this information, the baseline emissions during first fill, annual leakage and disposal are calculated in separate columns by multiplying the initial charge by the baseline refrigerants' GWP and the respective emission factor.

$$EM_{dir,fy,BL} = \frac{IC_{BL} * GWP_{BL} * EF_{manu}}{1000}$$

$$EM_{dir,operation,BL} = \frac{IC_{BL} * GWP_{BL} * EF_{serv}}{1000}$$

$$EM_{dir,disposal,BL} = \frac{IC_{BL} * GWP_{BL} * EF_{disp}}{1000}$$

3) To calculate the emission reduction, first the charge reduction, expressed in tCO2eq is calculated by subtracting the initial charge of the project unit from the initial charge of the baseline unit (both expressed in t CO2eq). To calculate the reduction during first fill, annual leakage and disposal, the charge reduction is multiplied by the respective emission factor.

$$\text{Charge reduction} = \frac{IC_{BL} * GWP_{BL} - IC_{PR} * GWP_{PR}}{1000}$$

$$ER_{dir,fy} = \frac{CR * EF_{manu}}{1000}$$

$$ER_{dir,operation} = \frac{CR * EF_{serv}}{1000}$$

$$ER_{dir,disposal} = \frac{CR * EF_{disp}}{1000}$$

4) The total emission reduction is determined by multiplying the per-unit reduction with the number of overall sold units. The results are still separated for first fill, annual leakage and disposal,

5) The attribution of emission to specific years depending on the year of sale and the product lifetime is carried out in the summary sheet, where years of occurrence for first fill and disposal are defined based on the respective reporting periods. First fill emissions are assumed to happen at the end of the reporting period. The product lifetime begins with the occurrence of the first fill.

The **indirect emission reduction** per equipment is calculated as follows:
1) The energy consumption of baseline and project equipment is calculated as described on a subsector basis. For some subsectors, the energy consumption is provided by the producers. Where a calculation is necessary, the tool retrieves the relevant technical information for those calculations (volume, number of doors, electric power, runtime, etc.) from the database and default BL sheets.

Subsector	Formula for Energy Consumption	Necessary Parameters
Domestic refrigeration: Refrigerator/freezer	Project: Energy consumption provided by database of eligible models Baseline: The energy consumption is calculated according to Thai label standard No 5: EC= x * AV + y The constants x and y are depending on the number of doors, AV is the model's volume.	Annual energy consumption [kWh/year] Volume [l] Constants are provided in the tool.
Commercial refrigeration: Stand-alone units	Project and Baseline: Energy consumption provided by producer	Annual energy consumption [kWh/year]
Unitary air conditioning: Split air-conditioners (duct-less)	Project and Baseline: a) Energy consumption provided by producer b) Electric power [kW] * runtime [h/year]	a) Annual energy consumption [kWh/year] b) Electric power[kW], Default: runtime [h/year] – possibly different for fixed speed or inverter speed models
Chillers, air-conditioning	Project and Baseline: Electric power [kW] * runtime [h/year]	Electric power[kW], default: runtime [h/year]
Unitary air conditioning: Monoblock and Mini Chiller	Project and Baseline: a) Energy consumption provided by producer b) Electric power [kW] * runtime [h/year]	a) Annual energy consumption [kWh/year] b) Electric power[kW], Default: runtime [h/year]

Table 2 - Calculation of Annual Energy Consumption, per subsector

2) The annual energy reduction is calculated from the difference of the energy use of baseline and project equipment. The unit is kWh/year.

$$EC_{red,unit} = EC_{BLannual} - EC_{Pannual}$$

$EC_{red,\ unit}$ → Annual Energy Consumption Reduction per Unit [kWh/year]
$EC_{BLannual}$ → Annual Energy Consumption of Baseline Equipment [kWh/year]
$EP_{Pannual}$ → Annual Energy Consumption of Project Equipment [kWh/year]

3) The energy consumption reduction per equipment unit is the summed up to the total energy consumption reduction. The unit is MWh/year

$$EC_{red,total} = \frac{\sum EC_{red,unit}}{1000}$$

$EC_{red,\ total}$ → Annual Energy Consumption Reduction of all Units Covered [MWh/year]

4) The indirect emission reduction is calculated by multiplying the Total energy consumption reduction by the Thai grid emission factor. The unit is t CO2/year.

$$ER_{ind,annual} = \text{Total energy consumption reduction} \bullet EF_{grid}$$

Calculating Domestic Emissions Mitigated in Thailand

In addition to the overall mitigation, provisions are added for those units that are produced in Thailand and then exported. For those units, only the emission reduction during manufacture can be counted as Thai reduction while emission reduction during use and disposal is occurring outside of Thailand. Therefore, national emission reduction is calculated as follows:

$$ER_{dir,national} = N_l * EM_{dir,LT,} + N_e * \text{Charge reduction} * EF_{manu}$$

N_l → Number of Units that are produced in Thailand and sold on the national market

N_e → Number of Units that are produced in Thailand and exported

The number of exported units can be entered in the input sheet, if the producer can report on it. A model specific estimate can be entered in the database sheet. In any case, a producer-based default estimate, based on the producer's plan on exports is provided in the default BL sheet.

2.2 Baseline Considerations

In order to determine the emission savings, the baseline scenario and project activity i.e., the resulting baseline and project models, respectively are compared. The project model is the unit resulting from activities (credit-card financing scheme, production line conversion, market introduction and sales promotion) directly supported by the different financing mechanisms of the RAC NAMA Fund. The baseline scenario describes what would have happened in the absence of project activity. This is what the tool refers to as the baseline model. Depending on the nature of the project activity, the baseline model varies for each subsector as summarized in the Table 3 below.

In case a model is redesigned, keeping the same cooling capacity and features but using environmentally friendly technology (low-GWP refrigerant and high energy efficiency), the parameters of the replaced model are used as baseline. This baseline is used for production conversions, market introduction, and sales promotion where a new is produced and/or marketed in place of the replaced model.

