Accelerating the Global Shift to Energy-Efficient and Climate-Friendly Appliances and Equipment

# Market Research of High-Efficiency Room Air Conditioner Models in Key Markets & Proposed New Labeling Efficiency Tiers for Singapore

Prepared for

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## Acronyms and Abbreviations

| | |
|---|---|
| AMS | ASEAN Member States |
| APF | Annual Performance Factor |
| APAEC | ASEAN Plan of Action and Energy Cooperation |
| BEE | Bureau of Energy Efficiency, India |
| CC | Clean Cooling Collaborative |
| CFHP | Climate Friendly Households Programme |
| COP | Coefficient of Performance |
| $CO_2$ | Carbon dioxide |
| CSPF | Cooling Seasonal Performance Factor |
| EE | Energy Efficiency |
| EER | Energy Efficiency Ratio |
| EGAT | Electricity Generating Authority of Thailand |
| GCP | Global Cooling Prize |
| GEF | Global Environment Facility |
| GHG | Greenhouse Gas |
| GWP | Global Warming Potential |
| HDB | Housing and Development Board |
| HFC | Hydrofluorocarbon |
| ISEER | Indian Seasonal Energy Efficiency Ratio |
| ISO | International Organization for Standardization |
| LBNL | Lawrence Berkeley National Laboratory |
| MELS | Mandatory Energy Labelling Scheme |
| MEPS | Minimum Energy Performance Standard |
| MSE | Ministry of Sustainability and the Environment of Singapore |
| NEA | National Environment Agency |
| PUB | Public Utilities Board |
| RAC | Room Air Conditioner |
| SEER | Seasonal Energy Efficiency Ratio |
| SE4ALL | Sustainable Energy for All |
| S&L | Standards and Labelling |
| U4E | United for Efficiency |
| UNEP | United Nations Environment Programme |
| WCOP | Weighted Coefficient of Performance |

# 1 EXECUTIVE SUMMARY

The "ASEAN Cool Initiative", funded by the Clean Cooling Collaborative (CCC), aims to accelerate the adoption of the ASEAN regional roadmap on room air conditioners (RACs) to enable countries to go straight to the more ambitious Regional Phase II levels (i.e., CSPF 6.09 Wh/Wh[1]) and ultimately supporting emission reduction goals outlined in the ASEAN Plan of Action for Energy Cooperation (APAEC) Phase II (2021-2025). Led by United for Efficiency (U4E) in collaboration with the International Institute for Energy Conservation (IIEC), ASEAN Centre for Energy (ACE) and Lawrence Berkeley National Laboratory (LBNL), the initiative provides technical assistance and capacity building to implement Minimum Energy Performance Standards (MEPS) and labels in the region.

In response to a request from the National Environment Agency (NEA) of Singapore regarding proposed efficiency tiers for the new RAC label aligned with the best available technology (BAT), discussions were held at the ASEAN Cool Initiative Regional Workshop on 14-15 November 2023 in Johor Bahru, Malaysia. IIEC, in close consultation with U4E and LBNL, was tasked to propose new efficiency ratings for the RAC energy labeling scheme aligned with the BAT and more advanced technology for Singapore, ranging from one to five ticks, following the adoption of the revised MEPS level of 6.09 CSPF (Cooling Seasonal Performance Factor) in 2025. This objective aligns with the ASEAN regional roadmap and the MEPS announcement by the NEA of Singapore, which will increase from 4.04 WCOP (5.13 CSPF) to 4.86 WCOP (6.09 CSPF), scheduled for implementation in April 2025. Therefore, IIEC also conducted market research on high-efficiency RACs to identify models surpassing the MEPS level of 6.09 CSPF to investigate and consider available models in the market.

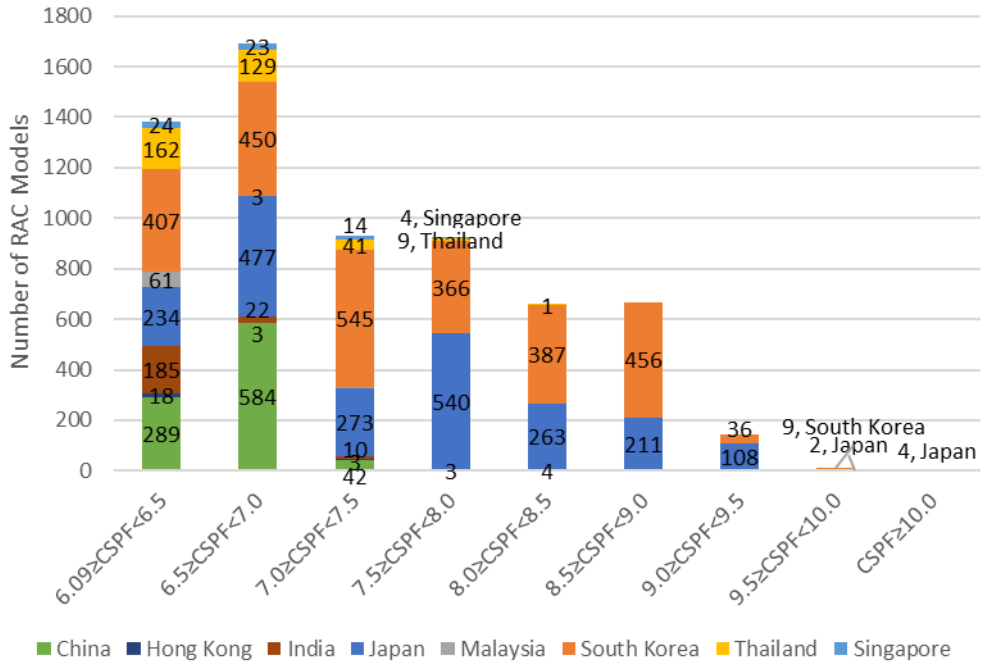
The methodology employed in researching high-efficiency RACs across the selected key markets involved extensive data gathering from various sources, including government and energy agency databases, e-commerce platforms, retail websites, and official manufacturer websites, forming the basis of the research. This diverse pool of information resources was utilized to identify relevant RAC models and their efficiency ratings. Comparative analysis across different markets was conducted to determine variations and trends in RAC efficiency, focusing on models surpassing predefined benchmarks (CSPF of 6.09). It should be noted that the efficiency metrics adopted by the selected key markets are based on different formulas and different temperature bins for calculation. Therefore, conversion from APF (Annual Performance Factor - China & Japan), Hong Kong CSPF, South Korea CSPF, ISEER (India Seasonal Energy Efficiency Ratio - India), SEER (Seasonal Energy Efficiency Ratio - Thailand), and WCOP (Weighted Coefficient of Performance - Singapore) to ISO CSPF metrics was undertaken to enable comparison of RACs' efficiency values across the selected markets.

**Availability of High Efficiency Models Across Key Markets**

The collected data on RAC models, categorized by their CSPF across various markets, reveal that almost half (48%) of RAC models with efficiency higher than 6.09 CSPF in these markets fall within the CSPF range of 6.09 to less than 7.0, with China, Japan, and South Korea leading in numbers. China has the highest number of models within this CSPF range, with 873, followed closely by South Korea with 857 models. Japan also contributes significantly with 711 models. However, as the CSPF range increases, the availability of RAC models decreases, and RAC model CSPF ≥ 9.5 models are extremely

[1] The Cooling Seasonal Performance Factor (CSPF) of 6.09 Wh/Wh is determined in accordance with ISO 16358-1.

rare. Out of the 6,404 models with a CSPF higher than 6.09, the highest CSPF model recorded was from Japan's database with ISO CSPF of 10.14.




***Distribution of RAC Models by CSPF Across Key Markets***

In terms of cooling capacity, high-efficiency RAC models are available across all markets, showcasing a diverse range of options for consumers, especially in the CC≤4.5kW-9.5kW range. South Korea exhibits a substantial presence of high-efficiency models across all cooling capacity categories. Japan shows dominance in the ≤4.5kW range. Similarly, China has a significant portion falling under the ≤4.5kW category. While South Korea have high portion in the 4.5kW<CC≤9.5kW range.

***Distribution of High-Efficiency RAC Models, with CSPF ≥ 6.09 by Cooling Capacity Across Key Markets***

| | CC≤4.5kW | 4.5kW<CC≤9.5kW | CC>9.5kW | Total |
|---|---|---|---|---|
| **China** | 672 | 250 | 0 | **922** |
| **Hong Kong** | 17 | 7 | 0 | **24** |
| **India** | 75 | 142 | 0 | **217** |
| **Japan** | 1,578 | 534 | 0 | **2,112** |
| **Malaysia** | 19 | 47 | 0 | **66** |
| **South Korea** | 172 | 2,467 | 17 | **2,656** |
| **Thailand** | 152 | 158 | 32 | **342** |
| **Singapore** | 29 | 34 | 2 | **65** |
| **Total** | **2,714** | **3,639** | **51** | **6,404** |

*Note: The data in the figure and table was retrieved and gathered in January 2024. The information presented is subject to updates as new data becomes available.*

**Proposed Efficiency Tiers of RAC Labeling Program**

The two proposed options for efficiency tiers (1 to 5 ticks) in response to NEA's request aim to enhance the efficiency label for single-split RACs after the new MEPS in 2025, aligning with the best available technologies.

