AC Challenge Program for India

March 2017

Acknowledgement

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Executive summary

India is the second fastest growing economy in the world. Increasing income levels, affluence and consequently changing consumer behaviour have led to a growing demand for different white goods such as room ACs (RACs). RACs constitute around 45% of total energy consumption in urban homes in India and the market has been growing at a Compound Annual Growth Rate (CAGR) of 12.9% over the last five years. Current market of RACs is around 4.5 million units and it is expected to reach 7.72 million units by 2020. BEE launched a standards and labelling programme for RACs in 2007 and revised the energy efficiency norms periodically, resulting in overall efficiency improvement to the extent of 36%. However, there is further potential to improve the efficiency of RACs to meet the rising energy demand.

The India-US Collaboration on Smart and Efficient Air Conditioning and Space Cooling is an initiative to facilitate the AC market transformation to super-efficient space cooling technologies. The AC Challenge Program is one of the initiatives under the India-US Collaboration on Smart and Efficient Air Conditioning and Space Cooling. The objective of the AC Challenge Program is to catalyse the private sector to develop super energy efficient **RACs (window or split ACs)** that perform efficiently and incorporate new climate-friendly refrigerants or other technologies to eliminate the use of high GWP substances. These RACs are primed for mass-market adoption with a compelling mix of consumer features and competitive pricing. It is also desirable to promote the production of demand-response ready RACs to ease peak load issues in India. The programme outcomes are summarised below.

Program coverage

The market assessment reveals that the programme should focus on RACs with a capacity of 1.5 TR and above and the supply chain analysis suggests that it is possible to achieve an Indian Seasonal Energy Efficiency Ratio (ISEER) of 5.5 in Indian conditions.

Establishing Indicative Price of super energy efficient RAC

In order to establish indicative maximum retail price (MRP) of super energy efficient RAC with an ISEER of 5.5, different cost components of a RAC were worked out in consultation with various manufacturers in India. A statistical tool, price of air conditioner (PAC), was developed to determine the percentage contribution by various cost components of an RAC. The PAC model was validated by estimating the market operating cost of existing fixed-speed and variable-speed RACs.

Possible options for the implementation of the AC challenge program were considered. This report includes two such potential options, namely, bulk procurement and incentives based mechanism, which have been discussed in detail.

Bulk procurement option

This option works on the principle of demand aggregation for the procurement of large quantities of super energy efficient RACs to get the benefit of price reduction. The benefit of lower cost is passed on to the consumer. Price reduction could occur due to the procurement of super energy efficient RACs directly from the manufactures and through competitive bidding on a large number of super energy efficient RACs.

Incentive based options

Different options have been considered for incentivising the manufacturers and/or consumers. For each of these options, the required incentive were calculated and discussed in detail.

Rules for implementation of the AC Challenge Programme in India

Draft rules for the bulk procurement and incentive options for AC Challenge program have been proposed. The rules include programme scope, key stakeholders, business models/mechanism, programme structure, duration, participation in the programme, technical specifications for super energy efficient ACs, selection of manufacturers, monitoring and verification, incentive disbursal, and action in the case of non-compliance.

The key findings of the programme are discussed in this report and supported by detailed analysis in the form of annexures.

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Introduction

Globally the demand for cooling is growing rapidly due to increasing urbanization and income levels and a demand for a better lifestyle. Growing demand for cooling and proliferation of low-efficiency air conditioners with high-GWP refrigerants is increasing the stress on power grids by contributing to peak loads, thus exacerbating brownouts and blackouts and generating substantial greenhouse gas emissions that contribute to climate change.

India is the second fastest growing economy in the world. Increasing income levels and the consequent changing consumer behavior has helped establish a growing demand for different white goods like Room ACs (RACs).

Room AC constitutes around 45% of total energy consumption in urban homes in India and its market has been growing at a CAGR of 12.9% over the last five years. The current market of RACs is around 4.5 million units and it is expected to reach 7.72 million units by 2020.

Within next two decades, the electricity demand for cooling could increase 25 times in India. According to the 2011 census, 30% of Indians (i.e. 363 million) live in cities and it is estimated that by 2050, this figure will reach 50% (CREDAI, CBRE, 2015).

BEE launched standards and labelling program for RACs in year 2007 and revised the energy efficiency norms periodically resulting in overall efficiency improvement to the extent of 36%. However, there is a further potential to improve the efficiency of RACs to meet the rising energy demand

Bureau of Energy Efficiency is currently expanding its scope of policy measures to cover high-efficiency variable speed drive technology RACs.

There is a potential to drive the market even faster and further toward higher efficiency through schemes such as public procurement, financial incentives, awards etc.

The India-US Collaboration on Smart and Efficient Air Conditioning and Space Cooling is an initiative to identify the potential for efficiency improvement in RACs in alignment with the global best available norms, and to explore various options for accelerated market transformation towards high-efficiency RACs over the existing standards set by BEE.

The AC Challenge Program

AC Challenge Program is one of the initiative under the India-US Collaboration on Smart and Efficient Air Conditioning and Space Cooling.

The objective of the AC challenge program is to catalyze the private sector to develop super-energy efficient **RACs (window or split AC)** that perform efficiently, incorporate new climate-friendly refrigerants or other technologies to eliminate the use of high GWP substances, and are primed for mass-market adoption with a compelling mix of consumer features and competitive pricing. It is also desirable to promote production of demand-response ready RACs to ease peak-load issues in India.

Structure of the report

The report discusses the following sections as per the sequence below

1	**Market assessment of the RAC segment in India**	Findings of the market assessment
		Stakeholder workshop to discuss the findings of the market assessment and feasibility of the AC challenge program
2	**Designining an AC challenge program for India**	Estimation of effciency levels (ISEER) of super energy efficient RAC
		Estimation of price of super energy efficient RAC
		Stakeholder consultations to discuss the effciency levels, price and design options for implementation of AC Challenge
3	**Options for Implementation of AC Challenge Program**	Bulk procurement
		Incentive option
4	**Rules for AC Challenge Program**	Program scope and key stakeholders
		Minimum requirements
		Selection of bidders and operation methodology for bulk procurement and incentive options
5	**List of annexures**	

1. Market assessment of the RAC segment

1.1. Findings of the market assessment

A detailed market assessment was essential to establish the baseline situation/readiness of RAC manufacturers in India to develop super-efficient RAC in India. The following parameters were assessed:

- Market segmentation for different cooling capacity products in India
- Technical specifications of RACs sold in the market
- Manufacturing capability to produce super-efficient RACs in India
- International best available technologies as well as availability of components/materials to design super-efficient RACs
- Discussions/meetings with key stakeholders such as RAC manufacturers association i.e. RAMA, key RAC manufacturers, national as well as international RAC component manufacturers/suppliers, test laboratories, DISCOMs etc.
- Inputs/suggestions on the feasibility options for implementing the AC Challenge program.

Details of the market assessment report is given in **Annexure A**.

A summary of key findings of the market assessment is presented in the table 1 below:

Table 1: Key findings of market assessment conducted for RAC segment in India

S. No.	Market assessment indicator	Key findings
1.	Market segmentation	• Fixed speed split ACs cater to the majority of the market and are a priority segment for manufacturers. • Manufacturers have limited interest in new investments in the window AC segment due to decreasing market share and limited scope for efficiency improvement • ACs of capacity 1.5 and 1 ton constitute the major share of the market • Variable capacity RACs are considered to be more energy efficient and can be seen as the fastest growing segment.
2.	Manufacturing capacity	• There is sufficient manufacturing capacity in India to manufacture fixed speed RACs as well as the required research and development infrastructure. • Investment in the Variable speed RAC is increasing with high potential to focus on various research and development for advanced technologies.
3.	Existing energy efficiency levels of RACs	• The AC with the best EER in the fixed speed category has a rating of 4.0, while the majority of the products available have an average EER of 3.7. • The AC with the best iSEER in the variable speed category has a rating of 4.5.
4.	Manufacturers' perception	• Few manufacturers shared their difficulty in meeting BEE's energy efficiency metric for variable speed RACs to be implemented by the

