# Policy measures and impact on the market for the Room Air Conditioners in India

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## ABSTRACT

Cooling is essential to human health and productivity and is becoming more important as India urbanizes, grows economically and increasing need for cooling due to extreme weather conditions. Room air conditioners (RAC) now account for up to 50% of peak load on the grid in major metropolitan areas of India. The RAC market in India has being growing enormously and these trends have resulted in a rapid increase in electricity demand in the commercial and residential sectors. Energy efficiency mitigates the individual risk of being saddled with inefficient, environmentally harmful and poor quality RACs.

India's Bureau of Energy Efficiency (BEE) launched the labelling program for fixed-speed Room Air Conditioners in 2006 with periodic revisions for increased stringency resulting in substantial efficiency improvement of 35% at the minimum energy performance standards. The most recent development covers both fixed and inverter units under a common rating plan based on an Indian seasonal energy efficiency metric. Over the years, the RAC policy and subsequent revisions has resulted in significant market transformations towards higher efficiencies comparable to the best in class globally.

Over the last decade, the annual sales of RACs in India have grown exponentially and with the improvements in efficiency have resulted in 38 million tons of carbon emission reduction as per the 2016-17 estimates. This paper analyses and discusses the trends in market growth, technology evolution and market transformation as a result of BEE's policy program and further explores possible efficiency improvements by 2030 and its climate impacts.

## The Room Air Conditioner Market in India

### Introduction

Room air conditioners (RACs) are a type of appliance used to dehumidify and lower indoor air temperatures, with the purpose of providing cooling comfort during hot weather. Air conditioners remove heat from enclosed spaces and discharge it outside. In India, air conditioning was once considered a luxury for affluent households, but the number of RACs is increasing rapidly due to extremely high ambient temperatures, urbanization and rising incomes and living standards.

The annual sales of RACs in India have grown exponentially in the last 10 years, from 0.3 million in 2007 to 7.6 million in 2017. These trends have resulted in a rapid increase in electricity demand and energy consumption in the commercial and residential sectors.

Air conditioning can substantially increase the electricity consumption of a household – typically, one AC of 1.5 ton capacity can consume an amount of electricity that is equivalent to operating 25 ceiling fans, which have been the traditional cooling appliance in India. In practice, electricity costs for running an AC depend upon the unit's energy efficiency, as designed by its manufacturer, the number of operating hours, and how efficiently it is operated and maintained.

Despite the fact that RACs consume significant amounts of electricity, demand continues to grow rapidly. Since RACs are used primarily during peak hours of the day, they now account for up to 50% of peak load on the grid in major metropolitan areas of India. There is thus an urgent need for energy efficiency policies for RACs to reduce electricity consumption and peak demand.

The Bureau of Energy Efficiency (BEE) launched the labeling program for fixed-speed RACs in 2006 as a voluntary initiative, and the program became mandatory in 2009 [1]. BEE revised the energy performance thresholds for RACs covered under the program on a biennial basis from 2009 - 2018. In 2015 BEE launched a voluntary labelling program for inverter RACs, and made the program mandatory in January, 2018. The labelling program for RACs now covers both fixed and inverter units under the same labelling scheme. These improvements in stringency have resulted in substantial efficiency

improvement of 35% to the minimum energy performance standards for split units, the most popular RACs. Since the inception of the RAC labelling program, 46 TWh of electricity have been saved and avoided 38 Million tons of carbon emissions till 2016-17.

## Indian Market Overview

### Types of Room Air Conditioners in India

There are four types of RACs available in the Indian market:

Split-type air conditioners: This type of AC is comprised of two parts, an outdoor unit and an indoor unit. The outdoor unit, fitted outside the room, houses components like the compressor, condenser and expansion valve. The indoor unit comprises the evaporator or cooling coil and the cooling fan.

Window air conditioners: In this type of AC, all the components, including the compressor, condenser, expansion valve or coil, evaporator and cooling coil are enclosed in a single box that is installed in a window in a household dwelling or commercial building.

Cassette air conditioners: Cassette units work the same way as wall-hung split system units, with the difference being that cassettes are installed into the ceiling instead of on the wall. The indoor unit sits flush to the ceiling and the outdoor unit is mounted outside as for a conventional wall mounted split system unit.

Floor mounted air conditioners: This type of AC is useful in indoor spaces that lack sufficient wall space to attach appliances, or within buildings constructed of fragile materials such as glass. Floor mounted units can look more discreet than their wall mounted alternatives, minimising the impact on a room's aesthetics.

| Split type(wall mounted) air conditioners | Window type air conditioners |
|---|---|
|  |  |
| **Cassette air conditioner (ceiling mounted)** | **Floor mounted air conditioner** |
|  |  |

**Figure 1: Types of room air conditioners**
Source: Bureau of Energy Efficiency

### Market Demand for RACs

The air conditioning market in India is dominated by room ACs. The RAC market size in 2007-08 was 0.3 million, and has grown by 25 times in the last decade, to 7.6 million in 2017-18. The RAC market is expected to grow at a CAGR of 11% in the next 10 years [2].