In case no new unit is produced and/or marketed, the baseline model is calculated based on the High Energy Performance Standard (HEPS) which in Thailand, corresponds to EGAT's Label No. 5 Scheme. This scenario is applied when a unit is replaced at the end of its lifetime or when an end-user purchases a certain appliance for the first time. It assumes that the baseline is the purchase of an average unit available on the market. The use of HEPS as the default baseline is based on the agreed terms with the donors (NAMA Facility).

Subsector	Baseline
Domestic refrigeration: Refrigerator/freezer	High Energy Performance Standard (HEPS) Label No 5 constitutes the baseline to calculate project emissions.
Commercial refrigeration: Stand-alone units	Producers report on the technical parameters of the old (replaced) model and of the new model. The emission reduction is calculated from the difference.
Unitary air conditioning: Split air-conditioners (duct-less)	Producers report on the technical parameters of the old (replaced) model and of the new model. The emission reduction is calculated from the difference.
Chillers, air-conditioning	Producers report on the technical parameters of the old (replaced) model and of the new model. The emission reduction is calculated from the difference.
Unitary air conditioning: Monoblock and Mini Chiller	Producers report on the technical parameters of the old (replaced) model and of the new model. The emission reduction is calculated from the difference.

Table 3 - Applied Baselines in Each Subsector

Other Potential Default Baselines

While the project uses HEPS as the default baseline in the absence of a replaced model, there are other potential baselines which can be used depending on the specific project activity:

MEPS Baseline

Minimum Energy Performance Standards (MEPS) are at the lowest spectrum of the units available on the market. If MEPS are updated regularly, it can be assumed that MEPS represent the market average of several years ago and therefore the installed stock. This baseline can be applied when a unit is replaced by a project unit before reaching the defined lifetime and the parameters of the replaced unit were not measured individually (which is rarely the case).

Market Average (MA) Baseline

The average of all units on the market is taken as the baseline. Ideally, the sales-rated average is taken, but this is not often available. This scenario is applied when a unit is replaced at the end of its lifetime or when an end-user purchases a certain unit for the first time. It assumes that the baseline is the purchase of an average unit available on the market. This baseline is only recommended if sales-rated averages are available.

Precautions to Avoid Double Counting

The project activities target the market from the supply and the demand side: On the supply side, units are provided that are more environmentally friendly through supporting producers to redesign their models. On the demand side, accelerated end-user's uptake is promoted by providing loan schemes for more climate-friendly and energy efficient units. Hence, double counting can occur when the same unit is reported by the producer and by a financial institution. Models that were produced under a project-supported model-redesign and reported by the producer must not be counted if also reported by a financial institution.

3 User's Guide

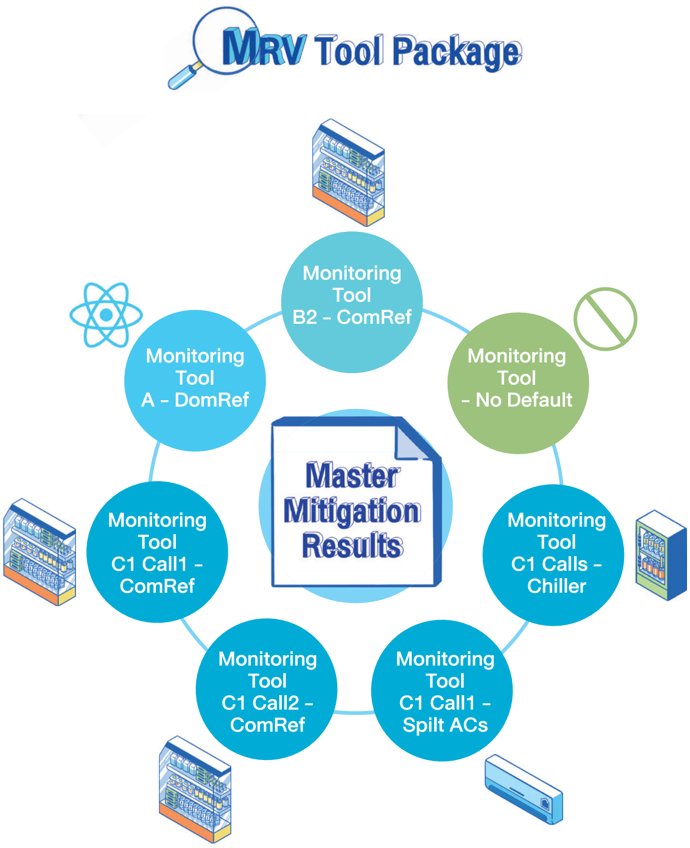


Figure 2 - MRV Tool Package

The MRV Tool Package works on the following principle: The user gives input on the number of units sold or produced under the project in an input sheet. Technical specifications are available and/or are input in a database sheet. The tool then automatically calculates the energy consumption and GHG emission reductions of the project interventions by combining the data on numbers and the technical specifications.

The tool design was adapted to the RAC NAMA Project MRV (see Figure 2) and follows the financing mechanisms in its structure. The MRV Tool Package is composed of 8 excel files: 1 Master Mitigation File and 7 Monitoring Tool Files. Each monitoring tool file corresponds to the financing scheme and the subsector as denoted in the file name, e.g. "Monitoring Tool B2 ComRef." Within each monitoring tool file, input and output sheets are structured according to the reporting periods that apply to that financial scheme.[6] Each monitoring tool file consolidates the annual direct and indirect emission reductions (based on the working principle mentioned previously) per year in the summary. The master mitigation file then consolidates emission reductions from the 7 monitoring tool files. The structure and the use of both the monitoring tool and master mitigation are further elaborated in the subsequent sections.

Important Reminder: The tool works as a package and relies on linkages between the different files. All 8 files must be kept in one folder and the file names cannot be modified. To view results in the master mitigation file, all files must be open.

[6] Reporting periods differ among the financial mechanisms and in some cases among companies within one mechanism as reporting begins from the contract signing date.

3.1 Monitoring Tool Files

The monitoring tool files follow a standard structure, containing the sheets described individually in this section.