S. No.	Market assessment indicator	Key findings
	towards transition to variable speed RAC	year 2018 while others were either neutral or excited about the thought of the AC Challenge. • As this is an evolving market, some of the manufacturers were not aware about the best available technologies/products sold globally in this segment. • There was consensus that there is a need to explore the role/availability of key component technologies to achieve energy efficiency in RAC segment.
Assessment of various RAC components		
5.	Compressors	• The existing compressors available in the market has an EER of 3.4. There is a need to explore strategy to develop 3.8 EER compressors to produce super-efficient RACs. • There should be focus on research and development and collaboration with compressor manufacturers to design/evolve high efficiency compressors.
6.	Heat Exchangers	• Copper tube aluminum fin (CTAF) and multi-channel aluminum (BAM) heat exchangers are used in existing RACs in the market • For some time, manufacturers has also started using BAM heat exchangers to achieve higher efficiencies. But there is concern regarding the life of BAM and it needs to be evaluated for future programs • Other options for energy efficiency improvement in heat exchangers need to be identified
7.	Refrigerants	• Changes are anticipated in the system design with different refrigerants. There is a need to align the challenge program with the overall national objective of hydro chlorofluorocarbons (HCFC) phase out and promotion of clean refrigerants • Most of the RAC manufacturers use R22 for fixed speed RACs and R 410 & R32 for variable speed RACs. There is some limited use of R290 as well but there are some safety concerns which needs to be evaluated
8.	Fan motors	• Most of the fixed speed RACs have Alternate Current (AC) motors while most of the variable speed RACs have Direct Current (DC) motors either as part of the complete unit or imported from global suppliers like Welling, Rechi etc. • Efficient DC motors are available; the additional cost of the controller and the fluctuating power scenario are the main barriers to its adoption
9.	Controllers	• Controllers are a key component of variable speed RACs • As of now, there is no manufacturing of controllers in India. All the local requirements are met through imports • There are concerns regarding life and cost of controllers. This needs to be explored
Market barrier for development/uptake of Super energy efficient RACs		
10.	Barriers	• Lack of consumer awareness about energy efficiency • Cost-sensitive market/affordability • Lack of motivation for manufacturers to do research and development and adopt best technologies • Lack of procurement commitments for energy-efficient products from large-scale buyers (governments, private players, etc.)

S. No.	Market assessment indicator	Key findings
		• Lack of incentive for manufacturers and consumers
Suggestive Options for market transformation towards energy efficient products		
11.	General suggestions	• Manufacturers/component suppliers must be motivated to invest in research and development facilities in India or at their locations to promote energy-efficient products/components. Manufacturers can be encouraged to align with the Make in India program and be guided to enjoy the benefits of producing energy-efficient products • There is a need to engage technology suppliers to supply their best products/technologies • Consumer awareness plan: One of the options to increase the penetration of energy-efficient RACs is through a robust consumer awareness plan/strategy • Strategies can be explored to make energy-efficient products affordable to Indian consumers
12.	Procurement commitments to manufacturers	• As the penetration of ACs in India is still very low, one of the motivators for manufacturers to invest in super-efficient ACs is to have a strong demand established for these products. One such strategy could be to ensure bulk procurement for energy efficient products. Large organized purchase organizations such as the Directorate General of Supplies and Disposal (DGS&D) and other institutions can be encouraged and engaged to procure super-efficient products • Energy Efficiency Services Limited (EESL) aggregation model can be adopted here to transform the market in line with the LED program A DISCOM-level program may be initiated to ensure the commitment to procure a large number of ACs that can replace existing/inefficient ACs for the general consumer
12.	Incentive options	• Incentives can be provided to component suppliers to invest in India for research and development of energy-efficient components • Incentive for manufacturers to provide super-efficient RACs in the market at an affordable price • Import duty/excise duty rebates for energy efficiency products • Rebates/discount coupons/IT rebates/loans at a lower rate of interest and replacement schemes for consumers to buy energy-efficient products • An award similar to the National Energy Conservation Award to manufacturers of super-efficient RACs
13.	Energy Efficiency Innovation Options	• Advancements have been made in chemical technologies to address the issue of latent load (which constitutes ~30% of the total load). The concept of two cycles—refrigerant cycle and moisture removal cycle—operating in tandem requires further analysis and discussion • The promotion of solar ACs in the Indian market (net zero load on grid) may be explored
Suggestions/Strategies for AC Challenge Program Design		
14.	Short term Strategy- Market	• In the present scenario, the market share of 5-star ACs is 15–20% of the overall market. One of the challenge options can be to increase the share of 5-star ACs to 50% of the overall market. This

S. No.	Market assessment indicator	Key findings
	transformation strategy	will result in real energy gains and is more of a market transformation strategy. This option requires further deliberation • Focus on the replacement of old and inefficient stock
15.	Medium term Strategy - Creating more efficient products in the Indian market	• Option 1: Identify the best products/technology sold globally and set a benchmark • Option 2: Set a 15-20% improvement in the best efficiency level of BEE's 2018 table for inverter ACs
16.	Long term strategy	• An "innovation program" focusing on developing new disruptive technologies • Challenge program aimed at accelerating the phase-out of HCFCs • Components, new metals, alternative space cooling options, etc., to be focused on; efforts to reduce losses from each and every component

1.2. Stakeholder workshop

A workshop, 'India AC Challenge: Identifying goals and market barriers' was held on September 10th, 2015 in New Delhi to present and discuss the findings of the market assessment and also market and technology barriers for development of superefficient ACs and potential measures to overcome the barriers. The workshop was well attended by the industry, component manufactures, test labs, civil society organizations and was designed to be interactive and sought to initiate a stimulating exchange of ideas among all the stakeholders. The detailed proceedings of the workshop are given in **Annexure B**.

The key takeaways from the workshop were:

- There was a general agreement on the findings of the market assessment
- There was an in-principal interest in the 'AC Challenge' program although there were several issues that was raised for the implementation of such an initiative
- The AC Challenge program should complement the ongoing AC labeling program
- The roadmap for the Challenge program may be considered in three phases:
    - Short-term (improving the penetration of existing five-star ACs through appropriate-market transformation strategies)

    - Medium-term (introduction of super-efficient ACs beyond ISEER of 5.5 at an affordable price) —both short-term and medium-term can be implemented concurrently.
    - Long-term (R&D for disruptive cooling technologies in association with academic, research institutes or through an award/prize initiative for manufactures of these technologies)
- Need to arrive at an optimal manufacturing cost for products of 5.5 ISEER and above
- Potential options for implementation of AC Challenge program including bulk procurement and incentive based to motivate manufacturer to produce ACs of 5.5 ISEER
- Identify various prizes/incentive based design options and global experiences of similar programs

2. Designing an AC Challenge program for India

Based on market assessment and stakeholder consultations, a detailed analysis was carried out to design an AC Challenge program for India. The approach along with the key steps and results are discussed below:

2.1. Technical analysis: Evaluating target ISEER value

Different approaches were considered to arrive at possible achievable ISEER value for super-efficient ACs. These are discussed below:

- Supply chain analysis to assess impact of various design options on efficiency and cost of an air conditioner
- Lawrence Berkeley National Laboratory (LBNL)'s analysis of cost-benefit and efficiency improvement options for RACs
- Oak Ridge National Laboratory's (ORNL) Design/Simulation model to establish the benchmark ISEER values

2.1.1. Supply chain analysis to assess impact of various design options on efficiency and cost of an air conditioner

PwC team evaluated the market to assess the readiness of the manufactures to supply super-efficient ACs to arrive at possible ISEER for the AC Challenge program.

- **BEE's existing energy efficiency metric for RACs** is as shown in table 2.

Table 2: Common star labelling program for RACs (fixed speed and inverters)

Star rating	Minimum ISEER	Maximum ISEER
1 star	3.10	3.29
2 star	3.30	3.49
3 star	3.50	3.99
4 star	4.00	4.49
5 star	**4.50**	

A survey undertaken to identify the best products available in the Indian market shows:

- Products of ISEER 5.2 for 1 TR cooling capacity RAC is available in the market. One product of ISEER 5.75 also available in 1 TR cooling capacity category.
- Products of ISEER 5.2 for 1.5 TR cooling capacity RAC is available in the market
- A review of the supply chain analysis revealed that compressors and other components such as heat exchanger, fan motors used in various combinations can be used in RACs to achieve an ISEER of 5.5 and above for 1.5 TR cooling capacity products. Incremental cost of these component with increased efficiencies were analyzed to ascertain possible increase in total cost for higher efficiency RACs indicating that super -efficient ACs can be made available but at an additional cost.

2.1.2. Lawrence Berkeley National Laboratory (LBNL) analysis of cost benefit and efficiency improvement options for RACs.

PwC considered LBNL's study undertaken to evaluate different efficiency improvement options in RACs. The study analyzed how the various component and their combinations influence the efficiency gains of RACs. The table 3 shows the various components (compressors, inverter, heat exchanger and expansion valve) and their combinations for achieving different efficiency levels that varies from 2.78 ISEER (1 star as per BEE's metrics for fixed speed RACs) to 5.82 ISEER.