- **Option#1**, adopting the current *Best Available Technology (BAT) Approach*, pushes the market towards higher performance standards, with CSPF of 10.10 or 10.13 as the most efficient tier (5 ticks). This scenario presents achieving a notable 66% increase in efficiency from the MEPS level (6.09).

*Raising Efficiency Levels by Uniformizing CSPF Value*

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range* (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,281 | 434-687 |
| **2** | 7.10 | 5.70 | 17% | 1,714 | 254-493 |
| **3** | 8.11 | 6.54 | 33% | 1,316 | 538-1,541 |
| **4** | 9.12 | 7.39 | 50% | 89 | 983-2,377 |
| **5** | 10.13 | 8.24 | 66% | 4 | 1,505-3,458 |

*Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 13.5%*

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 2,390 | 434-687 |
| **2** | 6.91 | 5.52 | 13% | 2,275 | 254-493 |
| **3** | 7.84 | 6.27 | 29% | 1,558 | 538-1,541 |
| **4** | 8.90 | 7.12 | 46% | 177 | 983-2,377 |
| **5** | 10.10 | 8.08 | 66% | 4 | 1,505-3,458 |

**Please note that the prices of RACs vary significantly due to the data being sourced from different markets and the cooling capacity (CC) of RACs (up to CC>9.5kW). Additionally, currency fluctuations, import/export tariffs, taxes, distribution costs, and retailer markups also contribute to these variations.*

- **Option#2**, adopting the *Advanced Efficiency Approach*, is a forward-looking strategy to further enhance the EE of RACs. This approach aims to push RAC manufacturers to produce more energy-efficient RACs than the current BAT, at least 10% more efficient, to meet the 5-tick requirement. The most efficient tier is proposed at CSPF of 11.13 or 11.14 or 83% increase in efficiency compared to tier 1. This offers a pathway for encouraging innovation and driving the market towards higher energy performance standards for RACs.

*Raising Efficiency Levels by Uniformizing CSPF Value*

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,658 | 434-687 |

| | | | | | |
|---|---|---|---|---|---|
| **2** | 7.35 | 5.91 | 21% | 2,125 | 1,216-1,290 |
| **3** | 8.62 | 6.97 | 41% | 615 | 1,270-1,310 |
| **4** | 9.88 | 8.03 | 62% | 6 | 1,700-1,924 |
| **5** | 11.14 | 9.08 | 83% | - | |

*Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 16%*

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,275 | 434-687 |
| **2** | 7.08 | 5.65 | 16% | 1,927 | 745-786 |
| **3** | 8.23 | 6.57 | 35% | 1,191 | 1,675-2,415 |
| **4** | 9.57 | 7.64 | 57% | 11 | 1,465-1,924 |
| **5** | 11.13 | 8.88 | 83% | - | |

# 2 INTRODUCTION

## 2.1 Project Background

Since 2020, the United for Efficiency (U4E), has been working with the ASEAN Centre for Energy (ACE) and ASEAN member states to help establish the regional and national roadmaps for room air conditioners (RACs) and to work towards harmonized testing standards and energy efficiency levels. In 2023, the "ASEAN Cool Initiative", funded by the Clean Cooling Collaborative (CCC), was introduced to accelerate the implementation of the ASEAN Regional Policy Roadmap for Energy Efficient Room Air Conditioners by providing technical assistance and capacity building on Minimum Energy Performance Standards (MEPS) and labels in the region. The ASEAN Cool Initiative, led by U4E in collaboration with the International Institute for Energy Conservation (IIEC) and Lawrence Berkeley National Laboratory (LBNL), aims to accelerate the adoption of the ASEAN regional roadmap on air conditioners to enable countries to go straight to the more ambitious Regional Phase II levels (i.e., CSPF 6.09 Wh/Wh).

In response to a request from the National Environment Agency (NEA) of Singapore regarding proposed efficiency tiers for the new RAC label, aligned with the best available technologies, discussions were held at the ASEAN Cool Initiative Regional Workshop on 14-15 November 2023 in Johor Bahru, Malaysia.

IIEC has been tasked with conducting market research on high efficiency RACs in key Asian markets. The aim is to identify high-efficiency RAC models and assess the availability of cooling-only single-split RACs that surpass the proposed MEPS level of 6.09 CSPF by 2025. This objective is in line with the ASEAN regional roadmap and the MEPS announcement by NEA, which will be increased from 4.04 WCOP (5.13 CSPF) to 4.86 WCOP (6.09 CSPF), scheduled for implementation in April 2025 (see Annex 6.1 for more details on new MEPS). The findings from this research will assist the NEA in making informed decisions on EE policies and shaping consumer choices. Moreover, in close consultation with U4E and LBNL, IIEC proposed the new efficiency ratings for the RAC energy labeling scheme in Singapore, ranging from one to five ticks, following the adoption of the revised MEPS level of 6.09 CSPF in 2025.

## 2.2 Objectives and Market Research Methodology

The objective of this market research activity is to assess the availability of high-efficiency cooling-only single split room air conditioners (RACs) in selected key Asian markets, including Singapore, China, the Republic of Korea, Japan, etc. Specifically, the research aims to address concerns about the potential scarcity of RAC products meeting or exceeding the proposed MEPS of 6.09 CSPF for RACs in Singapore by 2025.

The methodology for researching high-efficiency RACs across key Asian markets involves a multifaceted approach to data collection and analysis. Initially, a comprehensive data collection, in collaboration with LBNL, taps into a variety of sources, including government and EE databases, e-commerce platforms, retail websites, and official manufacturer websites, ensuring a broad and diverse pool of information.

Following the data collection phase, the methodology employs thorough desk research to examine and organize the gathered information, highlighting relevant RAC models and their efficiency ratings.

Comparative analysis is then conducted across different markets to identify variations and trends in RAC efficiency, with a particular focus on models that exceed the predefined MEPS (CSPF of 6.09). It should be noted that the efficiency metrices adopted by the selected key markets are derived from different formulas and different temperature bins for calculation. Therefore, conversions from APF (Annual Performance Factor - China & Japan), Hong Kong CSPF, South Korea CSPF, ISEER (India Seasonal Energy Efficiency Ratio - India), SEER (Seasonal Energy Efficiency Ratio - Thailand), and WCOP (Weighted Coefficient of Performance - Singapore) to ISO CSPF metrics are undertaken to enable comparison of RACs' efficiency values across the selected markets in efficiency measurements.

Finally, statistical mapping of the converted efficiency data against the proposed efficiency ratings allows for a detailed assessment of the availability of high-efficiency RAC products and the formulation of proposed efficiency tiers for the NEA, Singapore for future efficiency improvements and policy development.

According to LBNL, RAC manufacturers, capable of producing high efficiency reverse-cycle models, can also produce cooling-only models of the same efficiency levels. Considering this, the inclusion of reverse cycle models, particularly from countries like China and Japan where standalone cooling-only models have limited availability, is essential due to their significant market presence, and reverse cycle models can offer a more comprehensive assessment of high-efficiency RAC options across diverse markets.

Overall, 6,404 models of RACs with CSPF ≥ 6.09 were compiled and Table 2-1 summarizes the numbers of RAC models and main data sources.

***Table 2-1: Summary of Data Collection Sources***

| Region | Source | Number of models with a higher CSPF of 6.09 |
|---|---|---|
| **China** | Online retailer survey<br>https://product.suning.com/ | 922<br>(Reverse cycle) |
| **Hong Kong** | Electrical & Mechanical Services Department - Mandatory Energy Efficiency Labeling Scheme (MEELS) database<br>https://www.emsd.gov.hk/energylabel/en/households/rac/select_ac_result.php?type=all | 24<br>(Cooling only) |
| **India** | Bureau of Energy Efficiency (BEE) database | 217<br>(Cooling only) |
| **Japan** | Agency for Natural Resources and Energy – Registration Database (https://seihinjyoho.go.jp/index.html) | 2,112<br>(Reverse cycle) |
| **Malaysia** | Retailer survey | 66<br>(Cooling only) |
| **Singapore** | NEA - Energy Labeling Scheme database | 65<br>(Cooling only) |
| **South Korea** | Korea Energy Agency – Efficiency Rating System Database (https://eep.energy.or.kr/certification/certi_list_260.aspx) | 2,656<br>(Cooling only) |
| **Thailand** | EGAT - Label No5 database (https://labelno5.egat.co.th/home/) | 342<br>(Cooling only) |

# 3 Market Assessment of High Efficiency Room Air Conditioner Models

## 3.1 Availability of High Efficiency Models Across Key Markets

The numbers of RAC models, totalling 6,404, with CSPF ≥ 6.09 were categorized based on their CSPF across various markets including China, Hong Kong, India, Japan, Malaysia, Singapore, South Korea, and Thailand, as shown in Figure 3-1 and **Error! Reference source not found.**. The majority of RAC models in these markets fall within the CSPF range of 6.09 to less than 7.0, with China, Japan and South Korea having the highest numbers in this category. As the CSPF range increases, the number of RAC models decreases, indicating a lesser availability of higher efficiency models. The highest efficiencies (CSPF ≥ 9.5) are extremely rare across the board, with only a small percentage in Japan and South Korea showcasing the market presence of such high-performance models. In the highest efficiency tier, RACs with CSPF greater than or equal to 10.0 are only available in Japan with the highest CSPF of 10.14.