Where can the user do what?

- Inputs are required from the user for the sheets "Input" and "Database."
- Modifications of baseline and default parameters can be carried out in the sheet "Default values".
- Verification and plausibility checks are built into the tool, specifically in the sheets "Instructions" and "Database".

a) Instructions sheet

This provides a short description of the opened tool or file as well as a step-by-step guideline on the inputting of data. This sheet also contains a table (see below) that aids to verify if all technical parameters are provided for project and baseline models; it also provides instructions on how to interpret this table for verification and identify which data could be missing or incorrectly inserted.

Positive numbers indicate that models in the input sheet are not matched with technical data in the database sheet

		Technical Specifications				Technical Specifications of replaced unit if available				
		Volume [liter]	EC/Year [kWh/year]	Refrigerant Type	Initial Charge [kg]	Baseline Model	Volume [liter]	EC/Year [kWh/year]	Refrigerant Type	Initial Charge [kg]
Q4	2018	0	0	0	0	0	0	0	0	0
Q1	2019	0	0	0	0	0	0	0	0	0
Q2	2019	0	0	0	0	0	0	0	0	0
Q3	2019	0	0	0	0	0	0	0	0	0
Q4	2019	0	0	0	0	0	0	0	0	0
Q1	2020	0	0	0	0	0	0	0	0	0
Q2	2020	0	0	0	0	0	1	1	1	1
Q3	2020	0	0	0	0	1	1	1	1	1
Q4	2020	0	0	0	0	0	0	0	0	0
Q1	2021	0	0	0	0	0	0	0	0	0
Q2	2021	0	0	0	0	0	0	0	0	0
Q3	2021	0	0	0	0	0	0	0	0	0

b) Summary Sheet

This sheet links to all output sheets within one monitoring tool file and sums up the calculated energy consumption reduction as well as direct and indirect mitigation. These summarized calculations are available per reporting period, per calendar year and cumulated over the years in which the project units (i.e., those produced and/or supported with direct support from the RAC NAMA Fund) are expected to be in operation. The summary sheet contains information on domestic mitigation as well as overall mitigation. Equally, the overall and the national baseline is provided.

c) Input Sheet

One input sheet is provided per reporting period to be filled by the user; all reporting periods have already been generated with the corresponding start and end date for each period as stated in the contracts of the participating producers. The reporting periods are listed in the sheet "QR" and the name of the period, e.g., Q1/2020 is used to retrieve the corresponding dates from the list in the "QR" sheet. In the input sheet, the user provides the number of produced units (and locally sold units where available) per model from each brand and company or retailer. Together with the technical details (in the sheets "database" and "default BL values" – see subsequent descriptions), the number of units are essential for the calculation of the overall emission reductions. All data to be entered by the user is information extracted from the reports submitted by the producers and/or retailers to EGAT as the project fund manager of the RAC NAMA Fund.

Input Commercial Refrigerators

Reporting Period:	Q3/2020	Start:	16.5.2020	End:	15.8.2020
Units produced during the reporting period		*16,089*			

	Equipment List		Sold Units		
Company/ Retailer	Brand	Model	Produced Units	Sold locally	Turnover [THB] for locally sold units

d) Output Sheet

This sheet contains all the calculations performed by the tool and is fully automated. Similar to the input sheet, there is one output sheet per reporting period. It draws data from the sheets (1) input, (2) database and (3) default values and then matches the data for each model that is reported. It then calculates direct and indirect emissions of project and baseline model. The annual mitigation effect of each model is calculated by subtracting the project model emissions from the baseline model emissions. For each model, the annual mitigation effect is summarized for (i.e. multiplied with) the number of produced units. Finally, the mitigation of all units from all models in the respective tool or file are summed up. In addition, overall and domestic baseline emission are calculated within the output sheets.

e) Database Sheet

This sheet contains the technical specifications or parameters of the models supported by the project (project models) and the replaced models (baseline models), where applicable. The listed parameters are essential for estimating the emission reductions. For the domestic refrigeration subsector, no baseline model parameters are inserted. Instead, the tool uses the default parameters provided in the sheet "default BL values" to estimate baseline emissions. Depending on the subsector, different technical parameters are required as detailed in Table 4.

Project models

Brand	Model	Volume (liter)	EC/Year (kWh/year)	Refrigerant Type	Initial Charge [kg]

Baseline models

Brand	replaced by Model	Baseline Model	Volume [liter]	EC/Year [kWh/year]	Refrigerant Type	Initial Charge [kg]

To the right of the input tables, the tool provides some basic plausibility checks by comparing the entered values with expected ranges for the values. The comparison ranges are defined in the QC sheet.

Subsector	Required parameters to be inserted into database sheets
Domestic refrigeration: Refrigerator/freezer	Model name Type Volume [l] Energy consumption [kWh/year] Refrigerant type (no parameters for baseline models required)
Commercial refrigeration: Stand-alone units	Model name Volume [l] Energy consumption [kWh/year] Refrigerant type Initial Charge [kg]
Unitary air conditioning: **Split air-conditioners (duct-less)**	Model name Cooling Capacity [BTU/hr or kW] Fixed or variable speed Energy Efficiency Ratio EER [BTU/hr/kW or kW/kW] Cooling Season Performance Factor CSPF (for variable speed [kW/kW]) Electric Power [kW] Energy consumption [kWh/year] Refrigerant type Initial Charge [kg]
Chillers, air-conditioning	Model name Power [kW] Cooling Capacity [RT] Compressor type Air or water cooled Refrigerant type Initial Charge [kg]

Table 4 - Required Model Parameters to be Entered into the Database Sheets

Subsector	Required parameters to be inserted into database sheets
Unitary air conditioning: Monoblock and Mini Chiller	Model name Cooling Capacity [BTU/hr or kW] Fixed or variable speed Energy Efficiency Ratio EER [BTU/hr/kW or kW/kW] Cooling Season Performance Factor CSPF (for variable speed [kW/kW]) Electric Power [kW] Energy consumption [kWh/year] Refrigerant type Initial Charge [kg]

Table 4 - Required Model Parameters to be Entered into the Database Sheets

This information is extracted from the reports submitted by producers and retailers to the RAC NAMA Fund. This sheet needs to be updated by the user per reporting period; if no new model is added in the latest report submitted, the user can also simply copy and paste the list from the previous reporting period.