Table 3: Variation of ISEER with variation in the efficiency levels of various components of RAC

ISEER	Compressor	Inverter	Heat exchanger	Expansion valve
2.78	2.8 EER	No	Base case HX	Capillary tube
3.1	3.2 EER	No	Base case HX	Capillary tube
3.22	3.2 EER	No	Base case HX	Thermostatic expansion valve
3.39	3.4 EER	No	Base case HX	Thermostatic expansion valve
3.5	3.4 EER	No	Base case HX	Electronic expansion valve
3.78	3.4 EER	No	UA value of HX increased by 20%	Electronic expansion valve
4.02	3.6 EER	No	UA value of HX increased by 20%	Electronic expansion valve
4.24	3.4 EER	No	UA value of HX increased by 60%	Electronic expansion valve
4.29	3.6 EER	No	UA value of HX increased by 40%	Electronic expansion valve
4.5	3.6 EER	No	UA value of HX increased by 60%	Electronic expansion valve
4.7	3.6 EER	No	UA value of HX increased by 80%	Electronic expansion valve
5.02	3.6 EER	VSD	UA value of HX increased by 60%	Electronic expansion valve
5.25	3.6 EER	VSD	UA value of HX increased by 80%	Electronic expansion valve
5.45	3.6 EER	VSD	UA value of HX increased by 100%	Electronic expansion valve
5.6	3.6 EER	DC compressor with VSD	UA value of HX increased by 100%	Electronic expansion valve
5.82	3.6 EER	DC compressor and fan with VSD	UA value of HX increased by 100%	Electronic expansion valve

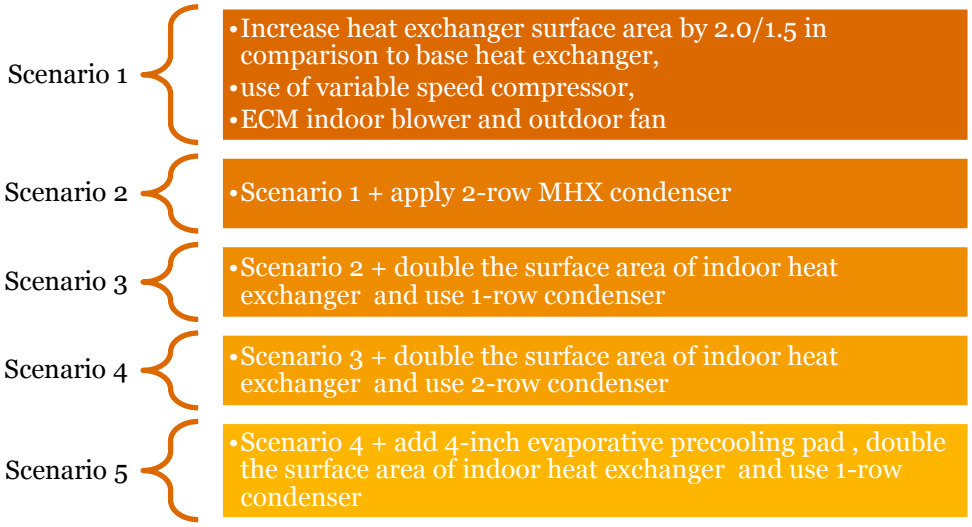
It is evident from table above that it is feasible to achieve ISEER of 5.5 and above with the existing efficiency level of components as shown below

- 3.6 EER compressor
- DC compressor with VSD
- UA value of heat exchanger increased by 100% in comparison to one star RACs
- Electronic expansion valve

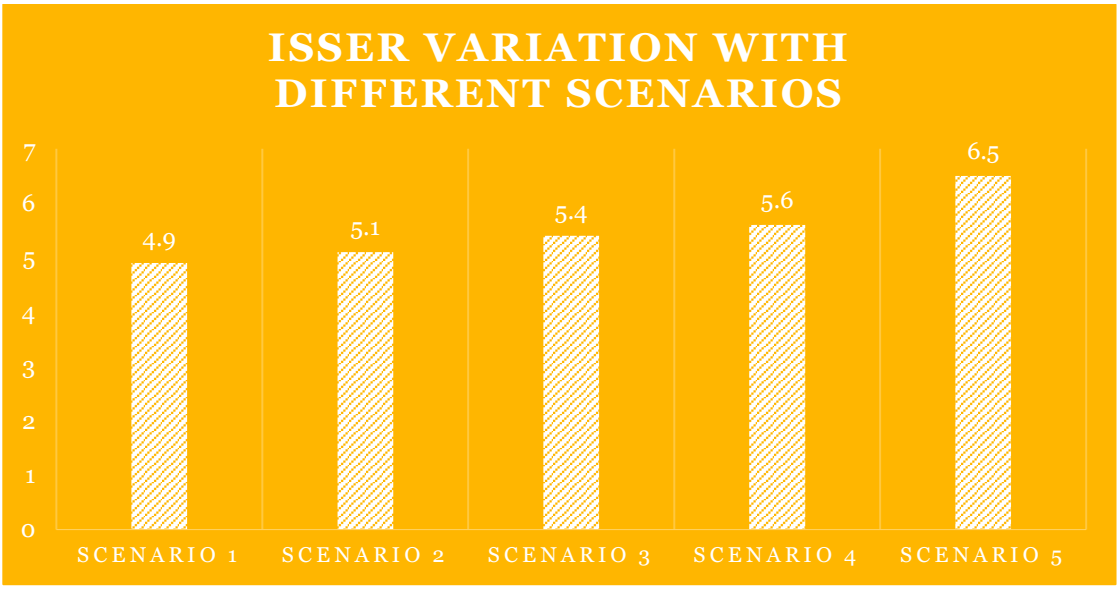
The LBNL paper further discussed indicative cost of super-efficient air conditioners with different combinations.

2.1.3. Oak Ridge National Laboratory (ORNL), Design/Simulation model to establish the benchmark ISEER values

ORNL, a U.S. national research laboratory does lot of design and simulation work in cooling technologies. ORNL team was consulted to arrive at various efficiency options and their feasibility for super-efficient RACs. ORNL team developed five simulation models to assess impact of component/design change on efficiency of RAC and considered the following five scenarios:



Based on different scenarios, ISEER values were calculated and is presented below

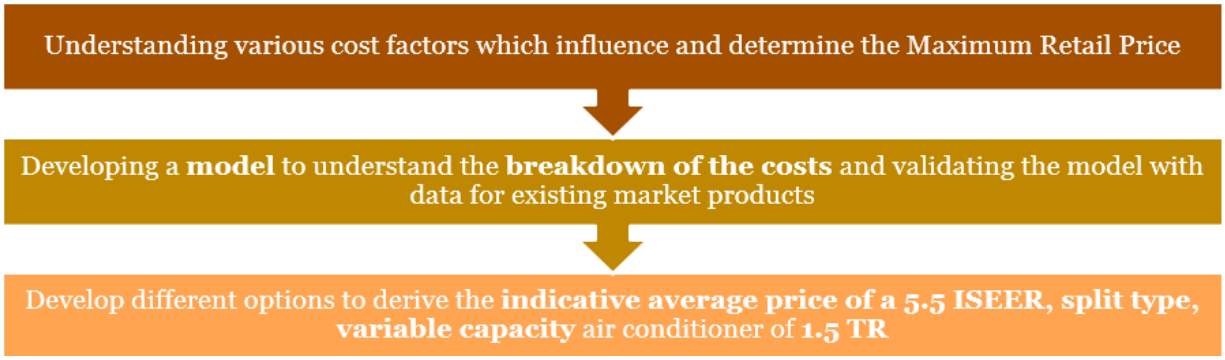


ORNL concluded that an ISEER of 6.5 is a challenging goal. Although, based on engineering optimized iSEER 6.5 is achievable but at an unrealistic and exorbitant expense. So the most viable ISEER for AC Challenge program could be 5.5.

From the above discussion it can be concluded that the ISEER value for AC Challenge program can be set at a minimum of 5.5 as it appears to be achievable and viable.

2.2. Estimating price of super energy-efficient RAC

To move forward with AC Challenge program, it is important to understand indicative market price of super-efficient RAC. Following approach was adopted to estimate the price of 5.5 ISEER super energy efficient RAC.