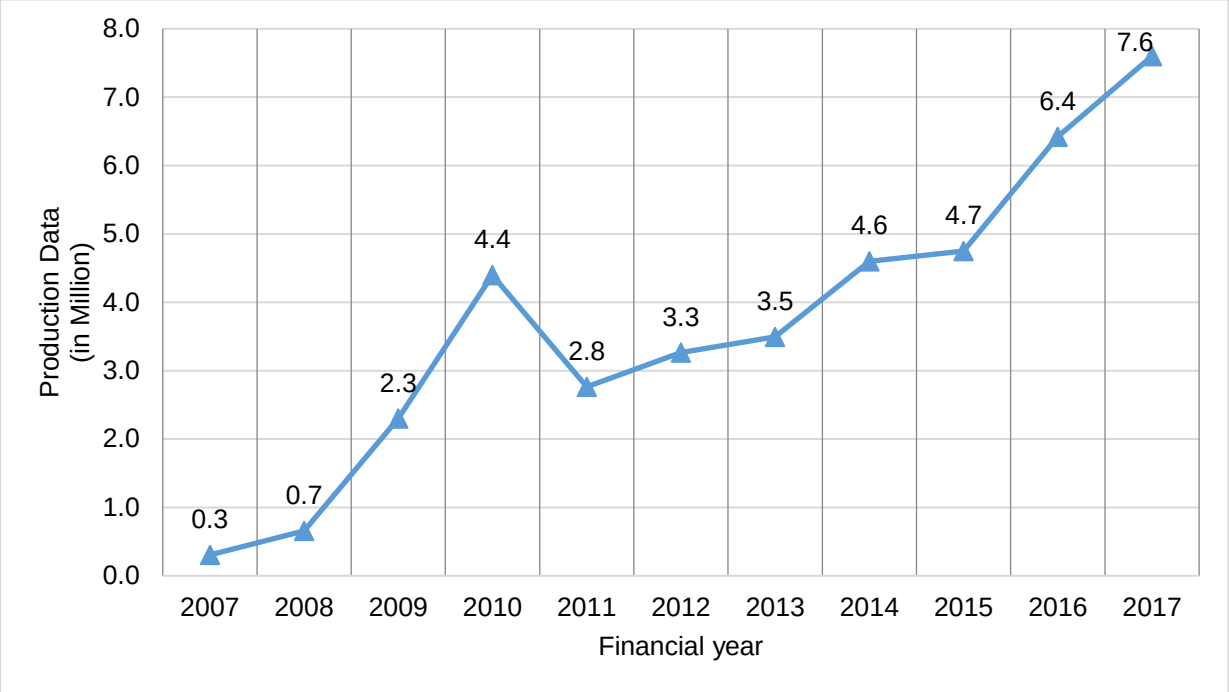


**Figure 2: RAC market growth from 2007-17**

Source: Bureau of Energy Efficiency

The split segment comprising the majority share throughout the period and is at 87% in 2017-18. The window AC share has decreased gradually from 23% to 12% during the same period primarily because of consumer preferences for split ACs due to aesthetics, higher efficiencies, and their availability at comparable prices. The production of RAC in 2017 is represented graph in Figure 3 below while the percent share of window and split RAC is represented by the column graph.