Information on the share of exported units per model can be entered into the database sheets as well. However, an estimated value is provided as default. The default is estimated per producer and entered in the Default BL Sheet (see below).

f) Default BL Sheet

This sheet contains default values and assumptions needed for the calculation, such as: annual refrigerant leakage factor, product lifetime, default refrigerant, default charge size, GWP value of refrigerants, grid emission factor. In line with the methodology used for the project MRV, the tool refers to the IPCC 2006 Guidelines for default values where no documented source is available.

The default sheet also contains data on energy efficiency requirements to calculate the HEPS baseline for domestic refrigeration, (availability depends on the subsector), referencing the Thai label No. 5 regulations. This sheet only needs to be modified if the user wants to adjust default values.

g) QC Sheet

This sheet contains the reporting periods and several columns used for referencing within the tool. All timelines have already been entered and no input is required from the user.

The reporting periods are used to estimate the emission reduction in the year when the respective units were produced. For example, a unit produced in Q4/2020 does not count for a full annual reduction in 2020 as it is most likely only put in use at the very end of 2020. To account for this fact, a column estimating the "fraction of year that units are in operation in the year on introduction" is added. This factor is used in the summary sheet when mitigation from project periods are summed to annual mitigation.

To distinguish between overall and domestic mitigation, the share of units that are produced in Thailand and exported is required. A table containing the default export share per producer is included in this sheet. These numbers are used by the tool when no specific information is entered into the input sheet (units sold domestically) or the database sheets.

The comparison ranges used for plausibility checks of data entered in the database sheets are defined in this sheet.

3.2 Master Mitigation File

The master mitigation file links to all the monitoring tool files, specifically to the summary sheets therein, summing up direct and indirect mitigation based on the data provided by the user and data that is already contained within the tool (as previously described for each of the sheet within one monitoring file). The results summarized within the master mitigation file are separated into two sheets: Overall and Domestic. The Overall sheet refers to mitigation resulting from all the units that were directly supported by the financing schemes of the RAC NAMA fund (credit-card financing scheme, production line conversion, market introduction and sales promotion). The Domestic sheet refers to mitigation that takes place in Thailand resulting from the same units. The Project MRV Tool follows IPCC 2006 Guidelines in distinguishing local from overall mitigation along the life cycle of the RAC equipment.

As described in Figure 3 below, direct domestic mitigation refers to units produced for the domestic market, counting mitigation that takes place at all points of the life cycle, i.e., manufacturing (or first fill), operation, and disposal. Direct domestic mitigation also refers to units produced for the export market, counting mitigation only that takes place at the manufacturing stage of the life cycle. For indirect domestic, this refers only to units produced for the domestic market and counting only mitigation that takes place at the operation stage of the life cycle. In principle, the total direct domestic can be included in the mitigation reported by Thailand to the UNFCCC.

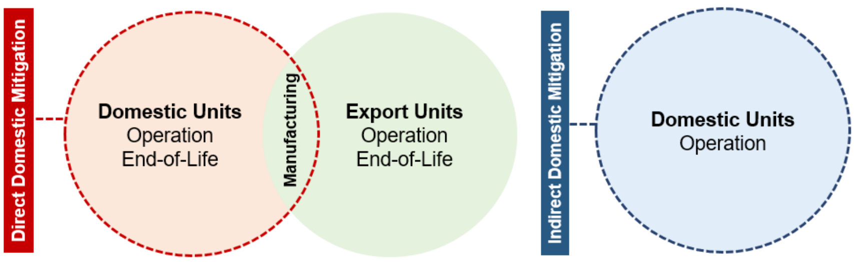


Figure 3 - Direct and Indirect Domestic (or Local) Mitigation

Both the overall and local sheets have the same structure. Each sheet has three main tables that summarize figures as: (1) emission reductions, (2) baseline emissions, and (3) project emissions.

Overall Emission Reduction for Baseline and Project Emissions, please scroll down

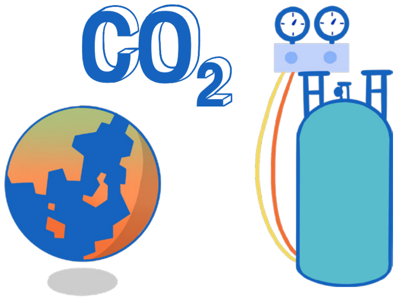
Emission Reduction
Measures | GHG Emissions Reductions per year
Baseline Emissions
GHG Baseline Emiss
Project Emissions
GHG Project E

Direct Emissions		2018	2019	2020	2021	2022	2023	2024	2025
Dom Ref	per year	0	0	0	0	0	0	0	0
Com Ref	per year	0	0	1	2	2	2	2	2
Split AC	per year	0	0	0	0	0	0	0	0
Chiller	per year	0	0	0	0	0	0	0	0
Other	per year	0	0	0	0	0	0	0	0
Dom Ref	accumulated	0	0	0	0	0	0	0	0
Com Ref	accumulated	0	0	2	4	6	9	11	13
Split AC	accumulated	0	0	0	0	0	0	0	0
Chiller	accumulated	0	0	0	0	0	0	0	0
Other	accumulated	0	0	0	0	0	0	0	0
Total per year (from refrigerant r		0	0	1	2	2	2	2	2
Total accumulated		0	0	2	4	7	9	12	14

In each table, figures are summarized according to the measure, i.e., from refrigerant replacement and from increased energy efficiency or direct and indirect emission reductions respectively. Direct emissions and emission reductions are further broken down into the type of gas in the unit replaced for each subsector. For both direct and indirect emissions and emission reductions, the figures are summarized per year and also accumulated per year (taking into account figures from previous years). Figures for each subsector are also summarized as accumulated per year.