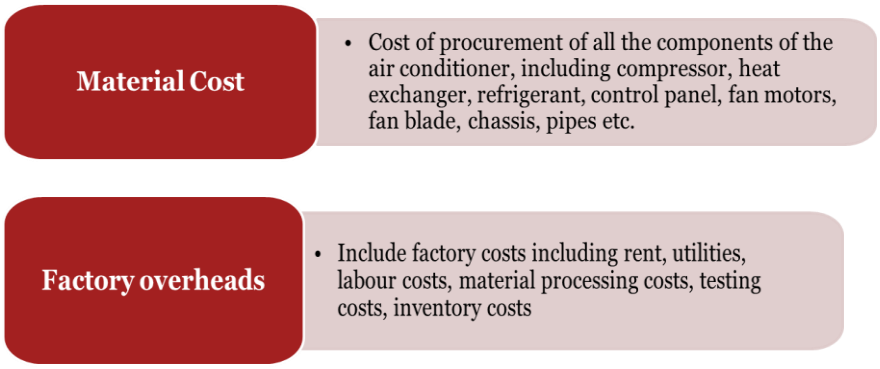


2.2.1. Understanding various cost factors influencing Maximum Retail Price of an air conditioner

The first step in determining the price was to recognize the factors which contribute to the cost of the product. PwC interacted with the manufactures to arrive at the cost and indicative cost percentages. The following cost factors determine the market price of an air conditioner

2.2.1.1. Factory costs

The "Factory costs" comprises of material cost, factory overheads, inventory cost. Material costs includes cost of procurement of all the components of the air conditioner, including compressor, heat exchanger, refrigerant, control panel, fan motors, fan blade, chassis, pipes etc. Factory overheads include factory costs including rent, utilities, labor costs, material processing costs, testing costs, inventory costs. In addition, an Excise duty is levied before the finished product leaves the factory premises.

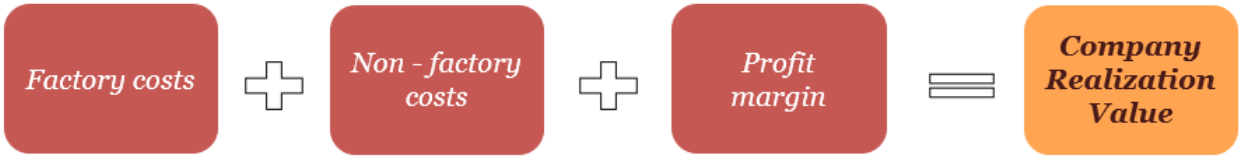


2.2.1.2. Transfer of the product from factory to the distribution unit of the company

At this stage, "Non-factory costs" and "product profit margin" are added to the existing costs. The non-factory costs, generally, are company costs incurred not for a particular product, but for the entire product portfolio of the firm. The price at which the product is transferred from factory to the distribution unit of the company is called the "Factory Transfer Price". Distribution unit receives the product from the factory at the factory transfer price and adds a set of "non-factory costs" to the existing price. Following are the different types of non-factory components which get added to factory transfer price:

- Warranty - Warranty includes replacement of product or components within the warranty period, which generally is one year
- Logistics - Costs incurred in transporting the product from the "Company" to dealers/distributors
- Warehousing - Costs incurred in storage of products in warehouses. This also includes inventory cost of the finished goods kept in warehouses
- Company Overheads - Include cost incurred of corporate offices in the form of rent, utilities, salaries etc.
- Warranty Services - Cost component to cover the services that the "company" provides by hiring a "warranty services provider/agency". These services are normally provided for one year
- Marketing and Advertising - Component to cover the costs incurred in marketing and advertising of the products.
- Research and Development - Cost incurred in Research & Development for the product development
- Royalty Cost - Royalty costs added to cover royalty charges for use of patented technologies/products etc.
- Product Profit Margin – It is profit that "company" makes on each unit sold in the market

All the costs added in this stage leads to a Company realization value.



2.2.1.3. *Sale of the product by the company to the consumer via distribution channels*

Once the company realization value for air conditioner is calculated, taxes are levied and added to the costs. The product has to go through distribution channels (dealers, retailers etc.) before reaching to the consumer. Distribution channel profit margins are further added to the costs. Companies give discounts on MRP (Maximum Retail Price) for certain products. Discounts are also considered as a cost while determining the final MRP of the product. After adding all these cost components, final price for AC is determined. Following is a summary of all types of costs considered while determining the price of an air conditioner:

Cost Component/ Price	Remarks
Material cost	Factory costs
Factory overheads	
Factory transfer price	Transfer price from factory to distribution unit of company
Warranty (components)	Non-factory costs
Logistics	
Warehousing	
Company overheads	
Warranty services	
Royalty	
Research & Development	
Marketing & Advertising	
Profit margin	Profit that company makes on each unit
Company realization	Amount company makes on the sale of each unit
Excise duty	Tax on production of goods
Value added tax (VAT)	Tax at each stage of value addition in supply chain
Profit margin for dealer	Profit that dealer makes on sale of each unit
Market operating price (MOP)	Price at which product is sold in the market
Discount to consumer	Discount on the Maximum Retail Price
Maximum Retail Price (MRP)	Maximum price that can be charged for the sale

2.2.2. Developing a model to understand the breakdown of various RAC costs

After analyzing all the cost component for an air conditioner, relative contribution of these components were assessed and analyzed in consultation with RAC manufactures. For assessing the cost structure of the product along with the cost weights, PwC developed a model called, "Price of Air Conditioner (PAC)" model. In this model, the material cost is assumed to be INR 100. All other costs are calculated relative to material cost as per cost construct discussed in 2.2.1. The table 4 describes the PAC model with the percent contributions of the various costs to establish the market price of a RAC.

Table 4: Cost components and their percent contribution

Cost component	Contribution in %	Value (in INR)
Material cost		**100**
Factory overheads	15%	15
Factory transfer price		**115**
Warranty (components)	4%	8
Logistics	3%	8
Warehousing	3%	6
Company overheads	10%	19
Warranty services	4%	8
Royalty, Inventory provision	3%	6
Research & Development	3%	6
Marketing & Advertising	5%	10
Profit margin	4%	8
Company realization		**192**
% of MRP on which Excise is charged	65%	
Excise duty	12%	23
Value added tax (VAT)	14%	30
Price to dealer		**245**
Profit margin for dealer	15%	37
Market operating price		**282**
Discount to consumer	5%	15
Maximum Retail Price (MRP)		**296**

The following observations are made about the cost structure of an air conditioner:

- Material cost = 34% of MRP
- Factory Transfer Price = 39% of MRP
- Company Realization Value = 65% of MRP
- Price to Dealer = 83% of MRP
- Market Operating Price = 95% of MRP

The PAC model was further validated on the basis of prevalent cost of RACs in the market. Average price for 3 star fixed, 5 star fixed and 5 star variable capacity products sold in the market currently, was used to calculate the corresponding material costs using the PAC model and also the calculated cost were compared with the cost established for the incremental cost analysis conducted by PwC-CLASP-LBNL[1]. These steps are discussed below:

[1] http://clasp.ngo/Resources/Resources/PublicationLibrary/2016/India-AC-Cost-Benefit-report

1. Estimation of average MRP for 3 star fixed, 5 star fixed and 5 star variable capacity split air conditioners *(Source: MRP listed on company websites)*. Most selling brands of RACs were considered. The average market prices of different star levels and types of RACs are presented in the table below considered for further analysis:

Table 5: Average MRP of RACs in India

Sr. No.	Star Rating Category	Average EER value (W/W)	Average ISEER value (Wh/Wh)	Average MRP (INR)
1	3 star fixed capacity	3.2	NA	38712
2	5 star fixed capacity	3.6	NA	45327
	5 star variable capacity	N.A.	4.5	56127

2. From the average market price, material cost of the three type of products was arrived at by using the PAC model

3. The material cost obtained through PAC model was compared with the cost arrived at in the supply chain analysis done by PwC-CLASP-LBNL as presented in Table 6 below:

Table 6: Difference between the material cost as per BEE-Clasp-PwC study and the material cost calculated by the PAC model

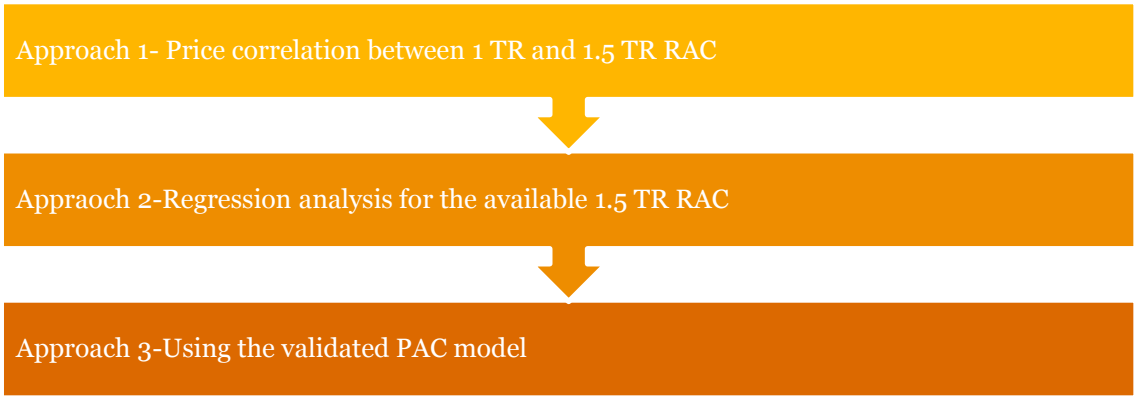
Sr. No.	Star Rating Category	Material costs as per PAC model (INR)	Material costs as per *BEE-CLASP-PwC* study (INR)	Variation in material costs (%)
1	3 star fixed capacity	13278	13328	1%
2	5 star fixed capacity	15547	14520	7%
3	5 star variable capacity	19252	19630	-2%

There were minor variations in the costs arrived through the various methods but not significantly different. This established that the construction of the PAC model is acceptable to arrive at an estimated cost of super-efficient RAC for the purpose of this study.