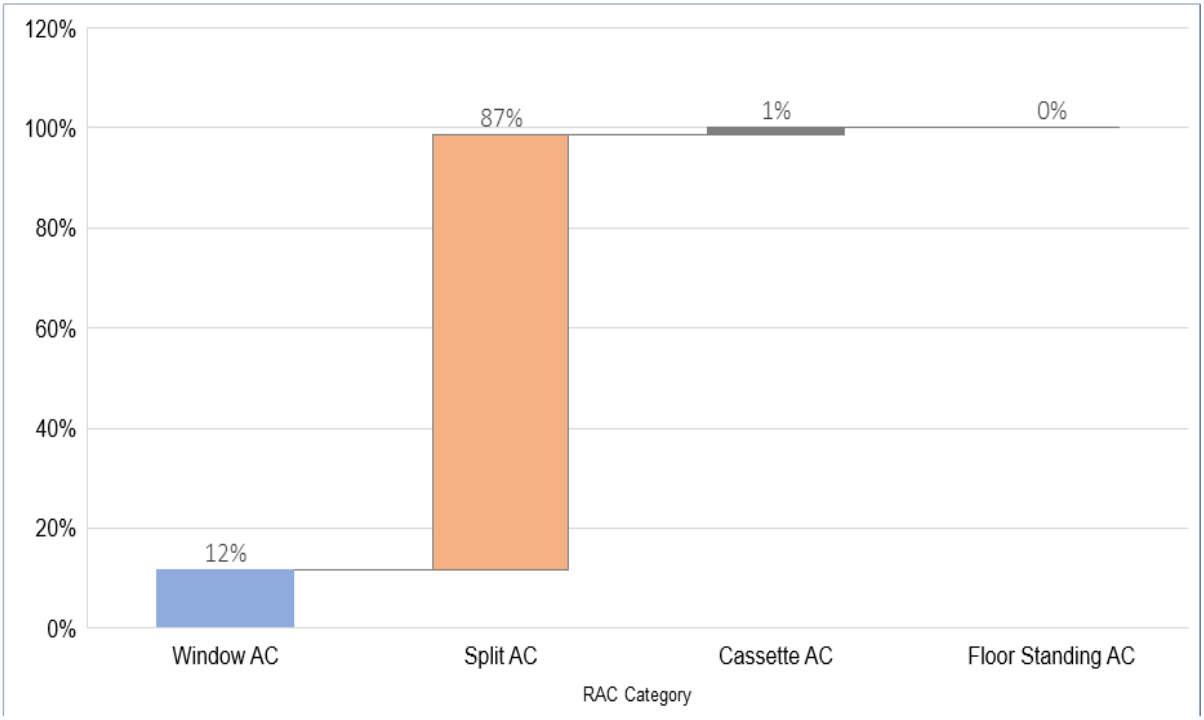


**Figure 3: RAC market segmentation in 2017**
Source: Bureau of Energy Efficiency

The RAC market is further categorized on the basis of cooling capacities (in tons, which is equal to approximately 3.5 kW), generally ranging from 0.5 to 2.8 tons.

As seen in **Error! Reference source not found.**, the market is well represented by RACs of all capacities. However, 1.5 ton capacity RACs have been consistently dominant for almost six years with share of 38 percent in 2017, followed by 23 percent of 1 ton capacity RACs.

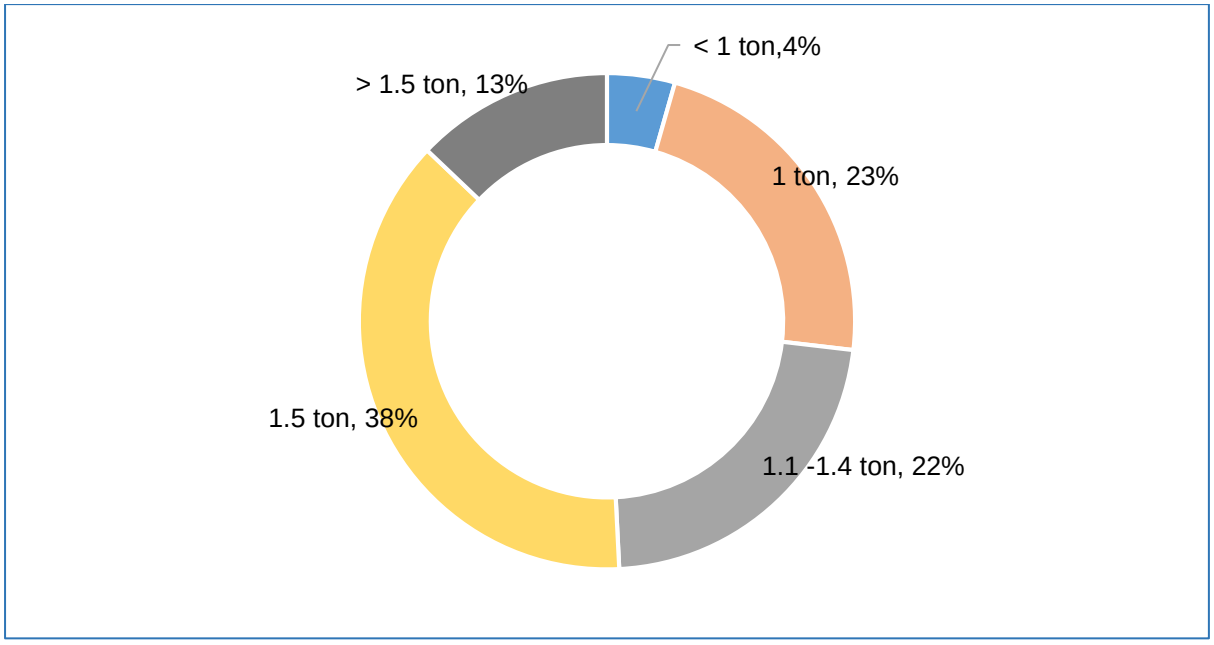


**Figure 4: RAC Segmentation by cooling capacity (in tons) in 2017**

Source: Bureau of Energy Efficiency

## Evolution of RAC Energy Efficiency Policy in India

In May 2006, Bureau of Energy Efficiency (BEE), a statutory body under the Government of India, Ministry of Power, launched the Standards and Labeling (S&L) Program for electrical home appliances with the objectives of regulating energy performance and assisting end users in making informed purchase decisions. BEE designed the program to rate appliances on a scale of 1 to 5, with the 5-Star rating going to the most efficient appliances on the market.

BEE launched the labeling program for RACs in 2006 as a voluntary initiative, and the program became mandatory on January 12, 2009. The program covers RACs of capacities up to 3TR with fixed speed technologies covered under the scope of Bureau of Indian Standards (BIS) – IS 1391(part I & II). The typical air conditioner energy label is shown in Figure 5.