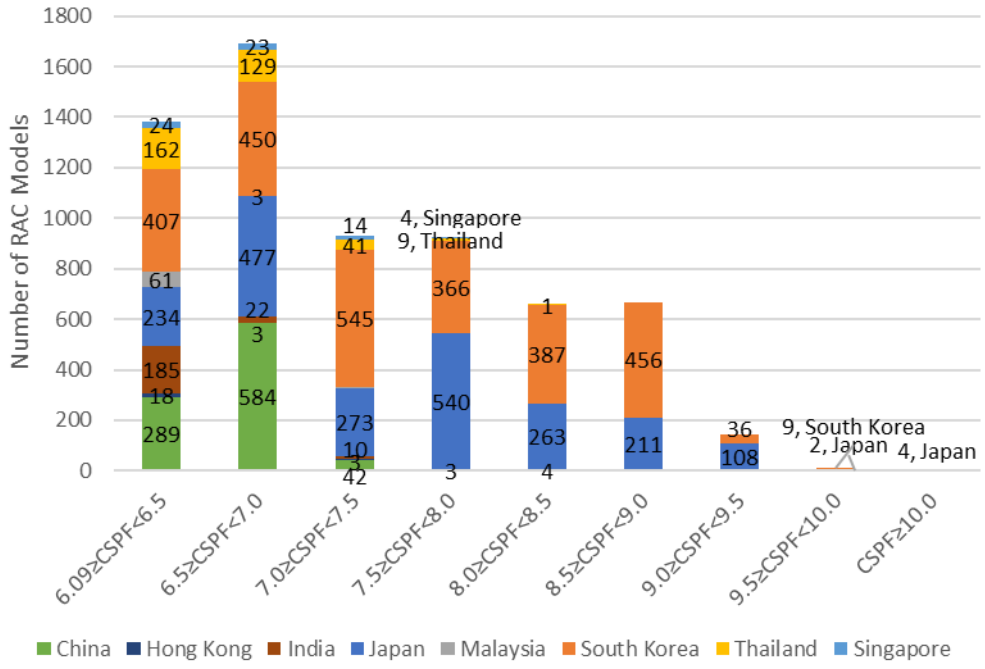



***Figure 3-1: Distribution of RAC Models by CSPF Across Key Markets***

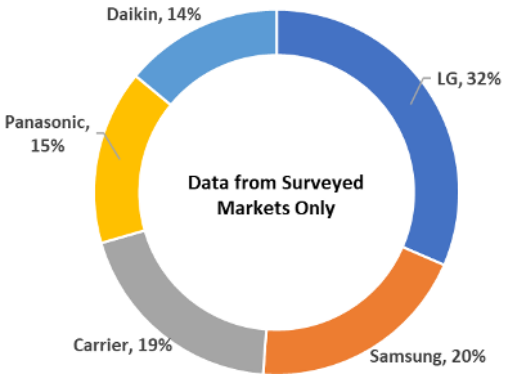
Table 3-1 provides a breakdown of high-efficiency RAC models across different cooling capacity (CC) categories in key markets. China has 922 models in total, with 672 models for cooling capacities up to 4.5kW and 250 models for capacities between 4.5kW and 9.5kW. In Japan, there is a significant number of models, totaling 2,112, with the majority (1,578) falling into the category of cooling capacities up to 4.5kW. South Korea also has a substantial number of models, with 2,656 in total, primarily concentrated in the range of 4.5kW to 9.5kW (2,467 models). Other markets like Thailand, and Singapore also have notable distributions of high-efficiency RAC models across various cooling capacity ranges.

***Table 3-1: Distribution of High-Efficiency RAC Models, with CSPF ≥ 6.09 by Cooling Capacity Across Key Markets***

| | CC≤4.5kW | 4.5kW<CC≤9.5kW | CC>9.5kW | Total |
|---|---|---|---|---|
| **China** | 672 | 250 | 0 | **922** |
| **Hong Kong** | 17 | 7 | 0 | **24** |
| **India** | 75 | 142 | 0 | **217** |
| **Japan** | 1,578 | 534 | 0 | **2,112** |
| **Malaysia** | 19 | 47 | 0 | **66** |
| **South Korea** | 172 | 2,467 | 17 | **2,656** |
| **Thailand** | 152 | 158 | 32 | **342** |
| **Singapore** | 29 | 34 | 2 | **65** |
| **Total** | **2,714** | **3,639** | **51** | **6,404** |

*Note: The data in the figure and table was retrieved and gathered in January 2024. The information presented is subject to updates as new data becomes available.*

In terms of RAC brands, LG emerges as the leading brand with CSPF ≥ 6.09, representing 32% of the total models across the surveyed markets/databases. Following closely behind is Samsung with 20%, while Carrier and Panasonic each account for 19% and 15%, respectively. Daikin is also in the top five with 14% of the models meeting the specified efficiency threshold (see Figure 3-2). Other leading brands, such as Mitsubishi Heavy Industries and Mitsubishi Electric, consistently feature prominently across multiple markets (see Table 3-2).




*Source*: Compilation from China, Hong Kong, India, Japan, Malaysia, Singapore, South Korea, and Thailand

***Figure 3-2: Distribution of Top 5 Brands with CSPF ≥ 6.09 across Key Markets***

***Table 3-2: Top 5 Brands with CSPF ≥ 6.09 across Key Markets***

| Country | Rank 1 | Rank 2 | Rank 3 | Rank 4 | Rank 5 | Total No. of Top 5 | Grand Total |
|---|---|---|---|---|---|---|---|
| **China** | Midea | Gree | Haier | Hisense | AUX | **600** | **922** |
| | 324 | 78 | 74 | 66 | 58 | | |
| **Hong Kong** | Panasonic | Daikin | Mitsubishi Electric | Mitsubishi Heavy Industries | Rasonic | **23** | **24** |
| | 6 | 5 | 5 | 4 | 3 | | |
| **India** | Daikin | Whirlpool | LLOYD | LG | Carrier | **88** | **217** |

| Country | Rank 1 | Rank 2 | Rank 3 | Rank 4 | Rank 5 | Total No. of Top 5 | Grand Total |
|---|---|---|---|---|---|---|---|
| | 28 | 19 | 16 | 14 | 11 | | |
| **Japan** | Panasonic | Daikin | Mitsubishi Electric | Hitachi | Fujitsu | **1,699** | **2,112** |
| | 400 | 366 | 357 | 288 | 288 | | |
| **Malaysia** | Sharp | Panasonic | Daikin | Hitachi | Midea | **66** | **66** |
| | 37 | 20 | 6 | 2 | 1 | | |
| **South Korea** | LG | Samsung | Carrier | Winia | Haier | **2,652** | **2,656** |
| | 1,001 | 623 | 596 | 430 | 2 | | |
| **Thailand** | Mitsubishi Heavy Industries | Mitsubishi Electric | Daikin | Saijo Denki | Carrier | **164** | **342** |
| | 44 | 42 | 29 | 28 | 21 | | |
| **Singapore** | Daikin | Panasonic | Mitsubishi Electric | Fujitsu | Mitsubishi Heavy Industries | **40** | **65** |
| | 11 | 9 | 7 | 7 | 6 | | |
| **Total** | **LG** | **Samsung** | **Carrier** | **Panasonic** | **Daikin** | **3,247** | **6,404** |
| | **1,023** | **639** | **628** | **502** | **455** | | |

*Source*: IIEC and LBNL, 2024

Among all compiled RAC models, data related to refrigerants is available only from China, Malaysia, and Hong Kong, where 92% of all models in these countries use R32 refrigerant, with the remaining models using R410A. R32 refrigerant is notable for its role in reducing greenhouse gas (GHG) emissions and global warming potential (GWP) due to its significantly lower GWP compared to other commonly used refrigerants like R410A. With a GWP of 675, R32 stands in stark contrast to R410A's GWP of 2088. Singapore has implemented various measures to mitigate GHG emissions from air conditioning, including the climate-friendly label, a ban on the supply of refrigeration and air-conditioning equipment that uses climate-unfriendly refrigerants, technician training and certification, and mandatory refrigerant recovery. The voluntary labeling program for climate-friendly refrigerants, operational from 2020 to 2023, aimed to facilitate the transition to the ban on the supply of household RAC equipment using high-GWP refrigerants, exceeding 750 from Q4 2022 (see Annex 6.3 for more details on NEA's measures to reduce GHG emissions from air-conditioning).