The PAC model is therefore used for determining the prices of super-efficient ACs to arrive at estimated fund required to implement the AC Challenge program.

2.2.3. Derivation of the price of 5.5 ISEER RAC

Assuming that the target ISEER for AC Challenge program is 5.5 for 1.5 TR capacity, it was important to establish a ball park price for this super-efficient RAC as there was no relevant market data available. Three different approaches were used to determine the price of the super-energy efficient RAC as described below:



A brief summary of the approach used is presented below and the detail presentation on each approach is given in **Annexure C.**

2.2.3.1. Approach 1- price correlation between 1 TR and 1.5 TR RAC

In this approach, the cost of 1.5 TR RAC of 5.5 ISEER efficiency was established based on the MRP relation between 1 TR and 1.5 TR RACs. The steps conducted to establish the cost is presented below:

Step 1- MRP of 1 TR RAC Vis a Vis ISEER levels

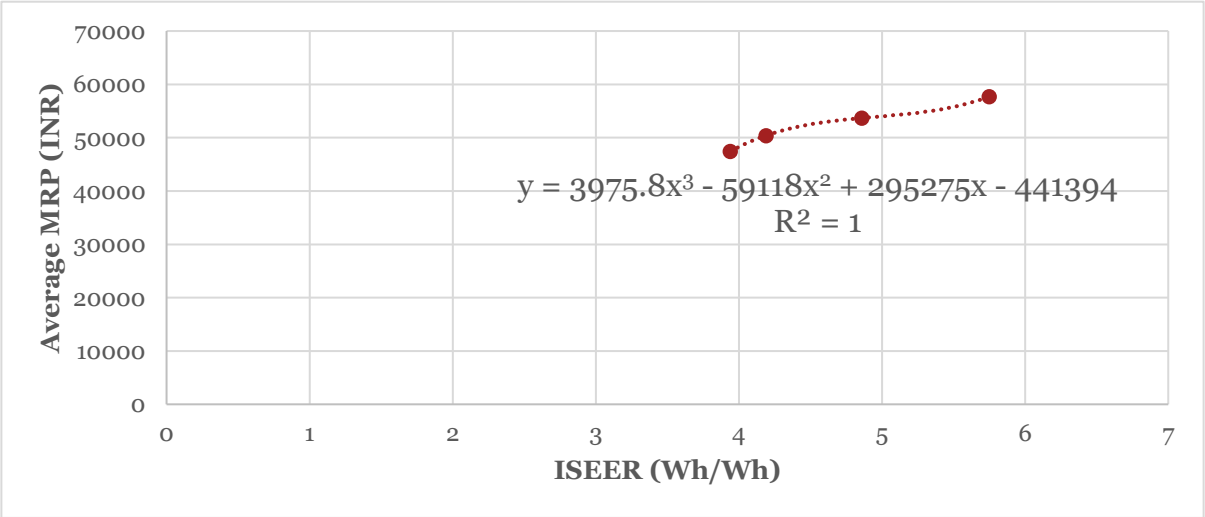
Data on average MRP of 1 TR RAC for various ISEER levels is collected from the manufacturer as shown below in table 7.

Table 7: MRP of 1 TR RAC of different ISEER values

ISEER value of 1 TR machine	Average MRP* (INR)
3.94	47440
4.19	50390
4.86	53690
5.75	57690

Step 2-Regression analysis to arrive at the cost of 1 TR with 5.5 ISEER efficiency

A regression analysis was carried out as presented below in the figure to arrive at an approximate cost of 1 TR with 5.5 ISEER. ***The estimated cost of 1 TR 5.5 ISEER RAC is INR 55773.***



Step 3: Maximum Retail Price (MRP) correlation between 1 TR and 1.5 TR RACs

The correlation between the MRP of 1 TR and 1.5 TR products was established based on the MRPs for different star rated products as presented below in the table 8. The price multiple for all the star rating categories varies between 1.10 – 1.12.

Table 8: Price multiple between the MRP of 1 TR and 1.5 TR fixed speed RAC

Sr. No.	Star Rating Category for variable speed ACs	Average MRP of 1 TR model (INR) with ISEER value	Average MRP of 1.5 TR model (INR) with ISEER value	Price multiple factor
1	3 star	47440 (3.9)	53423 (3.9)	1.12
2	4 star	50390 (4.2)	55790 (4.2)	1.10
3	5 star	53690 (4.8)	60190 (4.7)	1.12

Taking the estimated price of 1 TR RAC of 5,5 ISEER arrived at by the regression analysis above and using 1.2 as price multiple factor, the MRP of 1.5 TR RAC of 5.5 ISEER has been calculated as shown in Table 9 below

Table 9: Price estimation for super energy efficient RAC using price multiples

Sr. No.	Specification	Value
1	Average price multiple for existing products	1.12
2	Assumed price multiple for SE product	1.2
3	MRP estimate for 1 TR, 5.5 ISEER product (Using regression equation) in INR	55773
4	Estimated MRP of 1.5 TR, 5.5 ISEER product in INR	66927

The estimated MRP of 1.5 TR with 5.5 ISEER efficiency is INR 66927.

2.2.3.2. *Approach 2- regression analysis for the available 1.5 TR RAC*

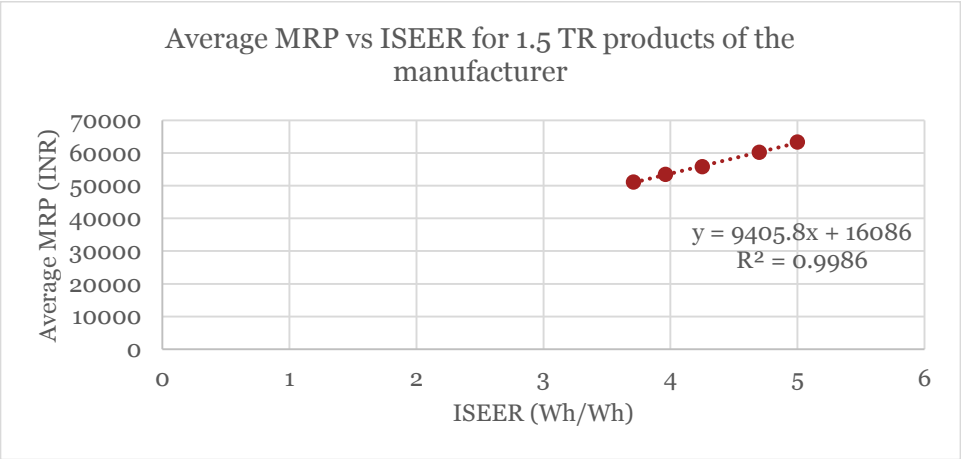
In this approach we have established the cost of 1.5 TR RAC of 5.5 ISEER efficiency by conducting a regression analysis for 1.5 TR based on the average MRP data provided by the manufacturer for various ISEER values. Average MRP data for various ISEER value RACs available in market is shown in Table 10.

Table 10: Variation of MRP with ISEER for 1.5 TR variable speed RAC

Sr. No.	*ISEER value*	*Average MRPs (INR)*
1	3.71	50982
2	3.8	51828
3	3.9	52769
4	3.96	53333
5	4	53709
6	4.25	56061

Sr. No.	ISEER value	Average MRPs (INR)
7	4.5	58412
8	4.7	60293
9	5	63115
10	5.1	64056
11	5.2	64996

RACs of maximum 5.2 ISEER are available in the market. The cost of 1.5 TR with 5.5 ISEER was established using the equation developed through regression analysis.



The estimated cost of 1.5 TR 5.5 ISEER RAC is INR 67818.

2.2.3.3. *Approach 3-Using the validated PAC model*

Using the material cost from the supply chain study of PwC-CLASP-LBNL and applying it in the PAC model explained earlier, the price of 1.5 TR 5.5ISEER RAC was calculated as presented below in the table 11.