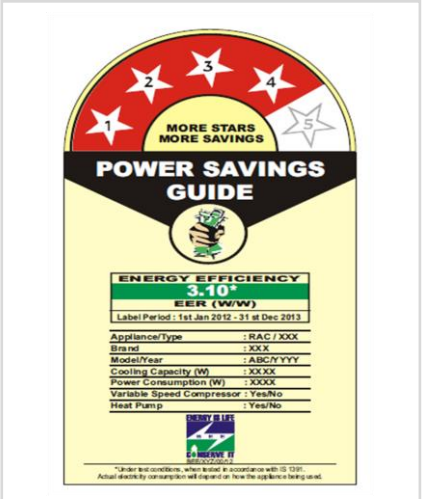


**Figure 5: Star label of room air conditioner**

### RAC Labeling Program

BEE developed distinct star rating plans for split and window/unitary type RACs. The split AC rating plan also includes the cassette and floor standing/ceiling mounted type RACs.

The efficiency of a RAC is defined in terms of the Energy Efficiency Ratio (EER), which is the ratio of the cooling output (in Watts) to the total power input (in Watts) at standard rating conditions. This means the higher the EER, the more efficient the air conditioner. In 2018, BEE adopted an improved rating methodology that factors in variance in temperature across the various climatic zones in India and operating hours. The new metric is called the Indian Seasonal Energy Efficiency Ratio (ISEER), which is the ratio of the cooling seasonal total load (in kWh) to cooling seasonal energy consumption (in kWh).

BEE has revised the star rating plans for window and split RACs to increase the stringency of the energy performance thresholds, as shown in Table 1 and Table 2 respectively.

**Table 1: Revisions in star rating levels for window/unitary type RACs**

| Star level | 1st January 2009 to 31st December 2011 | 1st January 2012 to 31st December 2013 | 1st January 2014 to 31st December 2015 | 1st January 2016 to 31st December 2017 | 1st January 2018 to 31st December 2019 |
|---|---|---|---|---|---|
| | EER | EER | EER | EER | ISEER |
| 1 Star | 2.3 | 2.3 | 2.5 | 2.5 | 2.5 |
| 2 Star | 2.5 | 2.5 | 2.7 | 2.7 | 2.7 |
| 3 Star | 2.7 | 2.7 | 2.9 | 2.9 | 2.9 |
| 4 Star | 2.9 | 2.9 | 3.1 | 3.1 | 3.1 |
| 5 Star | 3.1 | 3.1 | 3.3 | 3.3 | 3.3 |

Source: Bureau of Energy Efficiency

**Table 2: Revisions in star ratings plans for split type RACs**

| Star level | 1st January 2009 to 31st December 2011 | 1st January 2012 to 31st December 2013 | 1st January 2014 to 31st December 2015 | 1st January 2016 to 31st December 2017 | 1st January 2018 to 31st December 2019 |
|---|---|---|---|---|---|
| | EER | EER | EER | EER | ISEER |

| | | | | | |
|---|---|---|---|---|---|
| 1 Star | 2.3 | 2.5 | 2.7 | 2.7 | 3.1 |
| 2 Star | 2.5 | 2.7 | 2.9 | 2.9 | 3.3 |
| 3 Star | 2.7 | 2.9 | 3.1 | 3.1 | 3.5 |
| 4 Star | 2.9 | 3.1 | 3.3 | 3.3 | 4.0 |
| 5 Star | 3.1 | 3.3 | 3.5 | 3.5 | 4.5 |

Source: Bureau of Energy Efficiency

As per Table 1, the extent of efficiency improvements for window RACs has been limited due to technological and size constraints. As per the last revision in 2018, BEE does not allow registration of those models which would have been rated 1-Star.

In comparison, the split type RACs have seen more frequent and substantial revisions (see Table 2). For example, the existing 5-Star level in 2009 became 3-Star in 2015 and 1-Star in 2018 as per new star levels and ISEER methodology.