# 4 PROPOSED EFFICIENCY TIERS FOR SINGAPORE

The two proposed options for efficiency tiers (1 to 5 ticks) in response to NEA's request aim to enhance the efficiency label for single-split RACs after the new MEPS in 2025, aligning with the best available technologies (BAT) proposed as Option#1. In addition, Option#2, the advanced efficiency approach is a forward-looking strategy to further enhance the EE of RACs. In each option, dividing efficiency levels by 2 approaches, which are uniform by CSPF level and percentage increase.

**Note**: The data in the figures and tables below were retrieved and gathered in January 2024. The information presented is subject to updates as new data becomes available.

Please note that the prices of RACs vary significantly due to the data being sourced from different markets and the cooling capacity (CC) of RACs (up to CC>9.5kW). Additionally, currency fluctuations, import/export tariffs, taxes, distribution costs, and retailer markups also contribute to these variations.

## 4.1 Option#1 - Best Available Technology (BAT) Approach (CSPF 10.10 or 10.13 at 5 tick)

This option summarizes the proposed efficiency tiers, detailing the CSPF, Weighted COP, the percentage increase in efficiency, and the number of RAC models within each tier. Table 4-1 and Table 4-2 feature the best available energy-efficient RACs in the market with a CSPF of 10.10-10.13 at 5 ticks by raising efficiency values using two approaches: uniform by CSPF level and percentage increase.

### 4.1.1 Uniform by CSPF Level

The proposed efficiency tiers include (see Table 4-1):

- 1 Tick: RAC models starting with a CSPF of 6.09 or a Weighted COP of 4.86. This tier includes the largest number of models, totaling 3,281, setting the minimum efficiency benchmark.
- 2 Tick: Models with a CSPF of 7.10 or a Weighted COP of 5.70, demonstrating a 17% increase in efficiency over the 1 Tick models. This tier comprises 1,714 models.
- 3 Tick: These models have a CSPF of 8.11 or a Weighted COP of 6.54, indicating a 33% increase in efficiency from the base level. There are 1,316 models in this tier.
- 4 Tick: With a CSPF of 9.12 or a Weighted COP of 7.39, these models achieve a 50% efficiency improvement over the 1 Tick models, with 89 models meeting this standard.
- 5 Tick: The highest efficiency level at this scenario, models have a CSPF of 10.14 (the current best market-available) or a Weighted COP of 8.24, marking a 66% increase in efficiency from the 1 Tick level. This tier has the fewest models, with only 4 available.

***Table 4-1: Proposed Efficiency Tier - Best Available EE RAC in the Market (Raising Efficiency Levels by Uniformizing CSPF Value)***

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,281 | 434-687 |
| **2** | 7.10 | 5.70 | 17% | 1,714 | 254-493 |
| **3** | 8.11 | 6.54 | 33% | 1,316 | 538-1,541 |
| **4** | 9.12 | 7.39 | 50% | 89 | 983-2,377 |
| **5** | 10.13 | 8.24 | 66% | 4 | 1,505-3,458 |

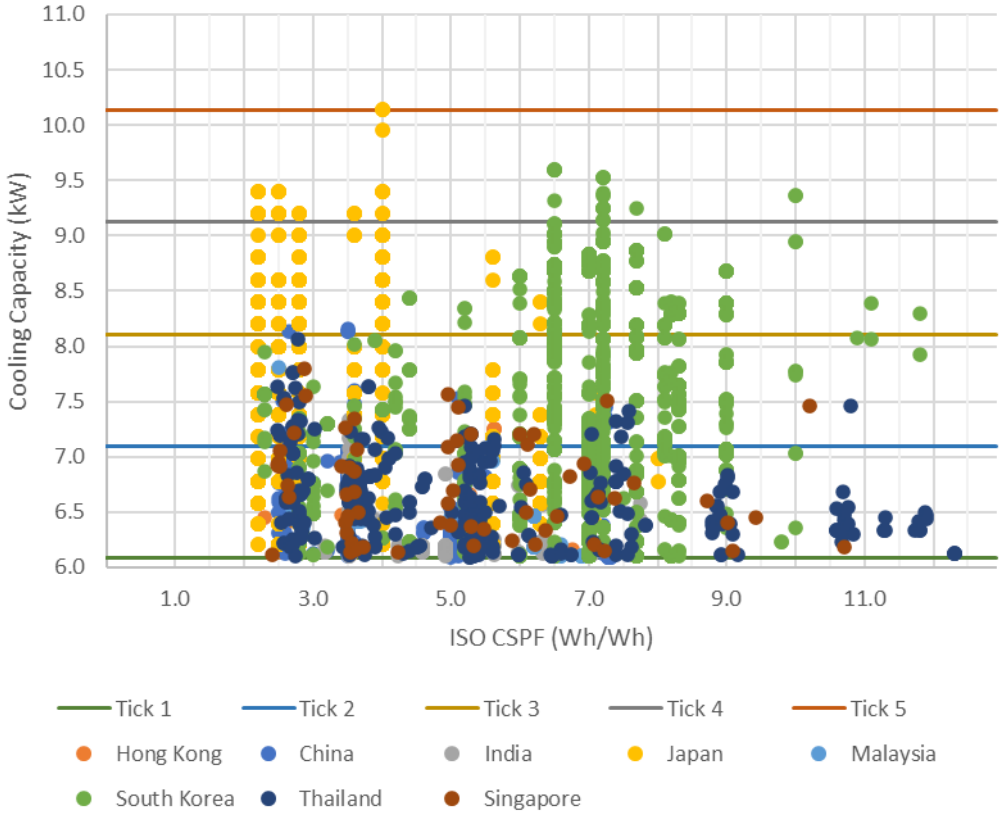



***Figure 4-1: Correlation Between Cooling Capacity (kW) and CSPF Efficiency Levels in Proposed Efficiency Tier Option#1 – Best Available Technology of High Efficiency RACs (Raising Efficiency Levels by Uniformizing CSPF Value)***

### 4.1.2 Uniform by Percentage Increase

The proposed efficiency tiers include (see Table 4-2):

- 1 Tick: RAC models starting with a CSPF of 6.09 or a Weighted COP of 4.86. There are 2,390 RAC models in this tier.
- 2 Tick: Models with a CSPF of 6.91 or a Weighted COP of 5.52. This represents a 13% increase in efficiency compared to the 1 Tick level. There are 2,275 RAC models in this tier.
- 3 Tick: These models have a CSPF of 7.84 or a Weighted COP of 6.27. This signifies a 29% increase in efficiency compared to the 1 Tick level. There are 1,558 RAC models in this tier.

- 4 Tick: With a CSPF of 8.90 or a Weighted COP of 7.12, these models achieve a 46% efficiency improvement over the 1 Tick models, with 177 models meeting this standard.
- 5 Tick: The highest efficiency level at this scenario, the proposed CSPF is 10.10 (the current best market-available) or a Weighted COP of 8.08, marking a 66% increase in efficiency from the 1 Tick level. This tier has the fewest models, with only 4 available.