Table 11: Variation in the cost of RACs using the PAC model

Cost component	Contribution	Value for 3 star fixed (INR)	Value for 5 star fixed (INR)	Value for 5 star variable (INR)	Value for 5.5 ISEER (in INR)
Material cost		13278	**15547**	**19252**	**26370**
Factory overheads	15%	1992	2332	2888	3956
Factory transfer price		15270	17879	22139	30326
Warranty (components)	4%	1001	1172	1452	1989
Logistics	4%	1001	1172	1452	1989
Warehousing	3%	751	879	1089	1491
Company overheads	10%	2503	2931	3629	4971
Warranty services	4%	1001	1172	1452	1989
Royalty, Inventory provision	3%	751	879	1089	1491
Research & Development	3%	751	879	1089	1491

Cost component	*Contribution*	*Value for 3 star fixed (INR)*	*Value for 5 star fixed (INR)*	*Value for 5 star variable (INR)*	*Value for 5.5 ISEER (in INR)*
Marketing & Advertising	4%	1001	1172	1452	1989
Profit margin	4%	1001	1172	1452	1989
Company realization		25033	29310	36294	49714
Abatement on excise	65%				
Excise duty	12%	3020	3536	4378	5997
Value added tax (VAT)	14%	3927	4598	5694	7799
Dealer price		31979	37444	46366	63510
Profit margin for dealer	15%	4797	5617	6955	9527
Market operating price		36776	43061	53321	73037
Discount to consumer	5%	1936	2266	2806	3844
Maximum Retail Price (MRP)		38712	**45327**	**56127**	**76881**

As can be observed from the above table, the model considers a fixed percentage for all cost components, resulting in ***increase in all the costs as we increase the efficiency***. However, stakeholder interactions reveal that, all the cost components do not vary with a change in the efficiency of the air conditioner. Some costs ***depend on overall company product portfolio/ company revenue or sales.***

It can be concluded that costs associated with material, warranty on components or services, factory overheads vary as the efficiency of AC changes while the cost of logistics, warehousing, company overheads, marketing and advertising, royalty etc. could be fixed costs and do not vary with efficiency improvements.

Costs that vary with efficiency	Material costs
	Warranty on components
	Warranty services
	Factory overheads (if capital investment is made to set up new lines)
	Research & Development (if high R&D costs go additionally into developing the product)
Costs that don't vary with efficiency	Logistics
	Warehousing
	Company overheads
	Marketing & Advertising
	Royalty (unless there are additional royalty costs for patented technology/components)

Making an adjustment for the fixed costs (in italics), the cost of 5.5 ISEER RAC is reworked to arrive at a more realistic estimate as shown in table 12 below:

Table 12: Cost of super energy efficient RAC

Cost component	Contribution for 5 star variable capacity	Value for 5 star variable Capacity (INR)	Contribution for 5.5 ISEER, variable capacity product	Value for 5.5 ISEER product (INR)
Material cost		19252		26370
Factory overheads	15%	2888	15%	3956
Factory transfer price		**22139**		**30326**
Warranty (components)	4%	1452	4%	1824
Logistics	4%	1452	3%	1452
Warehousing	3%	1089	2%	1089
Company overheads	10%	3629	8%	3629
Warranty services	4%	1452	4%	1824
Royalty, Inventory provision	3%	1089	2%	1089
Research & Development	3%	1089	2%	1089
Marketing & Advertising	4%	1452	3%	1452
Profit margin	4%	1452	4%	1824
Company realization		**36294**		**45596**
Abatement on excise	65%		65%	
Excise duty	12%	4378	12%	5500
Value added tax (VAT)	14%	5694	14%	6128
Dealer price		**46366**		**58250**
Profit margin for dealer	15%	6955	15%	8737
Market operating price		**53321**		**66987**
Discount to consumer	5%	2806	5%	3526
Maximum Retail Price (MRP)		**56127**		**70513**

The indicative price for 5.5 ISEER RAC as per PAC model comes out to be INR 70513.

2.2.4. Summary of the three price estimation approaches

The summary of the MRP calculated for 1.5 TR with 5.5 ISEER value is shown in table 13 below. The price estimation provided by the PAC model is compared to the regression analysis method used in approach 1 and 2. While approach 1 and 2 are comparable, the MRP estimated using PAC model is higher by about 5%. It can be construed that the PAC model is a reliable basis for estimating the price of the 1.5 TR with 5.5 ISEER RAC.

Table 13: Variation in the price of super energy efficient RAC estimated through various approaches

Sr. No.	Price estimation method	Description	Estimated price (INR)	Deviation in MRP w.r.t MRP calculated using PAC model
1	Market price correlations	Using price multiplier for 1.5 TR w.r.t. 1 TR product	66927	4.9%
2		Using regression model to extrapolate price for 1.5 TR products	67818	4%
3	Price modelling	Using the validated PAC model	70513	

For the purpose of subsequent discussion, the price of 1.5 TR with 5.5 ISEER RAC is taken is INR 70513.

2.3. Second stakeholder workshop

A stakeholder workshop was organized on 1st March 2016 to share and discuss the issues around incremental cost analysis as well as possible options for implementing the AC Challenge program. The discussions at the workshop focused on, supply chain analysis, incremental cost analysis for various energy efficiency improvement options, ISEER value for the challenge, industry challenges for manufacturing a super-efficient AC and incentives programs for manufactures and consumers. All the stakeholders agreed with the project results and agreed to move forward with an ISEER challenge of 5.5 and above. The workshop details are given in **Annexure D**.

3. Options for Implementation of AC Challenge Program

In order to increase the market transformation and penetration of super-efficient air conditioners in India, a menu of options to incentivize the manufacturers and consumers are discussed in this section. These incentive options could be monetary or non-monetary in nature and target different stakeholders in the RAC value chain. The plausible monetary and non-monetary options discussed here are presented below

Monetary incentives

Component suppliers	Manufacturers	Distribution channel and retailers	Consumers
• Cash incentives to SE component manufacturer • Tax rebates (Customs, excise duties) for raw material or components	• Cash incentives to SE AC manufacturers • Tax rebates (VAT, excise duties) • Grants for R&D	• Cash incentives on sale of SE products	• Cash back, coupons on purchase of SE products • Buy back schemes

Non-monetary incentives

Component suppliers	Manufacturers	Distribution channel and retailers	Consumers
• Technical assistance and support for commercialization of SE components	• Advance procurement commitments • Technical assistance and support for commercialization • Awards and recognition	• Awareness and training for promotion of SE products and consumer interaction, maintenance and installation	• Awareness generation • Tax benefit on the price difference between baseline product (3/5 star fixed capacity) and 5.5 ISEER

Based on discussions at the stakeholder workshop, two key options that emerged to be most viable for ease of implementation were **Bulk procurement and Cash based incentives** to manufacturers and/or consumers. These two options are discussed in details in the next section.

Bulk procurement	• Demand aggregation model giving advance procurement commitments to manufacturers
Incentives	• Incentive on price difference between company realisation value or on maximum retail price of super energy efficient RAC and 5 star fixed speed/inverter speed RAC • Tax rebates

3.1.1. Bulk procurement

This option works on the principle of demand aggregation for procurement of large quantities of super energy efficient RACs to get the benefit of price reduction. The benefit of lower cost is passed on to the consumer. This is a similar approach to the demand aggregation model adopted by EESL for creating and transforming the market for LEDs in India.

The price reduction could happen due to following reasons:

- Procurement of Super energy efficient RACs directly from the manufactures reduces the channel cost from 5% to15% and eliminates the additional cost (5%) kept by retailer as discount to customer on MRP.
- Competitive bidding on large number of super energy efficient RACs will bring out the best technology with a very competitive price.

The comparison of cost of super energy efficient RAC with and without bulk procurement model presented in table 14 below:

Table 14: Cost Comparison of Super energy efficient RAC with and without bulk procurement option

	Without bulk procurement		**With bulk procurement**	
Cost component	**Contribution**	**Value (in INR)**	**Contribution**	**Value (in INR)**
Material cost		**26370**		**26370**
Factory overheads	15%	3956	13%	3428
Factory transfer price		**30326**		**29798**
Warranty (components)	4%	1824	6%	2384
Logistics	3%	1452	2%	795
Warehousing	2%	1089	1%	397
Company overheads	8%	3629	8%	3178
Warranty services	4%	1824	3%	1192
Royalty, Inventory provision	2%	1089	2%	795
Research & Development	2%	1089	2%	795
Marketing & Advertising	3%	1452	0%	0
Profit margin	4%	1824	1%	397
Company realization		**45596**		**39731**
% of MRP on which Excise is charged	65%		65%	
Excise duty	12%	5500	12%	4092
Value added tax (VAT)	14%	6128	14%	6128
Dealer price		**58250**		**49957**
Profit margin for dealer	15%	8737	5%	2498
Market operating price		**66987**		**52455**
Discount to consumer	5%	3526	0%	0
PMC cost	0%		15%	7868
MRP		**70513**		**60324**

As seen from the table 17 above, with bulk procurement, there exist a possibility of reducing the retail price of super energy efficient RAC from INR 70513 to at least INR 60324.