		GHG Emissions Reductions per year (tCO_2eq)											
Direct Emissions		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Dom Ref	R134a	38	16	16	16	16	16	16	16	16	16	16	16
Com Ref		0	124	2.394	4.018	4.018	4.018	4.018	4.018	4.018	4.018	4.018	4.018
	R134a	0	124	2144	3529	3529	3529	3529	3529	3529	3529	3529	3529
	R404A	0	0	249	489	489	489	489	489	489	489	489	489
Split AC		0	0	0	0	0	0	0	0	0	0	0	0
	R410A	0	0	0	0	0	0	0	0	0	0	0	0
	R32	0	0	0	0	0	0	0	0	0	0	0	0
Chiller		0	0	0	1	1	1	1	1	1	1	1	1
	R134a	0	0	0	0	0	0	0	0	0	0	0	0
	R407C	0	0	0	1	1	1	1	1	1	1	1	1
Other		0	1	7	7	7	7	7	7	7	7	7	44
	R134a	0	0	0	0	0	0	0	0	0	0	0	0
	R410A	0	1	7	7	7	7	7	7	7	7	7	44
	R404A	0	0	0	0	0	0	0	0	0	0	0	0
Dom Ref	accumulated	38	54	70	86	102	118	134	150	166	182	198	215
Com Ref	accumulated	0	124	2.518	6.535	10.553	14.571	18.589	22.607	26.625	30.643	34.661	38.678
Split AC	accumulated	0	0	0	0	0	0	0	0	0	0	0	0
Chiller	accumulated	0	0	0	2	3	4	5	6	8	9	10	11
Other	accumulated	0	1	7	14	21	27	34	41	47	54	61	105
Total per year (from refrigerant r		38	141	2.417	4.042	4.042	4.042	4.042	4.042	4.042	4.042	4.042	4.079
Total accumulated		38	179	2.595	6.637	10.679	14.721	18.763	22.805	26.846	30.889	34.931	39.010
		GHG Emissions Reductions per year (tCO_2)											
Increase of EE		**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Dom Ref	HEPS	553	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659
Com Ref	Replacement u	0	1.105	25.175	39.722	39.722	39.722	39.722	39.722	39.722	39.722	39.722	39.722
Split AC	Replacement u	0	0	1	1	1	1	1	1	1	0	0	0
Chiller	Replacement u	0	0	0	0	0	0	0	0	0	0	0	0
Other	Replacement u	0	1	8	8	8	8	8	8	8	8	8	7
Dom Ref	accumulated	553	2.212	3.870	5.529	7.188	8.846	10.505	12.164	13.822	15.481	17.139	18.798
Com Ref	accumulated	0	1.105	26.280	66.002	105.725	145.447	185.170	224.892	264.615	304.337	344.060	383.782
Split AC	accumulated	0	0	1	1	2	2	3	3	4	4	4	4
Chiller	accumulated	0	0	0	0	0	0	0	0	0	0	0	0
Other	accumulated	0	1	8	16	24	32	40	48	55	63	71	79
Total per year (from EE increase)		553	2.764	26.841	41.390	41.390	41.390	41.390	41.390	41.390	41.389	41.389	41.388
Total accumulated		553	3.317	30.159	71.548	112.938	154.327	195.717	237.106	278.496	319.885	361.274	402.663
		Total GHG Emissions Reductions per year (tCO_2eq)											
		2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
Dom Ref	per year	590	1.675	1.675	1.675	1.675	1.675	1.675	1.675	1.675	1.675	1.675	1.675
Com Ref	per year	0	1.229	27.568	43.740	43.740	43.740	43.740	43.740	43.740	43.740	43.740	43.740
Split AC	per year	0	0	1	1	1	1	1	1	1	1	0	0
Chiller	per year	0	0	0	1	1	1	1	1	1	1	1	1
Other	per year	0	1	14	15	15	15	15	15	15	15	15	51
Dom Ref	accumulated	590	2.265	3.940	5.615	7.289	8.964	10.639	12.314	13.988	15.663	17.338	19.013
Com Ref	accumulated	0	1.229	28.797	72.538	116.278	160.018	203.759	247.499	291.239	334.980	378.720	422.461
Split AC	accumulated	0	0	1	1	2	2	3	3	4	5	5	5
Chiller	accumulated	0	0	0	2	3	4	5	6	8	9	10	11
Other	accumulated	0	1	16	30	45	59	74	88	103	118	132	183
TOTAL EMISSIONS REDUCTIONS (tCO2eq per year)		**590**	**2.905**	**29.258**	**45.431**	**45.431**	**45.431**	**45.431**	**45.431**	**45.431**	**45.432**	**45.431**	**45.467**
ACCUMULATED		**590**	**3.496**	**32.754**	**78.185**	**123.617**	**169.048**	**214.480**	**259.911**	**305.342**	**350.774**	**396.205**	**441.672**

Figure 4 - GHG Emission Reductions per year (tCO_2eq)



4 Technical Parameters

This section provides elaboration on equipment parameters contained in the default BL values sheet. These parameters are based on available published resources; in the absence of any, parameters refer to default values provided by the IPCC 2006 Guidelines. Some assumptions specific to the subsectors are also further elaborated. These values may be modified by the user in the default values sheet; it is recommended that modifications are only carried out when published resources or documented expert reviews are available.

4.1 Carbon Intensity of Electricity Generation

In Thailand, per average kWh, 0.5664 kg CO2 are produced during electricity generation[7]. This grid emission factor is used to calculate the indirect emission from energy use.

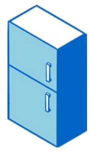
4.2 Global Warming Potential of Refrigerants

Table 5 includes the global warming potential of the most common refrigerants in the Thai market.