***Table 4-2: Proposed Efficiency Tier - Best Available EE RAC in the Market (Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 13.5%)***

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 2,390 | 434-687 |
| **2** | 6.91 | 5.52 | 13% | 2,275 | 254-493 |
| **3** | 7.84 | 6.27 | 29% | 1,558 | 538-1,541 |
| **4** | 8.90 | 7.12 | 46% | 177 | 983-2,377 |
| **5** | 10.10 | 8.08 | 66% | 4 | 1,505-3,458 |

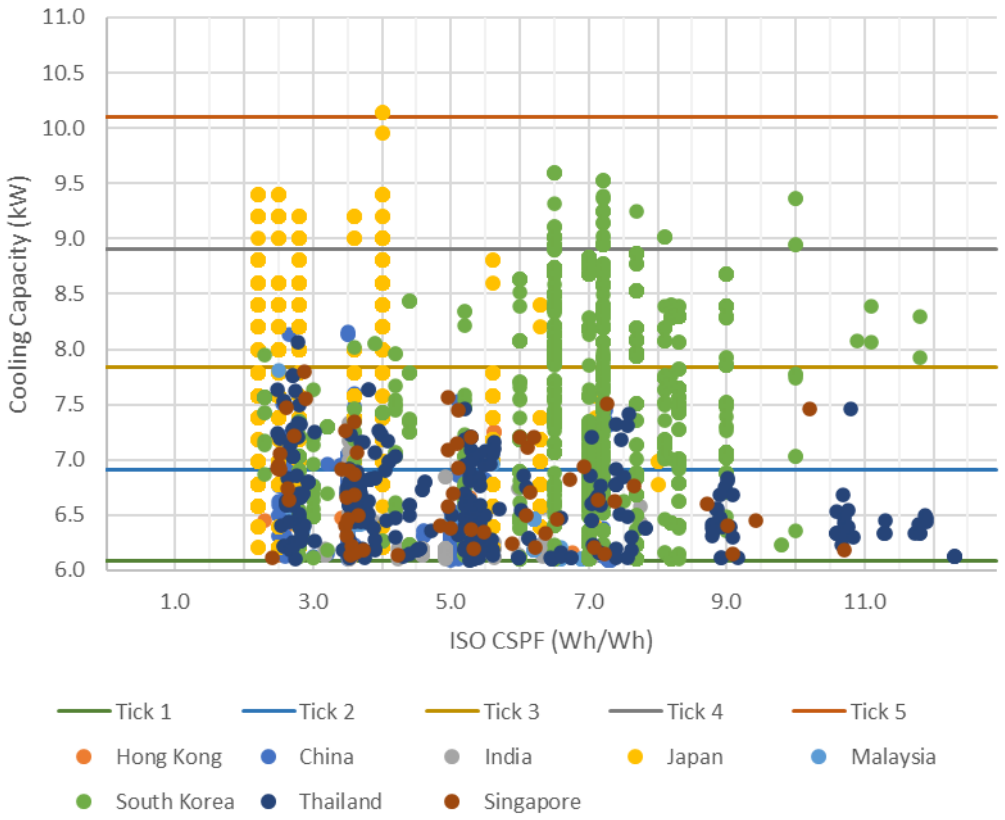



***Figure 4-2: Correlation Between Cooling Capacity (kW) and CSPF Efficiency Levels in Proposed Efficiency Tier Option#1 – Best Available Technology of High Efficiency RACs (Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 13.5%)***

## 4.2 Option#2 - Advanced Efficiency Approach (CSPF 11.13 or 11.14 at 5 tick)

This option presents the proposed efficiency tier, outlining a more advanced approach than option#1 BAT. This approach represents a more ambitious and forward-looking strategy for improving RAC EE, aiming to elevate the market towards higher performance standards. This approach aims to push RAC manufacturers to produce more energy-efficient RACs than the current BAT, at least 10% more efficient, to meet the 5-tick requirement at CSPF 11.13-11.14.

In 2021, prototypes developed by Daikin and Gree, two of the largest AC manufacturers globally, surpassed the five times (5X) lower climate impact criteria of the Global Cooling Prize (GCP)[2]. The energy performance of these GCP-winning technologies, as estimated by LBNL, exceeds the 10 CSPF achieved by the BAT currently on the market. The Global Cooling Efficiency Accelerator is actively working to successfully bring these innovative products to market.

Given the lengthy gap between efficiency level adjustments, last in 2014 and next in 2025, adopting ambitious-level adjustments becomes crucial to spur manufacturers. This proactive approach ensures market alignment with evolving efficiency goals and fosters continuous improvement in RAC EE.

### 4.2.1 Uniform by CSPF Level

The proposed efficiency tiers include (see Table 4-3):

- 1 Tick: This tier represents the baseline efficiency level, with RACs having a CSPF of 6.09 or a Weighted COP of 4.86. There are 3,658 models available at this efficiency level.
- 2 Tick: Moving up to Tier 2, RACs demonstrate an improved efficiency, with a CSPF of 7.35 or a Weighted COP of 5.91. This represents a 21% increase in efficiency compared to Tier 1. There are 2,125 models available in this tier.
- 3 Tick: Tier 3 offers even higher efficiency, with RACs boasting a CSPF of 8.62 or a Weighted COP of 6.97. This marks a substantial 41% increase in efficiency from Tier 1. There are 615 models available in this tier.
- 4 Tick: Tier 4 signifies a significant leap in efficiency, with RACs achieving a CSPF of 9.88 or a Weighted COP of 8.03. This represents a remarkable 62% increase in efficiency compared to Tier 1. However, there are only 6 models available at this tier, indicating its rarity in the market.
- 5 Tick: The highest tier, Tier 5, represents the peak of efficiency standards. RACs in this tier have a CSPF of 11.14 or a Weighted COP of 9.08. This marks an impressive 83% increase in efficiency from Tier 1. Currently, there are no models meeting this exceptional efficiency level,

[2] The Global Cooling Prize is an international competition launched in November 2018. It aims to spur the development of residential cooling technology with a significantly lower environmental impact than current air conditioning units. The competition challenges innovators worldwide to create affordable and sustainable cooling solutions that are five times more climate-friendly than existing models. The winning technology is expected to address the growing demand for cooling while reducing energy consumption and GHG emissions, benefiting millions of people globally and contributing to efforts to combat climate change. URL: https://globalcoolingprize.org/

however, further technological advancements assure that new highly efficient products will be available in near future.

***Table 4-3: Proposed Efficiency Tier – Advanced Efficiency (Raising Efficiency Levels by Uniformizing CSPF Value)***

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,658 | 434-687 |
| **2** | 7.35 | 5.91 | 21% | 2,125 | 1,216-1,290 |
| **3** | 8.62 | 6.97 | 41% | 615 | 1,270-1,310 |
| **4** | 9.88 | 8.03 | 62% | 6 | 1,700-1,924 |
| **5** | 11.14 | 9.08 | 83% | - | |

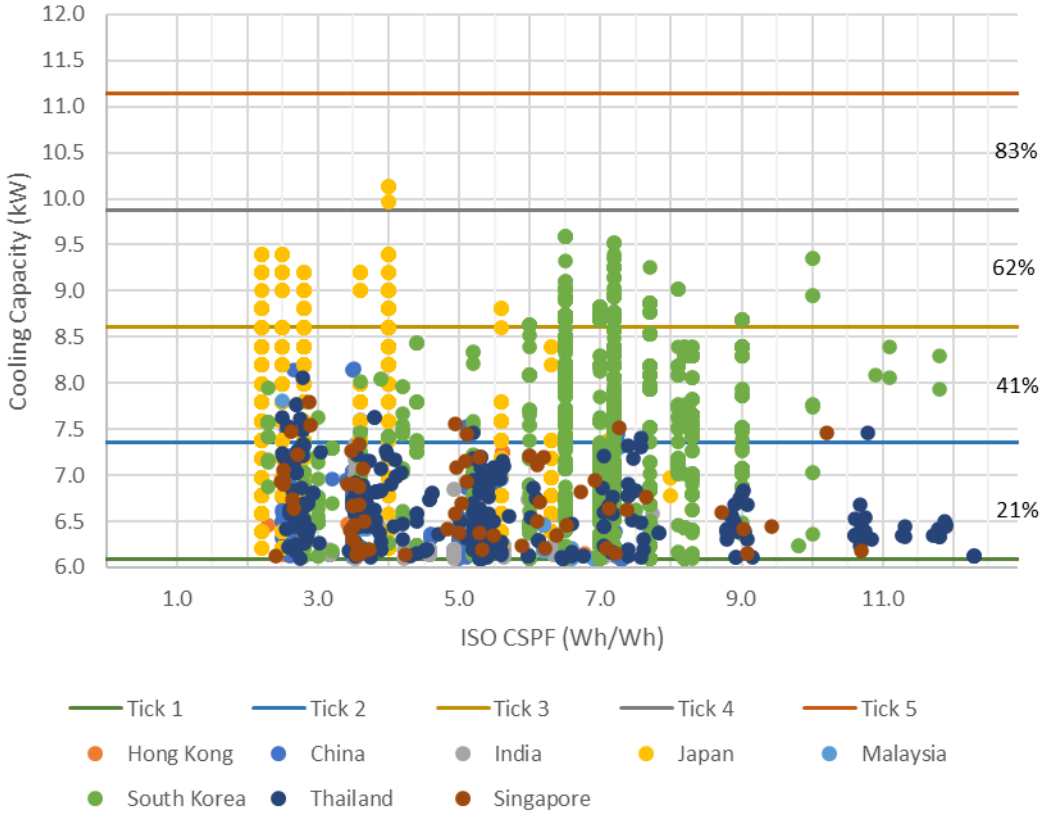



***Figure 4-3: Correlation Between Cooling Capacity (kW) and CSPF Efficiency Levels in Proposed Efficiency Tier Option#2 – Advanced Efficiency (Raising Efficiency Levels by Uniformizing CSPF Value)***

### 4.2.2 Uniform by Percentage Increase

The proposed efficiency tiers include (see Table 4-4):

- 1 Tick: This tier represents the baseline efficiency level, with RACs having a CSPF of 6.09 or a Weighted COP of 4.86. There are 3,275 models available at this efficiency level.
- 2 Tick: The proposed CSPF is 7.08, or a weighted COP of 5.65. This represents a 16% increase in efficiency compared to the 1 Tick level. There are 1,927 RAC models in this tier.
- 3 Tick: The proposed CSPF is 8.23, or a weighted COP of 6.57. This signifies a 35% increase in efficiency compared to the 1 Tick level. There are 1,191 RAC models in this tier.
- 4 Tick: The proposed CSPF is 9.57, or a weighted COP of 7.64. This marks a substantial 57% increase in efficiency compared to the 1 Tick level. There are 11 RAC models in this tier.
- 5 Tick: The highest efficiency level is 11.13, or a weighted COP of 8.88. This represents an impressive 83% increase in efficiency compared to the 1 Tick level. There are no RAC models listed in this tier.