The price reduction through competitive bidding has a huge possibility for further reduction in price which cannot be estimated at this stage as it is completely unknown and is total dependent on manufacturer's strategy and other factors.

3.1.1.1. *Additional options with bulk procurement*

Combination of bulk procurement with other price reducing options like buy back of old RACs, tax rebates were also evaluated using the PAC model. The summary of the analysis is presented below:

Table 15: Bulk procurement analysis with normal tax (VAT and excise duty)

Bulk procurement with other price reducing options	Consumer Payback w.r.t 3 star fixed capacity (years)	Consumer Payback w.r.t 5 star fixed capacity (years)	Indicative Market Price (INR)
Retail market sale (No incentive)-Base case	5.1	5.6	70,513
Case 1-Base case+ Advance procurement	3.4	3.3	60,324
Case 2-Base case+ Advance procurement+ buy back	3.0	2.7	57,324
Case 3-Base case+ Advance procurement+tax rebate	1.5	0.6	47,975
Case 4-Base case+ tax rebate+ Advance procurement+ buy back	1.0	0	44,975

Table 16: Bulk procurement analysis with GST

Incentive Option with GST	Consumer Payback w.r.t 3 star fixed capacity (years)	Consumer Payback w.r.t 5 star fixed capacity (years)	Indicative Market Price (INR)
Retail market sale (No incentive)-Base case	5.1	5.6	70,513
Case 1-Base case +GST	4.7	5.2	65,131
Case 2-Base case+ GST+ Advance procurement	3.3	3.3	56,610
Case 3-Base case+ GST+ Advance procurement+buy back	2.8	2.6	53,610
Case 4-Base case+ GST rebate+ Advance procurement	1.9	1.4	47,975
Case 5-Base case+ GST rebate+ Advance procurement+ buy back	1.5	0.7	44,975

It can be seen from the table 15 and 16 above:

- Analysis with normal tax- It is possible to reduce the MRP of super energy efficient RAC with an option of bulk procurement with buy back and tax rebates to INR 44975 from the base indicative MRP (INR 70513) of super energy efficient RAC.
- Analysis with GST tax- It is possible to reduce the MRP of super energy efficient RAC with an option of bulk procurement with buy back and tax rebates to INR 44975 from the base indicative MRP (INR 70513) of super energy efficient RAC.

It is evident from above analysis that cost of super-efficient RACs can be reduced by adopting number of options along with advance procurement commitments.

The detailed analysis is given in **Annexure E**.

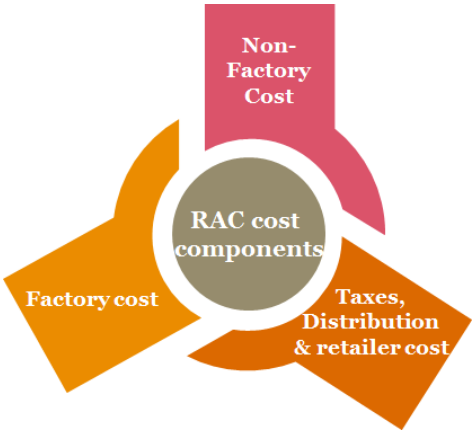
3.1.2. Incentive option

3.1.2.1. Why do we need incentive?

Financial incentive acts as a motivation for customers to buy a particular product. This motivation can be provided to customers in the form of lower cost without compromising with quality of the product. While delivering incentive in form of lower cost of product, price of the product is decreased to an extent which is beneficial for buyer and seller. Customer tries to get the product at the minimum price possible whereas seller is trying to recover its cost with some profit margin over it.

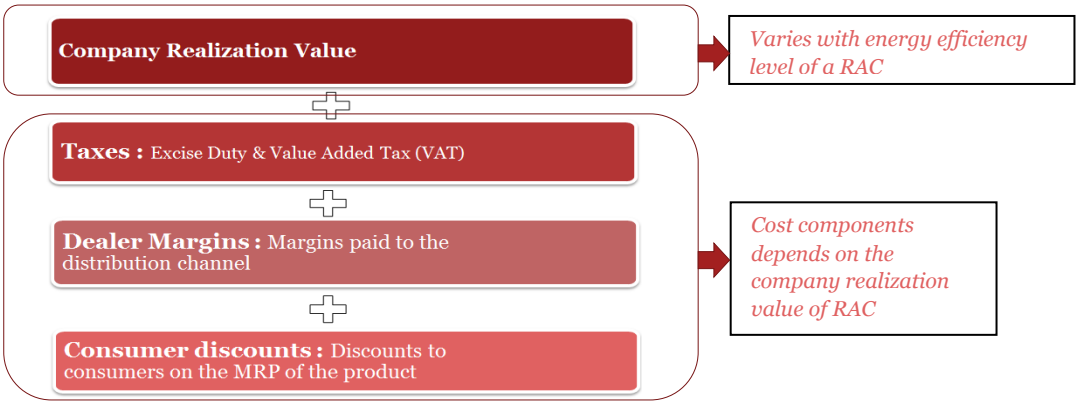
3.1.2.2. Cost component of a Room Air Conditioner (RAC)

The cost of a RAC comprises of three major components presented schematically below and as discussed in detail in Section 2.2.1 of this report



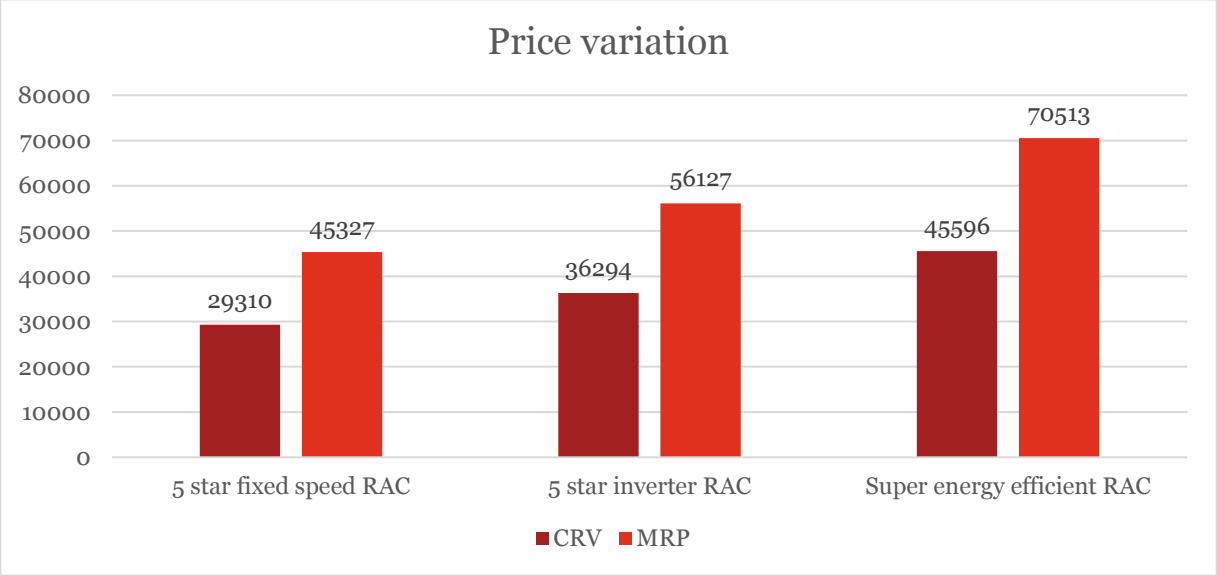
3.1.2.3. Impact on cost of an air conditioner with energy efficiency levels

The company realization value (factory and non-factory cost) varies with the energy efficiency levels of an air conditioner. The government taxes and distribution cost are calculated as the percentage of company realization value and doesn't play a direct role in the Market Retail Price (MRP) of an air conditioner as shown below in the figure:



The company realization value (CRV) and average MRP for various types of 5 star fixed speed and inverter AC, has been calculated based on the market/technical data for different capacity RACs. These details are

presented in **Annexure_ "Incentive 1"**. The CRV and MRP for super energy efficient RAC has been calculated using the PAC model. The brief summary analysis is presented graphically below