Refrigerant	GWP
R-134a	1430
R-32	675
R-410A	2088
R-404A	3922
R-407C	1774
R-600a	3
R-290	3

[7] http://ghgreduction.tgo.or.th/images/Grid_Emission_Factor_2559_-_Finalised.pdf

4.3 Subsector-specific Parameters



4.3.1. Domestic Refrigerators

Indirect Emission Calculations

Energy consumption in domestic refrigerators is measured by an accredited laboratory. It is reported by manufacturers in kWh/year as it is assumed that domestic refrigerators run continuously throughout the year. Runtime hours are therefore not considered for the calculation. Similarly, HEPS, in this case the Label No. 5 also states a maximum admissible energy consumption.

The project intervention is measured against HEPS (Label No. 5). An extended version of the tool also includes other options for baselines, such as MEPS and market average – as additional resources, all three baselines are implemented in that tool as the energy consumption of BL MEPS, BL HEPS and BL MA.

Baseline MEPS and HEPS are based on MEPS (TIS 2186/2547) and Label No. 5. Both are defined by a maximum energy consumption for domestic refrigerators based on formula depending on volume (AV in the formula) and number of doors.

		MEPS (TIS 2186/2547)	HEPS (Label No 5):
1-door:	**< 100 L:**	EC < 0.80 • AV + 300	EC < 0.62 • AV + 233
	> 100 L:	EC < 0.46 • AV + 171	EC < 0.36 • AV + 133
2-door or more:	**< 450 L:**	EC < 0.46 • AV + 457	EC < 0.36 • AV + 354
	> 450 L:	EC < 0.80 • AV + 457	EC < 0.62 • AV + 354

Table 6 - Thai MEPS and HEPS for Domestic Refrigerators

Baseline MA is the market average, derived from EGAT's Label No 5 database. The market was divided into volume classes of 50 L difference, and the average energy consumption was calculated per volume class. The energy consumption of the project model is compared with the average energy consumption of its volume class.

Volume [litre]	Annual energy consumption per litre [kWh/litre/year]	Annual energy consumption of refrigerator [kWh/year]
75	3.71	278.62
125	1.24	155.53
175	1.36	237.28
225	1.50	338.42
275	1.32	362.49
325	1.10	356.31
375	1.03	387.85
425	0.97	412.05
475	0.77	366.54
525	0.92	481.56
575	0.95	546.66
625	0.84	526.27
675	0.66	443.01
725	0.66	475.82

Table 7 - Energy Consumption per Volume Class, based on EGAT's Label No 5 database.

There are two limitations to this approach:

- EGAT only records models where a label was applied for. There might be additional models on the market without a label. If these models exist, it is likely that their energy consumption is higher.
- The data is not weighted according to sales numbers. Each model has the same influence on the average efficiency.

Direct Emission Calculations

There is only one baseline for direct emissions. It is based on the most common refrigerant that is being replaced. For domestic refrigerators, this is R-134a. There are no other refrigerants being used in domestic refrigerators, apart from R-134a and R-600a.

Parameters such as emission factors, lifetimes, charge sizes and end-of-life emissions are either determined from a national RAC sector inventory or taken from the "IPCC 2006 Guidelines for National Greenhouse Gas Inventories Volume 3 Industrial Processes and Product Use. Chapter 7: Emissions of fluorinated substitutes for ozone depleting substances".

The charge size for flammable refrigerants is limited at 0.150 kg by standard IEC 60355-2-24. This is therefore taken as the default value. Most domestic refrigerators have a lower charge size and the charge size for R-600a refrigerators is generally lower than that of R-134a refrigerators. There is currently no data being collected in Thailand about the charge size of these units. As it has little influence on the final results, no further distinction is being made.

The following parameters were used to calculate the baseline direct emissions.

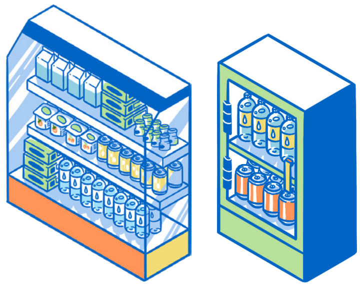
Parameter	Assumption	Source	IPCC 2006 Range
Default baseline refrigerant	R-134a	Global market analysis/ Bright	
GWP R-134a	1430	IPCC AR 4	
Default charge size	0.150 kg	IPCC 2006/ Global market analysis	0.05 – 0.5 kg
Annual refrigerant leakage	0.5 %	IPCC 2006	0.1-0.5%
Manufacture emission factor	1%	IPCC 2006	0.2-1%
Disposal emission factor	100%	Assuming no recovery due to lack of documentation	Not given
Product Lifetime (years)	15	Bright Inventory	12-20

Table 8 - Baseline Domestic Refrigerator Direct Emission Parameters

The following parameters were used to calculate the direct emissions after project intervention (parameters not mentioned are the same as the baseline):

Project Units	Assumption	Source/Explanation
Refrigerant	R-600a	Condition of project
GWP R-600a	3	IPCC AR 4
Default charge size	0.150 kg	Maximum allowed charge size (IEC standard)

Table 9 - Project Intervention Domestic Refrigerator Direct Emission Parameters



4.3.2. Commercial Refrigeration Stand-alone Systems

Indirect Emission Calculations

The energy consumption of the project units and the replaced baseline unit is given as inputs.

The project intervention is measured against the replaced unit.

An extended version of the tool also includes other options for baselines, such as MEPS HEPS and market average – as additional resources, those three additional baselines are implemented in that tool as the energy consumption of BL MEPS, BL HEPS and BL MA.

The energy consumption is calculated by the formula given in the table using the parameters given in the Label No. 3 (=MEPS) and Label No. 5 (=HEPS). The formula in the mentioned standard results in the energy consumption per day. Hence the value is multiplied with 365 to calculate the energy consumption per year. There is no market average available. In absence of market data, the average of HEPS and MEPs is used as market average.