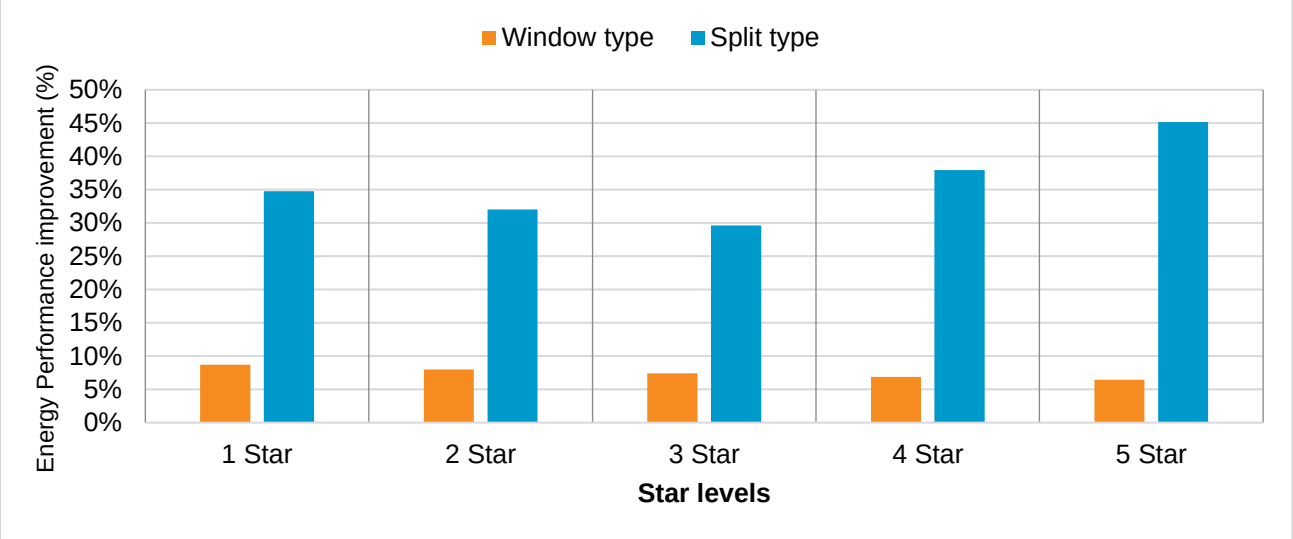


**Figure 6: Star level improvement of air conditioners from 2009-2018**

Source: Bureau of Energy Efficiency

As shown in **Error! Reference source not found.**6, the improvements in energy efficiency for window RACs resulted in marginal efficiency improvements of 9% to the minimum energy performance standard (1-Star) and 6% for 5-Star level. For split RACs, energy efficiency improvements resulted in overall improvement of 35% for minimum energy performance standards (1-Star) and 45% for the 5-Star level.

**Market share by star levels and overall efficiency improvement**

The majority of RAC sales over the last four years were of 3-Star and 5-Star models, with average market shares of 61% and 23% respectively. This trend points to a consumer preference for 3-Star RACs, possibly due to lower, more affordable upfront purchase costs.

Considering production data available for RACs in 2017-18, and as shown in **Error! Reference source not found.**, 3-Star RACs dominated the market with 66% followed by 5-Star RACs with 18% market share.

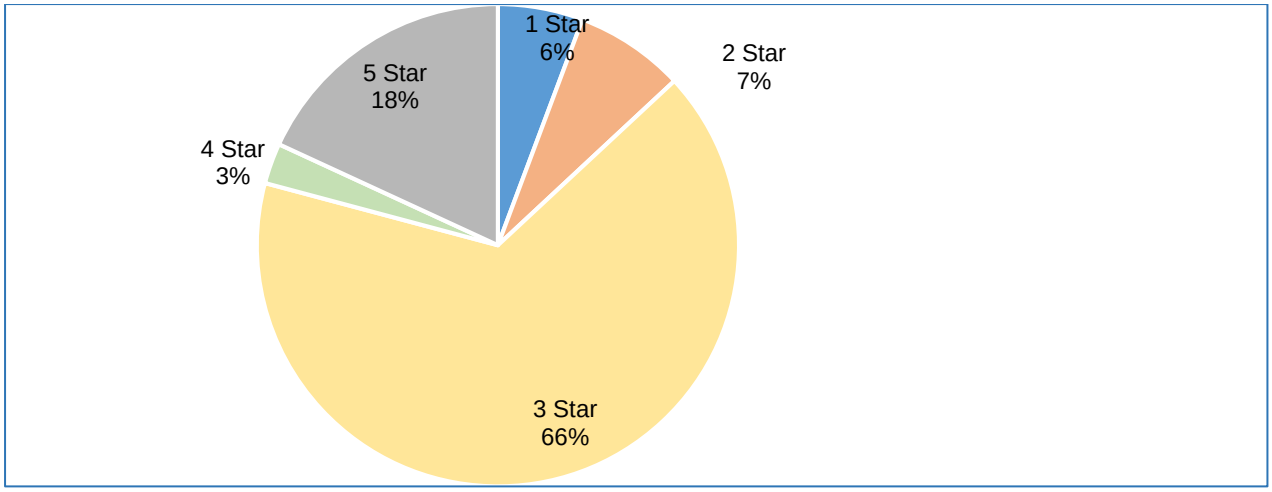


**Figure 7: RAC market by Star Level in 2017**
Source: Bureau of Energy Efficiency

## Market Transformation of Fixed and Variable Speed Labeled RAC

### Overview of labeling program for variable speed RACs

In 2015, the market share of variable speed (commonly known as inverter) RACs was less than 1%. In June of that year, BEE introduced a voluntary labeling program for variable speed RACs with a new star rating methodology called Indian Seasonal Energy Efficiency Ratio (ISEER)[1] [3].

In January 2018, BEE mandated the labeling program for variable speed RAC and introduced a single star rating plan for variable and fixed speed RACs. The overall market for RACs reached 7.6 million units by 2017-18, the highest volume of sales recorded under the RAC labeling program, while the share of variable speed RACs increased to 30% (see **Error! Reference source not found.**8).