***Table 4-4: Proposed Efficiency Tier – Advanced Efficiency (Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 16%)***

| Tick | Proposed CSPF | Weighted COP | % Increase in Efficiency from Tick 1 | Number of RAC Models | Price Range (USD) |
|---|---|---|---|---|---|
| **1** | 6.09 | 4.86 | | 3,275 | 434-687 |
| **2** | 7.08 | 5.65 | 16% | 1,927 | 745-786 |
| **3** | 8.23 | 6.57 | 35% | 1,191 | 1,675-2,415 |
| **4** | 9.57 | 7.64 | 57% | 11 | 1,465-1,924 |
| **5** | 11.13 | 8.88 | 83% | - | |

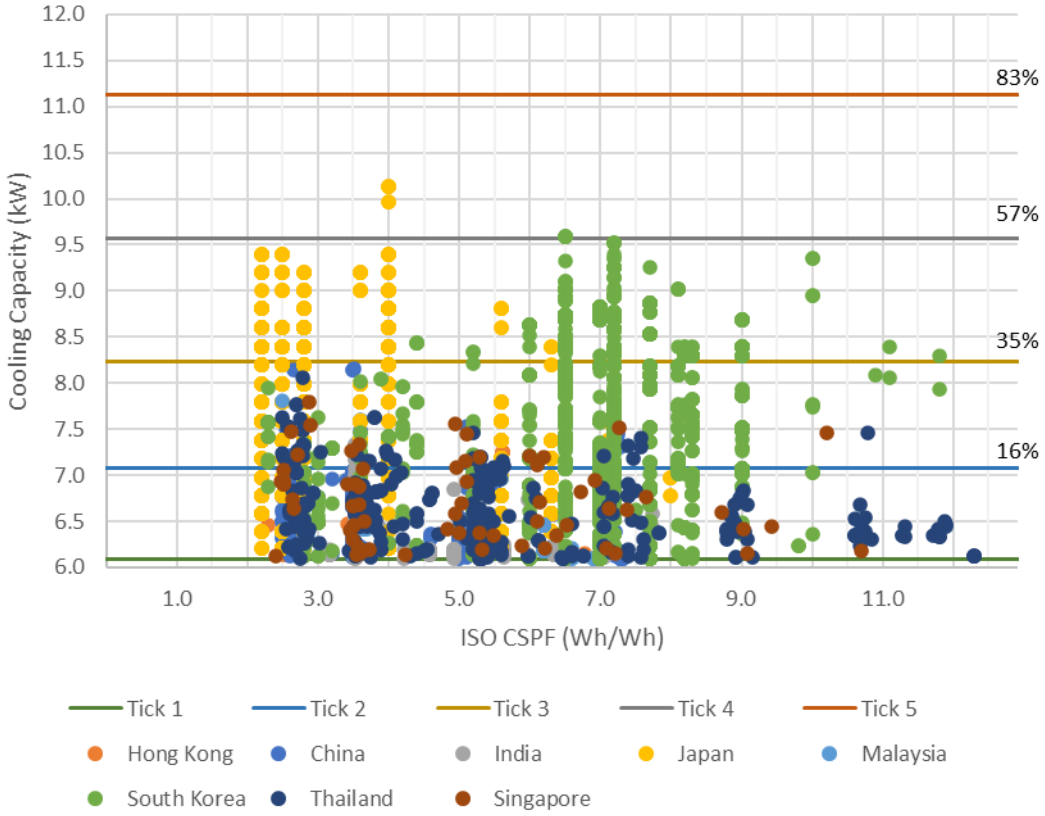



***Figure 4-4: Correlation Between Cooling Capacity (kW) and CSPF Efficiency Levels in Proposed Efficiency Tier Option#2 – Advanced Efficiency (Raising Efficiency Levels by Uniformly Incremental Percentage in Each Level to 16%)***

# 5 CONCLUSION

The comprehensive market assessment of high-efficiency Room Air Conditioner (RAC) models across key markets (China, Hong Kong, India, Japan, Malaysia, South Korea, Thailand, and Singapore) reveals significant insights into the availability and efficiency levels of these units. The data collected from these countries indicates a predominant concentration of RAC models within the Cooling Seasonal Performance Factor (CSPF) range of 6.09 to less than 7.0. This range signifies a high availability of moderately efficient models, with a notable decline in the availability of models as the CSPF range increases, highlighting the scarcity of ultra-high-efficiency RAC models across these markets.

The proposed efficiency tiers for Singapore offer two distinct approaches: the Best Available Technology (BAT) Approach and the Advanced Efficiency Approach. While both scenarios aim to improve RAC efficiency, the latter presents a more ambitious and forward-looking approach, pushing the market towards higher performance standards. The implementation of these efficiency tiers is crucial for enhancing energy efficiency (EE) and reducing carbon emissions, aligning with global efforts to combat climate change and promote sustainable development. The findings support the need for Singapore and similar markets to adopt more ambitious EE standards. By aligning new regulations with the best available technologies, as illustrated in the proposed efficiency tiers, policymakers can drive innovation and market transformation toward higher efficiency RACs.

**Key Findings:**

***Variations in Energy Efficiency Levels & Potential Scarcity Concerns***

- The data highlight variations in the availability of high-efficiency RAC models across different markets, with Japan and South Korea leading in the adoption of most EE models. While India, Malaysia, and Hong Kong show a concentration in the lower end of the high-efficiency spectrum. High-efficiency RAC models (CSPF ≥ 9.5) are exceptionally rare, with Japan and South Korea being the only markets where such models are slightly more prevalent.
- Japan leads in the highest efficiency tier (CSPF ≥ 10.0), emphasizing the country's advancement in developing and adopting high-performance RAC models.
- The market distribution of RAC models by cooling capacity categories shows a significant presence of models in both the ≤4.5kW and 4.5kW<CC≤9.5kW categories, with China, South Korea, and Japan showcasing a substantial number of models across these categories.
- LG, Samsung, Carrier, Panasonic, and Daikin are identified as the top 5 brands, collectively representing a significant portion of high-efficiency models across the surveyed markets.

***Proposed Efficiency Tiers for Singapore***

The proposed efficiency tiers for single-split RACs present two distinct approaches for enhancing the EE of RAC models.

- Option#1 employs the Best Available Technology Approach, with a CSPF of 10.10 or 10.13, and also includes five efficiency tiers ranging from 6.09 to 10.13 CSPF.
- Option#2, the Advanced Efficiency Approach, features a more ambitious efficiency standard and sets a top-level CSPF of 11.13 or 11.14 based on the GCP-winner, which exceeds the 10 CSPF achieved by the BAT. This option includes five efficiency tiers ranging from 6.09 to 11.14 CSPF.

# 6 ANNEXES

## 6.1 MEPS & Tick Rating for Single Split RACs

**Regulated Air-Conditioners**

Single-phase non-ducted room air-conditioner (not being second-hand goods) having a cooling capacity of:

- 17.6 kW or lower, in the case of split type (inverter) air-conditioner; or
- 17.6 kW or lower, in the case of split type (non-inverter) air-conditioner.

Single-phase non-ducted room air-conditioner means an encased assembly or assemblies of one or more evaporators, compressors and condensers, designed to be used as a permanently-installed piece of equipment to provide conditioned air to any enclosed space. It includes a prime source of refrigeration for cooling and dehumidification and may include other means for dehumidifying, circulating and cleaning the air.

Split type (non-inverter) air-conditioner means an assembly of components of a refrigeration system fixed on 2 or more mountings to form a matched functional unit that employs technologies that vary the output of the compressor by start-stop operation.

Split type (inverter) air-conditioner means an assembly of components of a refrigeration system fixed on 2 or more mountings to form a matched functional unit that employs technologies that vary the output of the compressor, by means other than start-stop operation.