	Label No. 3	Label No. 4	Label No. 5
Energy consumption per day [kWh]	0.0065 • V+3.8988	0.0065 • V+3.5739	0.0065 • V+3.249

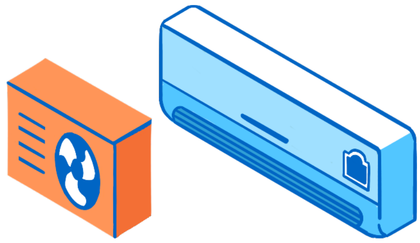
Table 10 - Calculation Parameters for Commercial Stand-alone Energy Consumption according to Thai HEPS, V =Volume of the model

Direct Emission Calculations

The refrigerants used in project and baseline models and the respective charge sizes are provided by the producers. The following parameters were used to calculate the direct emission reduction.

Parameter	Assumption	Source	IPCC 2006 Range
Emission factor at production	1%	IPCC 2006	
Annual refrigerant leakage	15 %	IPCC 2006	10 – 15 %
Emission factor at decommissioning	100%	Assuming no recovery due to lack of documentation	Not given
Product Lifetime (years)	15	IPCC 2006	10 – 15

Table 11 - Baseline Commercial Refrigeration Stand-alone Unit Direct Emission Parameters



4.3.3. Split ACs

Indirect Emission Calculations

The project intervention is measured against the replaced unit.

The reduction against the replaced unit is calculated using the technical specifications of the replaced unit.

The MEPS and HEPS thresholds are used as plausibility check for the entered efficiency factors. The entered energy consumption is compared to an expected energy consumption estimated using the CSPF calculation method of the standard ISO 16538 and Thai temperature bins.

	MEPS (TIS 2134-2553)	HEPS (Label No 5)	Average
fixed speed EER	2.8	4	3
variable speed CSPF	4	6	4.2

Table 11 - Fixed Speed AC EER Variable Speed AC CSPF according to Thai MEPS, HEPS and for market average

Tables of energy consumption depending on cooling capacities and EER/CSPF for fixed speed and variable speed are given in the sheet "Default baseline values split AC".

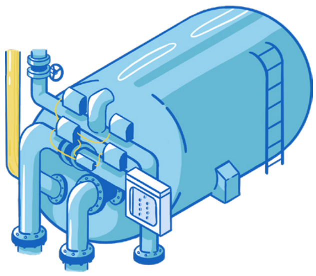
An extended version of the tool also includes other options for baselines, such as MEPS, HEPS and market average – as additional resources, those baselines are implemented in that tool as the energy consumption of BL MEPS, BL HEPS and BL MA.

Direct Emission Calculations

The refrigerants used in project and baseline models and the respective charge sizes are provided by the producers. The following parameters were used to calculate the direct emission reduction.

Parameter	Assumption	Source	IPCC 2006 Range
Annual refrigerant leakage	10%	IPCC 2006/ Bright inventory	1-10%
Manufacture emission factor	1%	IPCC 2006	0.2-1%
Disposal emission factor	100%	Assuming no recovery due to lack of documentation	Not given
Product Lifetime (years)	8	Bright inventory	10-20

Table 12 - Baseline Split AC Direct Emission Parameters



4.3.4. Chillers

Indirect Emission Calculations

The energy consumption of the project units is a requested input. A runtime of 1560 hours is assumed annually for a fixed speed chiller to derive the annual energy consumption.

The project intervention is measured against the replaced unit.

The reduction against the replaced unit is calculated based on the entered technical specifications of the replaced unit. The difference in energy consumption is multiplied with the grid emission factor to calculate the indirect emission savings.

An extended version of the tool also includes other options for baselines, such as MEPS, HEPS and market average – as additional resources, those baselines are implemented in that tool as the energy consumption of BL MEPS, BL HEPS and BL MA.

		MEPS (installation in building only, based on ministerial announcement (DEDE))	HEPS range (Ministerial regulation High efficiency chillers)	
	type of compressor	kW/RT	kW/RT	kW/RT
air-cooled	all type <300 RT	1.33	1.12	0.95
	all type > 300 RT	1.31	1.12	0.95
water-cooled	reciprocating	1.24	0.88	0.75
	rotary, screw, scroll < 150 RT	0.89	0.7	0.6
	rotary, screw, scroll > 150 RT	0.78	0.7	0.6
	centrifugal < 300 RT	0.76	0.67	0.54
	centrifugal > 300 RT < 500 RT	0.76	0.61	0.5
	centrifugal > 500 RT	0.62	0.61	0.5

Table 13 - MEPS for Installation in Buildings and HEPS for AC Chiller

Direct Emission Calculations

The refrigerants used in project and baseline models and the respective charge sizes are provided by the producers. The following parameters were used to calculate the direct emission reduction.

Parameter	Assumption	Source	IPCC 2006 Range
Annual refrigerant leakage	15 %	IPCC 2006	2 - 15%
Manufacture emission factor	1%	IPCC 2006	0.2-1%
Disposal emission factor	100%	Assuming no recovery	Not given
Product Lifetime (years)	30	IPCC 2006	15-30

Table 14 Baseline Chiller Direct Emission Parameters

4.3.5. Other Unitary AC Equipment

Indirect Emission Calculations
The project intervention is measured against the replaced unit.

The reduction against the replaced unit is calculated using the technical specifications of the replaced unit.

As this subsector contains different model types, no baseline default was included and hence no additional baselines (MEPS or HEPS) are provided in the extended version of the tool.

Direct Emission Calculations
The refrigerants used in project and baseline models and the respective charge sizes are provided by the producers. The following parameters were used to calculate the direct emission reduction.

Parameter	Assumption	Source	IPCC 2006 Range
Annual refrigerant leakage	10%	IPCC 2006/ Bright inventory	1-10%
Manufacture emission factor	1%	IPCC 2006	0.2-1%
Disposal emission factor	100%	Assuming no recovery	Not given
Product Lifetime (years)	8	Bright inventory	10-20

Table 15 - Baseline Unitary AC Direct Emission Parameters

5 References

IPCC AR4 (2007): IPCC 4th Assessment Report: Climate Change 2007. The Physical Science Basis. Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; Miller, H.L., eds., Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, ISBN 978-0-521-88009-1

IPCC (2006): 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 3 Industrial Processes and Product Use. Chapter 7: Emissions of fluorinated substitutes for ozone depleting substances. Authors: Paul Ashford, James A. Baker, Denis Clodic, Sukumar Devotta, David Godwin, Jochen Harnisch, William Irving, Mike Jeffs, Lambert Kuijpers, Archie McCulloch, Roberto De Aguiar Peixoto, Shigehiro Uemura, and Daniel P. Verdonik.