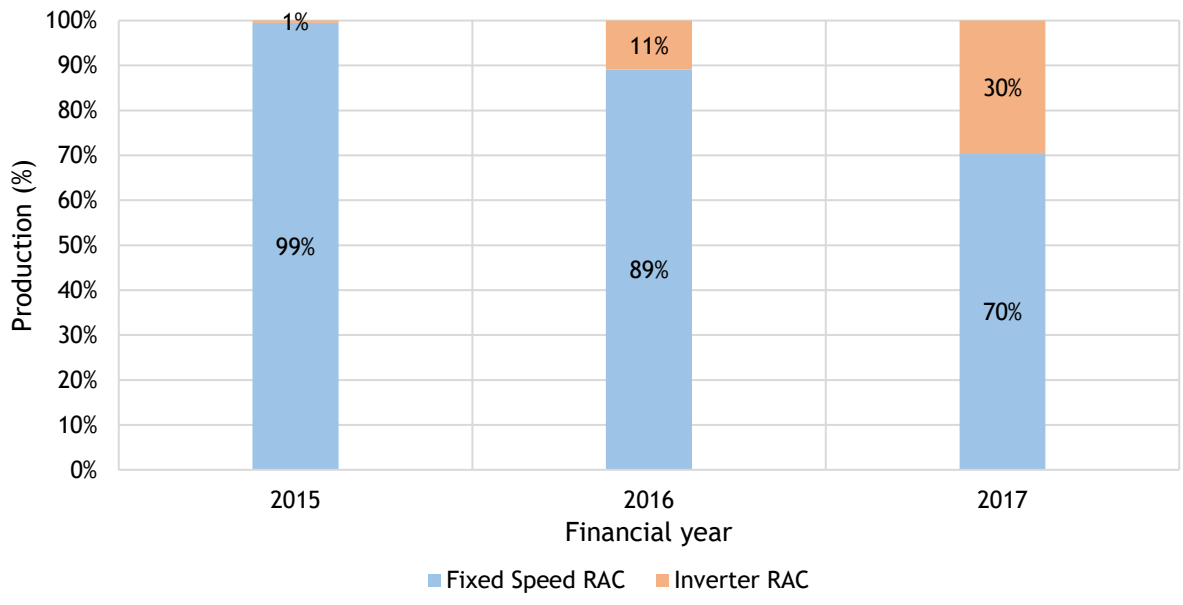


**Figure 8: Market segmentation of fixed speed vs. inverter ACs, 2015-2017**
Source: Bureau of Energy Efficiency

[1] The ISEER method of evaluation is based on bin hours of the Indian climatic zone, bin temperature range of 24 - 43°C and 1600 operating hours for cooling per year. BEE derived this methodology from the ISO 16358-1 standard for calculating the seasonal performance metric for both fixed-speed and inverter ACs and modified the temperature bin distribution to account for hotter weather in India.

## Impact at the National Level

### Energy saving and Emission reduction

BEE estimates the actual energy saving attributable to S&L program by factoring in verified annual/quarterly productions for all equipment/appliances models produced by the manufacturers registered with it and actual energy consumption, annual hours of usage and accounting the average life of each appliance. This energy saving approach is adopted for mandatory & voluntary households' appliances/equipment.

The baseline energy performance level for each appliance is established with following criteria:

- Minimum efficiency levels at the time of launch of appliance are used in case of appliance where energy performance parameters have been defined for each star level without any variable function. (example: Air Conditioner etc, where minimum level is fixed, which is 1-star)

Energy Savings Calculation Procedure

$$Annual\ Energy\ Savings_{\ (Appliance\ Name)} = (Baseline\ Value - Actual\ Value) \times Production \times Operation\ Usage \times (1 - T\&D\ Losses)$$

$$For\ Operation\ Usage\ of\ each\ appliance$$

In Billion Units

Since the inception of the RAC labelling program, 46 TWh of electricity have been saved and 38 Million tons (MT) of carbon emissions have been avoided cumulatively by 2016-17. The highest carbon emission reduction was recorded in 2016-17 at 9.7 MT $CO_2$, as the overall market of efficient RACs increased significantly (see figure 9).