**Details of MEPS enhancement for single-split air-conditioners, effective from April 2025[3]**

Raise MEPS from 2-tick to 4-tick for single-split air-conditioners

To allow importers, manufacturers, suppliers and retailers time to clear their existing stock, products that are supplied to the market before the effective date will be exempted from the MELS and MEPS requirements for 1 year (published, 2 March 2023).

***Table 5-1: Current and Revised MEPS for Single Split-type Air-conditioners***

| Type | Cooling capacity | Current MEPS | Revised MEPS (effective from Apr 2025) |
|---|---|---|---|
| **Single-Split (inverter)** | Up to 17.6kW | $COP_{weighted} \geq 4.04$ | $COP_{weighted} \geq 4.86$ |
| **Single-Split (non-inverter)** | | $COP_{100\%} \geq 4.04$ | $COP_{100\%} \geq 4.86$ |

- *Weighted COP = 0.4 x $COP_{100\%}$ + 0.6 x $COP_{50\%}$*

[3] NEA (2023). Enhancing Energy Efficiency Requirements Of Home Appliances, 2 March 2023. URL: https://www.nea.gov.sg/media/news/news/index/enhancing-energy-efficiency-requirements-of-home-appliances

**Current Minimum Energy Performance Standards for Single-Phase Air-conditioners**

***Table 5-2: Current MEPS for Single Split-type Air-conditioners***

| Type of Air-Conditioners | Minimum Coefficient of Performance (COP) |
|---|---|
| **Single-split (non-inverter)** | $COP_{100\%} \geq 4.04$ |
| **Single-split (inverter)** | Weighted COP[1] $\geq 4.04$ and $COP_{100\%} \geq 3.34$ |

Cooling capacity refers to the measured total cooling capacity in accordance with the applicable test standards.

[1] Weighted COP = 0.4 x $COP_{100\%}$ + 0.6 x $COP_{50\%}$

**Tick Rating for Single-Phase Air-conditioners**

The current tick rating is defined as follows:

***Table 5-3: Tick Rating for Single-Phase Air-conditioners***

| Type | COP (W/W) and Standby Power (W) | | | | |
|---|---|---|---|---|---|
| | **1 tick** | **2 ticks** | **3 ticks** | **4 ticks** | **5 ticks** |
| **Single-split (non-inverter)** | N/A | $COP_{100\%} \geq 4.04$ | $4.29 \leq COP_{100\%} < 4.86$ and Standby power ≤ 18 | $COP_{100\%} \geq 4.86$ and Standby power ≤ 18 | $COP_{100\%} \geq 5.50$ and Standby power ≤ 4 |
| **Single-split (inverter)[2]**<br>• **$COP_{100\%}$**<br>• **Weighted COP[3]** | N/A | Weighted COP ≥ 4.04 and $COP_{100\%} \geq 3.34$ | Weighted COP ≥ 4.29, $COP_{100\%} \geq 3.78$ and Standby power ≤ 18 | Weighted COP ≥ 4.86, $COP_{100\%} \geq 4.29$ and Standby power ≤ 18 | Weighted COP ≥ 5.50, $COP_{100\%} \geq 4.86$ and Standby power ≤ 4 |

[1] $COP_{100\%}$ is defined as the ratio of total cooling capacity to effective power input at full load cooling capacity

[2] For split (inverter) type air-conditioners, the model shall meet both the minimum $COP_{100\%}$ and weighted COP

[3] Weighted COP = 0.4 x $COP_{100\%}$ + 0.6 x $COP_{50\%}$

[4] N is the number of indoor and outdoor units

[5] Standby power is expressed in Watts

## 6.2 Climate Friendly Households Programme (CFHP)

The Climate Friendly Households Programme was launched, by the National Environment Agency (NEA) and Public Utilities Board (PUB), Singapore's National Water Agency in November 2020 to help 1-, 2- and 3-room HDB (Housing and Development Board) households save on utility bills in the longer run through vouchers for the purchase of energy-efficient refrigerators, LED lights and water-efficient shower fittings.

From 15 April 2024, all HDB households [1] will receive $300 worth of Climate Vouchers as part of the enhanced CFHP. These vouchers can be used to purchase 10 types of energy- and water-efficient household products, with new additions such as **5-tick air conditioners**, direct current fans, washing machines and water closets. The Climate Vouchers will be valid until 31 December 2027.

The programme will be enhanced to benefit more households when they purchase eligible energy- and water-efficient household products. In addition to extending the Climate Vouchers to all HDB households, the voucher quantum is increased and included a wider range of eligible products. Households can also flexibly select different denominations of vouchers to use for their purchases.

HDB households can claim their Climate Vouchers by logging on to RedeemSG (go.gov.sg/cv-claim) with their Singpass account. To use the Climate Vouchers, they can present the voucher with proof of address [2] at participating retail outlets. More details on how to redeem the vouchers and the list of participating retailers are listed in the Annex

Singpass accounts may be created online or by visiting the nearest Singpass counter [3] for assistance. Seniors who do not own a smartphone or require assistance may approach members of their households for assistance in accessing their vouchers. Alternatively, they can contact NEA at nea@redeem.gov.sg or 6225 5632.

More details of the current and enhanced Climate Friendly Households Programme are appended below:

| | Current Programme | Enhanced Programme |
|---|---|---|
| **Household Eligibility** | 1-, 2- and 3-room HDB households | All HDB households |
| **Eligible Products** | • 3- or 4-tick refrigerators<br>• 3-tick shower fittings<br>• LED lights | • 3- or 4-tick refrigerators<br>• 3-tick shower fittings<br>• 2-tick and above LED lights*<br>• **5-tick air-conditioners**<br>• 3-tick basin taps and mixers<br>• 3-tick sink/bib taps and mixers<br>• 3-tick water closets<br>• 4-tick washing machines<br>• Direct current fans<br>• Heat pump water heaters<br>*Illustrations of the full list of products covered under the enhanced CFHP are in the Annex* |
| **Vouchers** | $225 worth of vouchers comprising:<br>• $150 refrigerator voucher | $300 Climate Vouchers in different denominations (e.g. $2, $5, $10 and $50) provided to each household which can be used to purchase eligible products |

| | Current Programme | Enhanced Programme |
|---|---|---|
| | • $50 shower fittings voucher<br>• $25 LED lights voucher | |
| **Validity** | 28 November 2020 to 20 March 2024 | From 15 April 2024 to 31 December 2027 |

**Includes LED circular lights and LED downlights*

[1] Singaporean/Permanent Resident
[2] Examples of proof of address include bank statements, utility bills, Singpass mobile application or NRIC.
[3] The list of Singpass counters is available on https://www.singpass.gov.sg/home/ui/counter-locations

Annex - Steps to claim and spend Climate Vouchers[4]

[4] https://www.nea.gov.sg/docs/default-source/default-document-library/annex---steps-to-claim-and-spend-climate-vouchers.pdf

## 6.3 NEA's Measures to Reduce Greenhouse Gas Emissions from Air-Conditioning

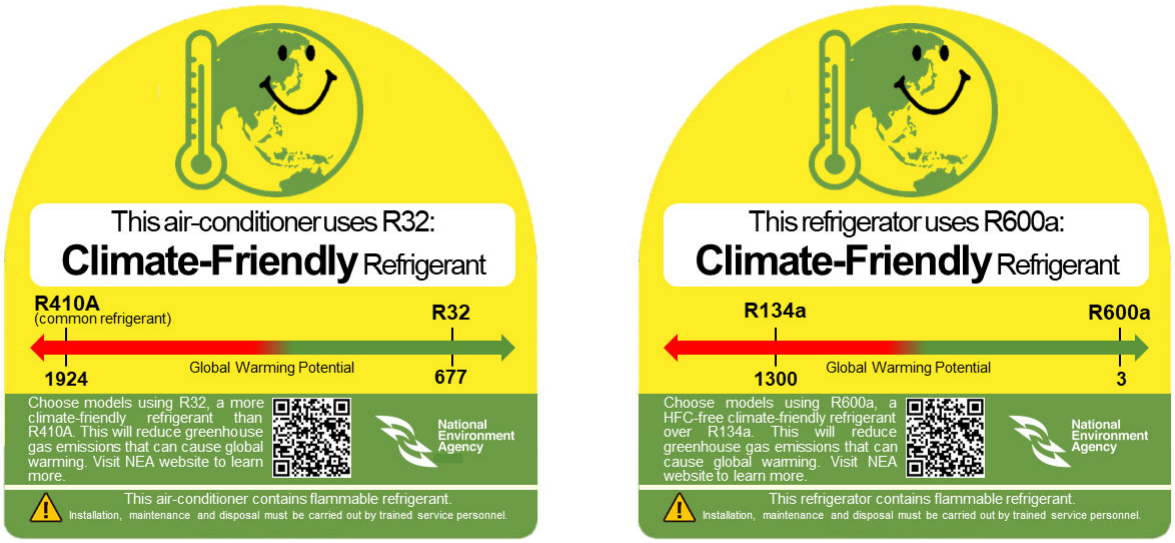
Measures include *Climate-friendly Label*, *ban on supply of refrigeration* and *air-conditioning equipment* that use climate-unfriendly refrigerants, *training and certification of technicians*, and *mandatory recovery of refrigerants*[5].