Annex I: Financing Mechanisms of RAC NAMA Fund & Reporting Timelines of Partners Producers

"RAC NAMA Fund" was established in 2018 as a funding mechanism to promote green cooling technologies in Thailand's RAC sector. With a budget of €8.3 million (about 300 million Baht) and targeted financial mechanisms combined with technical support, the fund served the needs of different stakeholders (e.g. direct consumers, producers, training institutions). The Fund was established under the project Thailand Refrigeration and Air Conditioning Nationally Appropriate Mitigation Actions (RAC NAMA) with EGAT as the Project Fund Manager (PFM) on behalf of Thai Government. The total budget is divided into 3 components: consumer finance (Scheme A), revolving fund (Scheme B1 and B2) and grant scheme (Scheme C1 and C2) as elaborated below. The financing schemes directly contribute to the mitigation and are thereby monitored through the Project MRV Tools.

1.Scheme A: Consumer Finance - To support sale promotions and stimulate consumer spending for domestic refrigerators with high energy efficiency and natural refrigerants, the Fund initiated a 0% interest credit card campaign (with installment over for 10 months) during March 2018 – August 2018.

2.Scheme B1: Credit Line for Production Line Conversion (Revolving Fund) - To support producers with finance costs incurred during the production line conversion of cooling appliances and expansion towards use of natural refrigerants (e.g. equipment and raw material costs), the short-term loan was rolled out during 2019 – 2020 and was all returned to the RAC NAMA Fund. A total of 4 companies participated in this scheme, including:
- Sanden Intercool (Thailand) Co., Ltd.
- Songserm Commercial Refrigeration (Thailand) Co., Ltd.
- Songserm Intercool Stainless Co., Ltd.
- The Cool Manufacturing Co., Ltd.

3.Scheme B2: Credit Line for Market Introduction & Sales Promotion (Revolving Fund) - The short-term loan was launched to support the market introduction and sales promotion for cooling appliance. Two partnered producers received the support and implemented the marketing campaigns during January – December 2020, and already returned the loan back to the RAC NAMA Fund, which are:

- Sanden Intercool (Thailand) Co., Ltd.
- Patana Intercool Co., Ltd.

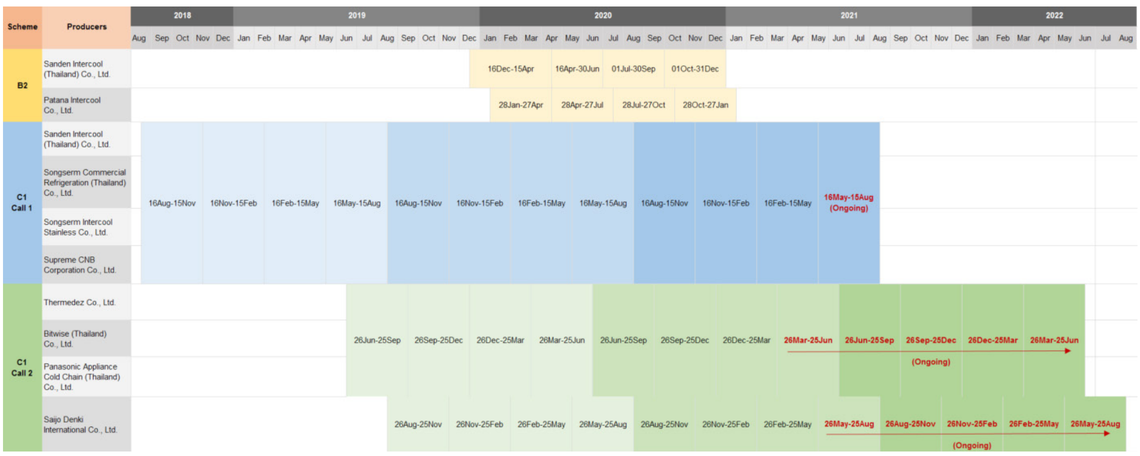
4.Scheme C1: Sub-Grant for Production Line Conversion - To encourage the production of climate-friendly and energy-efficient cooling technologies, the Fund provided grants for producers to convert their production lines towards the use of natural refrigerants. Partnered companies received the support during 2019 – 2021. Each company also contributed its own investment to the production line conversion, including:

- Sanden Intercool (Thailand) Co., Ltd.
- Songserm Commercial Refrigeration (Thailand) Co., Ltd.
- Songserm Intercool Stainless Co., Ltd.
- Supreme CNB Corporation Co., Ltd
- Panasonic Appliance Cold Chain (Thailand) Co., Ltd.
- Thermedez Co., Ltd.
- Bitwise (Thailand) Co., Ltd.
- Saijo Denki International Co., Ltd.
- The Cool Manufacturing Co., Ltd. (Withdrawn due to economic effects from COVID-19 situation)

5.Scheme C2: Sub-Grant for Training and Testing Facilities - Apart from supporting the supply and demand sides, the Fund also aimed to enhance capacity of the service sector. Two sub-financial schemes were launched to support (1) trainings and (2) the improvement of testing facilities;

- Grant was provided to the King Mongkut's University of Technology North Bangkok (KMUTNB) to establish training centers throughout the country and to carry out trainings on the topic of "Safe Use and Handling of Flammable Refrigerants".
- Grant was provided to the Electrical and Electronic Institute (EEI) to improve its testing facility for air-conditioners using natural refrigerants.

Reporting Timelines of Partnered Producers



Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Registered offices
Bonn and Eschborn, Germany

Friedrich-Ebert-Allee 32 + 36
53113 Bonn
Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1 - 5
65760 Eschborn
Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de