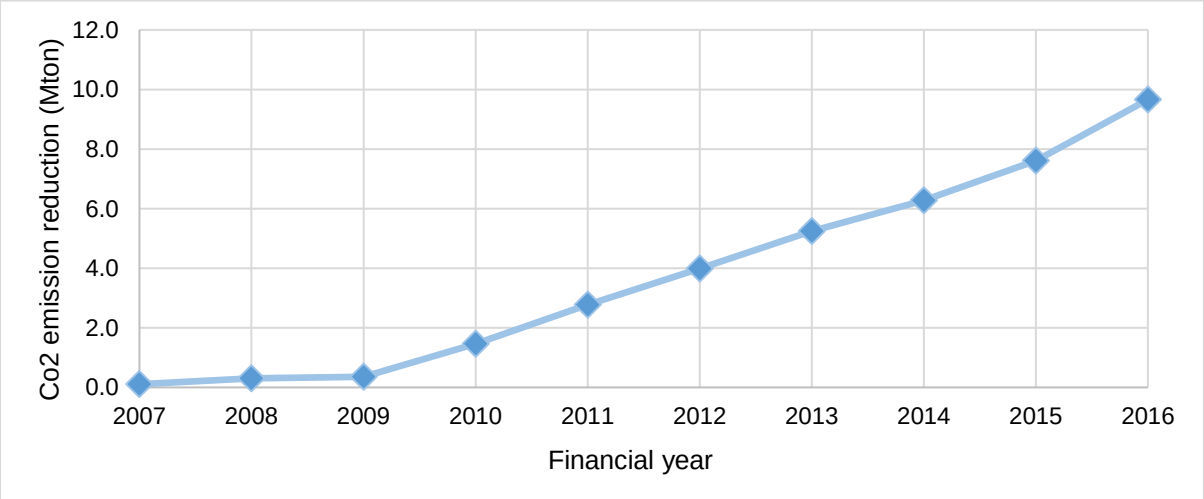


**Figure 9: Carbon emission reduction since inception of labeling program**
Source: Bureau of Energy Efficiency

## Policy options and results

### Policy Options

For split type RACs, the minimum energy performance standards (MEPS) (1-Star) has increased by 3% on yearly basis (since 2009 to 2020), which resulted in annual average energy saving of 9%. The energy performance levels were revised or upgraded biennially.

### Increasing MEPS by 4% and Star Ratings levels

Given that India's MEPS efficiency levels increased gradually with biennial revisions and has resulted in 3% improvement each year, it can be considered as baseline scenario. Alternatively, for accelerating the policy revision, MEPS could be increase by 4% on yearly basis for the period of 2021 to 2030, with

periodic revision of every three years instead of two years, as India's RAC market has technological transformed with efficient products over the last decade. Thus, under this accelerated policy scenario, the MEPS will become ISEER 3.3 in 2021, with gradually increase of ISEER 4.5 in 2030 (see figure 10).

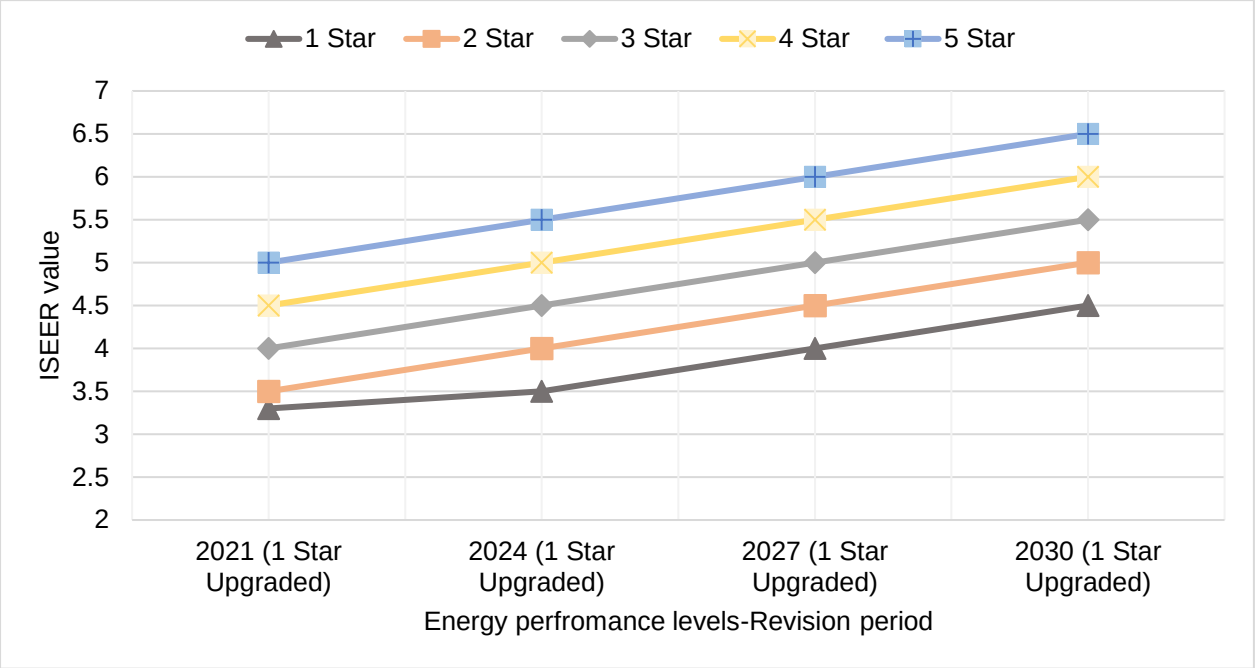


**Figure 10: Energy performance revision level in 2021-2030**

### Energy saving and Emissions reductions

Under the accelerated policy scenario, 4% increase in MEPS, will result in energy savings of over 6.9 TWh of electricity in 2030, equivalent to GHG emission reduction of 5.6 MT $CO_2$. Over ten-year period, the cumulative energy savings could reach nearly 56 TWh of electricity from 2021- 2030, which is equivalent to GHG emission reductions of 46 MT $CO_2$. Whereas in the business as usual scenario (increasing MEPS by 3%), the cumulative GHG emissions reduction of 40 MT $CO_2$ can be achieved, as shown in figure 11. Therefore, accelerated scenario would result in additional GHG emission reduction of 6MT $CO_2$ by 2030.