A package of mitigation measures to reduce Singapore's greenhouse gases emissions arising from the use of hydrofluorocarbons (HFCs) in the refrigeration and air-conditioning (RAC) sector. The package of measures comprises four key initiatives, aimed at reducing HFC-related greenhouse gas emissions, to be implemented by the National Environment Agency (NEA) in phases from 2020 to 2023.

*1.* **Climate-friendly Label for household air-conditioners and refrigerators**

The first key initiative is the Climate-friendly Label for household refrigerators and air-conditioners that use refrigerants with a lower global warming potential (GWP).

The voluntary label for climate-friendly refrigerants was designed to enable consumers to identify and select air-conditioner and refrigerator models that use climate-friendly refrigerants. Major retail stores provided their support to display the label in stores from March 2020.




*The Voluntary Labels for air-conditioners (left) and refrigerators (right) using climate-friendly refrigerants*

5 https://www.nea.gov.sg/media/news/news/index/nea-introduces-measures-to-reduce-greenhouse-gas-emissions-from-refrigeration-air-conditioning#:~:text=Measures%20include%20Climate%2Dfriendly%20Label,and%20mandatory%20recovery%20of%20refrigerants.

***** This voluntary label program introduced in 2020 to support and facilitate the transition to the Ban on the supply of RAC equipment that uses high-GWP refrigerants from Q4 2022 has been closed*****

**2. Ban on supply of RAC equipment that use high-GWP refrigerants from Q4 2022**

NEA has also progressively phased out RAC equipment that use high-GWP refrigerants. NEA has banned the supply of the following RAC equipment in Singapore from Q4 2022 as there are climate-friendly alternatives:

- Household air-conditioners that use refrigerants with GWP of more than 750;
- Household refrigerators that use refrigerants with GWP of more than 15; and
- Water-cooled chillers that use refrigerants with GWP of more than 15.

**3. Training and certification of technicians**

Hydrofluorocarbons (HFCs) can leak into the atmosphere if the refrigerants are improperly handled. To prevent this, NEA worked with the Institute of Technical Education (ITE) and Temasek Polytechnic to introduce training courses for household air-conditioner technicians. The training and certification scheme aims to raise competencies within the industry on proper handling of refrigerants during installation, maintenance and decommissioning of RAC equipment. The training courses conducted by ITE for household air-conditioner technicians commenced in the second half of 2020.

Companies carrying out installation, maintenance and decommissioning of household air-conditioners were encouraged to send their technicians for training and certification. Consumers were also encouraged to request for certified technicians to install and service their air-conditioners, as part of taking climate action at the individual level, to reduce the likelihood of HFC refrigerant emissions into the atmosphere.

The industry was supportive and companies such as Mitsubishi Electric and Toshiba Air-Conditioning expressed their support to contribute to train household air-conditioner technicians through equipment sponsorship and funding. Retailers also expressed interest to engage certified technicians to install air-conditioners after the training courses are rolled out.

**4. Mandating recovery, and reclamation or destruction of refrigerants**

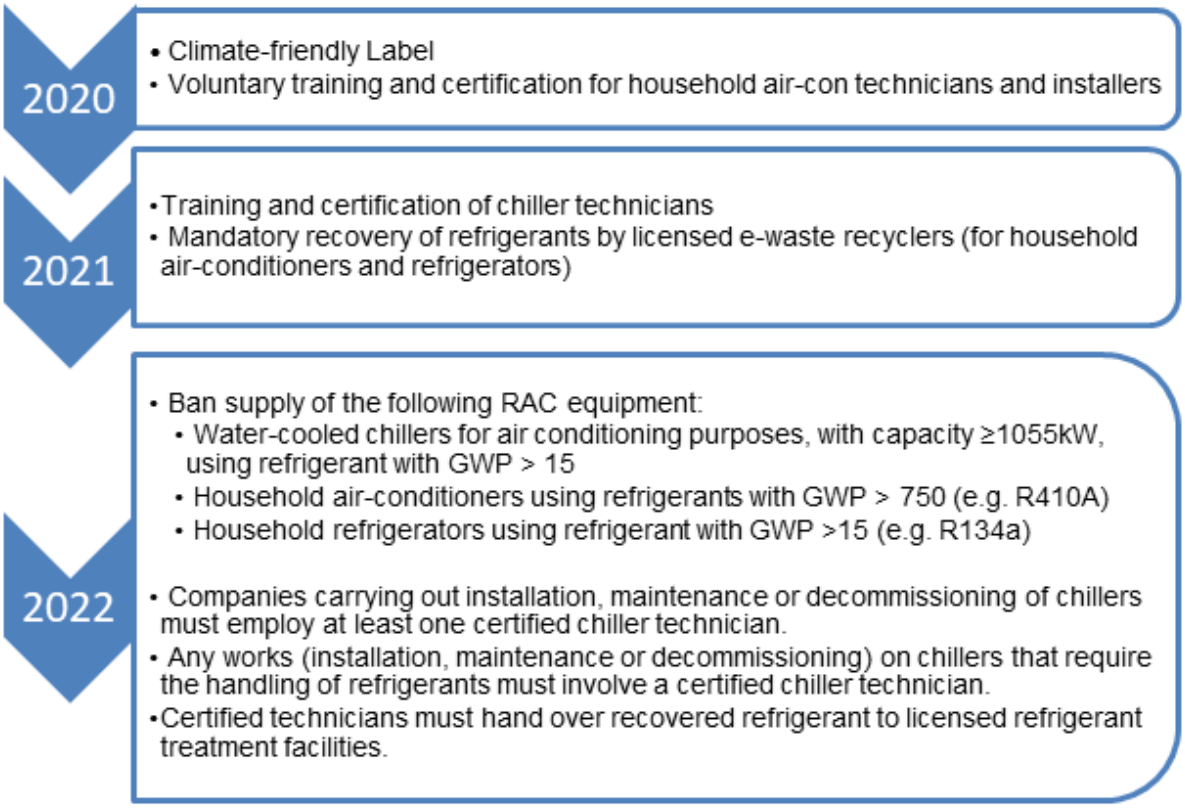
In conjunction with the training and certification of technicians, from July 2021, NEA mandated the recovery and reclamation or destruction of spent refrigerants in decommissioned RAC equipment. E-waste recyclers, who take in household air-conditioners and refrigerators for recycling, and certified chiller technicians will be required to recover refrigerants from decommissioned RAC equipment. Refrigerant treatment facilities and e-waste recyclers that handle the reclamation and destruction of spent refrigerants have to obtain a Toxic Industrial Waste Collector (TIWC) licence from NEA.

Recovered refrigerants that are passed to the licensed refrigerant treatment facilities can either be reclaimed and re-introduced into the market to service RAC equipment or destroyed using established destruction technologies to ensure environmentally sound management of the spent refrigerants.

The HFC mitigation measures would help reduce Singapore's HFCs consumption and contribute towards meeting Singapore's 2030 pledge under the Paris Agreement. The table shows the timeline



and summary of the key initiatives.




[1] Global warming potential (GWP) is a measure of the warming effect of a gas relative to the warming effect of an equivalent mass of CO2, usually over a 100-year time horizon.
[2] The label can be affixed on 1) household air-conditioners that use refrigerants with GWP ≤ 750 (i.e. R32 models), and 2) household refrigerators that use refrigerants with GWP ≤15 (i.e. R600a models). About 10 per cent of registered air-conditioner models in Singapore use refrigerants that are climate-friendly, while majority of the registered refrigerator models in Singapore already use a climate-friendly refrigerant. The list of household air-conditioners and refrigerators can be found on www.go.gov.sg/mels-database
[3] The ban would effectively phase out the sales of household air-conditioner models using the R410A refrigerant (GWP of 1,924), and refrigerator models using the R134a refrigerant (GWP of 1,300). In comparison, climate-friendly alternatives R32 (for air-conditioners) and R600a (for refrigerators) have GWPs of 677 and 3 respectively.
[4] Of capacity equal to or more than 1055kW and used for air-conditioning purposes.
[5] The typical refrigerant used in chillers is R134a, which has a GWP of 1,300. The climate-friendly alternative is R1233zd, which has a GWP of 1.

***Source:*** https://www.nea.gov.sg/media/news/news/index/nea-introduces-measures-to-reduce-greenhouse-gas-emissions-from-refrigeration-air-conditioning#:~:text=Measures%20include%20Climate%2Dfriendly%20Label,and%20mandatory%20recovery%20of%20refrigerants.