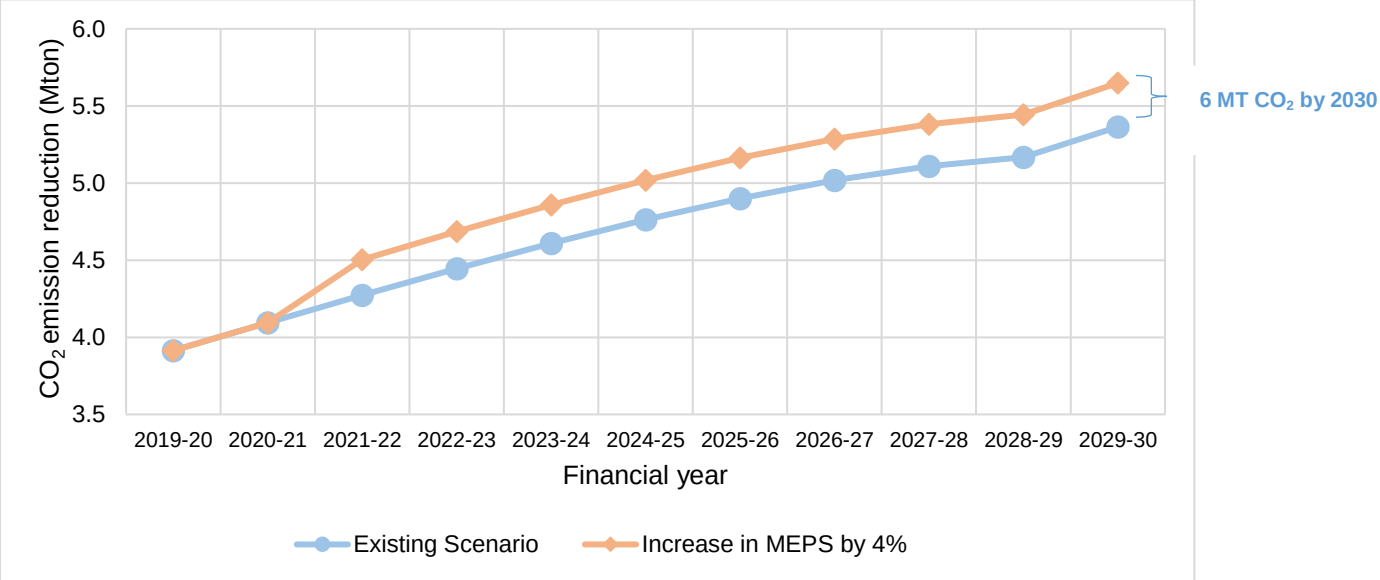


**Figure 11: Avoided $CO_2$ emissions over time and in 2030**

**Policy Implementation Assumptions**

- The standard year, or year when the policy is implemented, is set at 2021. The analysis focuses on the impacts of a policy implemented from 2021 to 2030.
- The RAC market estimated to transform towards variable speed technology over this period at an annual growth rate of 6%.

## Conclusions

The paper analyses RAC market growth, technology evolution and market transformation as a result of BEE's labeling program and further estimates the electricity saving potential with accelerated revision by 2030. The Indian RAC market is ready for an increase in MEPS by 4% and further revision of the labeling ratings in 2021. This paper can be used to revise efficiency level for RACs, quantify potential energy and GHG emissions savings in support of national energy efficiency targets or national determined contribution (NDC) commitments, and estimate other potential benefits from revising the S&L program.

The RAC market in India has grown 25 times in the last 10 years and is expected to grow further at a CAGR of 11% in the next 10 years. The overall production for RACs reached 7.6 million units in 2017-18, the highest volume recorded thus far under the RAC labeling program.

BEE's labelling program has effectively moved the Indian RAC market to higher efficiencies through star rating plans that revise periodically and increase the stringency of energy performance thresholds. The introduction of labeling for variable speed RACs also facilitated the transition to more efficient RACs. The market share of inverter RACs went from less than 1% in 2015 to 30% in 2017-18.

Following the analysis of RAC market and the findings presented above, it is recommended to

- **Ratchet the energy performance standards for room air conditioner by January 2021:**

As the existing star rating plan for split type RACs is valid until December 31, 2020, there is strong evidence to increase the stringency of the RACs labeling program before or at the time of the next revision scheduled for January 2021. The current market for variable speed RACs has already transformed towards higher efficiencies, with 30% penetration in 2017-18.

It is proposed to revise star rating plan based on analysis of the data, to i**ncrease MEPS by 4% on yearly basis for 2021 to 2030, with periodic revision of every three years** as India's RAC market has technological transformed with efficient products over the last decade. Thus, under this policy scenario, the MEPS will become ISEER 3.3 in 2021, with gradually increase of ISEER to 4.5 in 2030, this results in the cumulative energy savings nearly 56 TWh of electricity from 2021- 2030 and the projected cumulative emissions reduction of 46 MT $CO_2$

## Acknowledgements

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