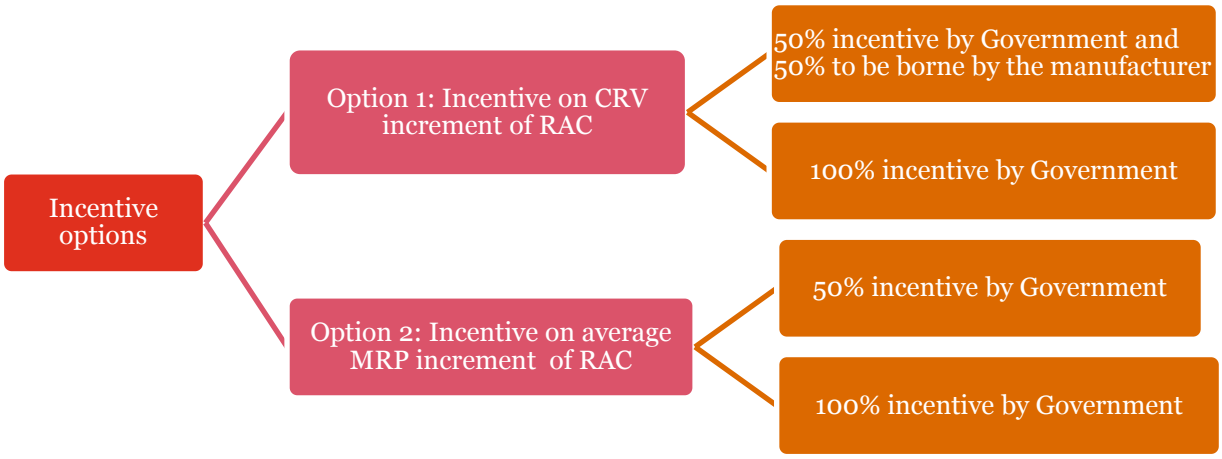


The figure shows that the company realization value increases with the increase in energy efficiency levels mainly due to an increase in the cost of components. As the Maximum retail price (MRP) is a function of CRV, so an increase in CRV results in a corresponding increase in MRP.

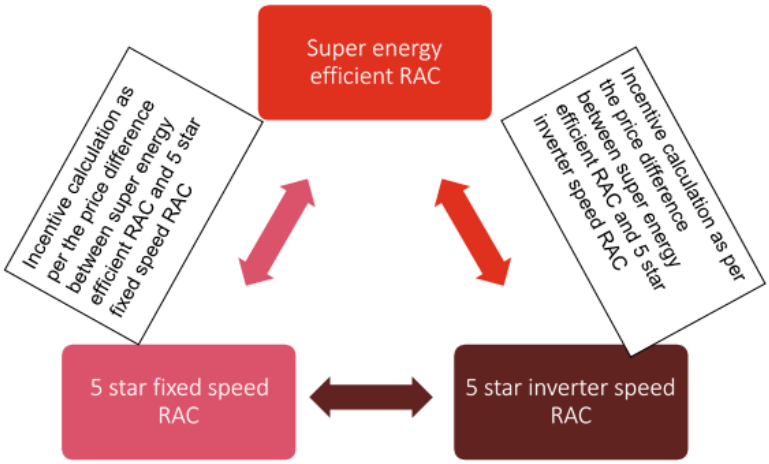
One of the ways to reduce the incremental cost of super-efficient RACs is through incentives. A few options for incentives are discussed below:

3.1.2.4. Options for Incentives and net cost to Government/Manufacturers

Different options have been considered for incentivizing super-efficient RACs as presented schematically below:



For each of the options, incentive has been calculated for super energy efficient RAC with base as 5 star fixed speed RAC and 5 star inverter speed RAC respectively.



a. Option 1: Incentive on CRV

i. Incentive for super energy efficient AC taking the base price of 5 star fixed speed AC

The incentive mechanism can have two different scenarios

- **Scenario 1- 50% of price difference in company realization value to be provided by the Government and 50% to be borne by the manufacturer**

In this case, 50% of price difference in company realization value between 5 star fixed speed AC and super energy efficient RAC comes out to be INR 8143 per RAC. It is proposed that this amount be provided by the government as incentive to manufacturer and the remaining 50% (INR 8143) will be borne by the manufacturer.

- Incentive to be provided by the government INR 8143
- Cost to be borne by the manufacturer INR 8143

- **Scenario 2: 100% of price difference in company realization value to be provided by the Government**

In this case, 100% of price difference (INR 16286) in company realization value between 5 star fixed speed AC and super energy efficient RAC will be provided by the Government.

- Incentive to be provided by the government INR 16286

Impact on net cost to Government:

Assuming the cost for 0.1 million RACs, the total incentive and the net savings to government are presented in the table 17 below.

Table 17: Net savings to government- Incentive for super energy efficient AC taking the base price of 5 star fixed speed RAC

Description	With no incentive	With 50% incentive	With 100% incentive
Incentive to be given by the Government per unit of RAC	0	8143	16286
Number of ACs (0.1 million)	100000	100000	100000
Total Incentive to be given by the Government (INR crores)	0	81	163

Description	With no incentive	With 50% incentive	With 100% incentive
Avoided Peak generation capacity (MW)	64	64	64
Cost avoided for power generation (INR crores)	384	384	384
Net savings to government (INR crores)	384	303	221

Additional burden on the manufacturer:

Manufacture will bear the burden of providing 50% incentive i.e., INR 8143 for every unit of super energy efficient AC. This will amount to INR 81 crores for 0.1 million number of RAC.

Cost to consumer

The cost to customer for super energy efficient RAC will be the same as that of 5 star fixed speed AC.

Risk:

In this option, we have not factored any potential impact of taxes on MRP of the AC or on that of the components.

ii. Incentive for super energy efficient AC taking the base price of 5 star variable speed RAC

The incentive mechanism can have two different scenarios

- **Scenario 1-50% of price difference in company realization value to be provided by the Government and 50% to be borne by the manufacturer**

In this case, 50% of price difference in company realization value between 5 star inverter speed RAC and super energy efficient RAC comes out to be INR 4651 per RAC. It is proposed that this amount be provided by the government as incentive to manufacturer and the remaining 50% (INR 4651) will be borne by the manufacturer.

  - Incentive to be provided by the government INR 4651
  - Cost to be borne by the manufacturer INR 4651

- **Scenario 2-100% of price difference in company realization value to be provided by the Government**

In this case, 100% of price difference (INR 9302) in company realization value between 5 star inverter speed RAC and super energy efficient RAC will be provided by the Government.

  - Incentive to be provided by the government INR 9302

Impact on net cost to Government:

Assuming a cost for one lakh ACs, the total incentive and the net savings to government are presented in the table 18 below.

Table 18: Net savings to government- Incentive for super energy efficient AC taking the base price of 5 star variable speed RAC

Description	With no incentive	With 50% incentive	With 100% incentive
Incentive to be given by the Government (INR)	0	4651	9302
Number of ACs (0.1 million)	100000	100000	100000

Total Incentive to be given by the Government (in INR crores)	0	47	93
Avoided Peak generation capacity (MW)	44	44	44
Cost avoided for power generation (INR crores)	264	264	264
Net savings to government (INR crores)	264	218	171

Additional burden on the manufacturer:

Manufacture will bear the burden of providing 50% incentive i.e., INR 4651 for every unit of super energy efficient AC. This will amount to INR 47 crores for 0.1 million number of RAC.

Cost to consumer

MRP to customer for super energy efficient RAC is considered same as that of 5 star inverter speed RAC.

Risk:

In this option, we have not factored any potential impact of taxes on MRP of the AC or on that of the components.

b. Option 2: Incentive on MRP

i. Incentive option for super energy efficient AC taking the base price of 5 star fixed speed AC

The incentive mechanism can have two different scenario as follows:

- **Scenario 1-50% of price difference in Maximum retail price (MRP) to be provided by the Government**

In this case, 50% of price difference (INR 12593) in MRP between average MRP of 5 star fixed speed AC and MRP of super energy efficient RAC will be provided by the Government. The impact on the MRP cost of super energy efficient RAC is explained below:

- Indicative MRP of super energy efficient RAC INR 70513
- Indicative Incentive to be provided by the government INR 12593
- Revised Indicative MRP of super-efficient RAC if there is no commitment from manufacturers **INR 57920**

- **Scenario 2-100% of price difference in Maximum retail price (MRP) to be provided by the Government**

In this case, 100% of price difference (INR 25186) in MRP between average MRP of 5 star fixed speed AC and super energy efficient RAC (lowest cost bid by the manufacturer) will be provided by the Government. The impact on the MRP cost of super energy efficient RAC is explained below:

- Indicative MRP of super energy efficient RAC INR 70513
- Incentive to be provided by the government INR 25186

Impact of incentive on payback period and net savings to Government

Impact on payback period is shown in table 19 below:

Table 19: Impact on payback period with 5 star fixed speed RAC as base

	Cost of 5 star fixed speed RAC (INR)	Cost of super energy efficient RAC (INR)	Cost increment per RAC (INR)	Monetary savings (INR/yr) per AC	Payback period (yrs.)
With no incentive	45327	70513	25186	4,512	5.6
With 50% incentive	45327	57920	12593	4,512	2.8
With 100% incentive	45327	45327	0	4,512	0.0

Impact on net cost to Government:

Assuming a cost for one lakh ACs, the total incentive and the net savings to government are presented in the table 20 below.

Table 20: Net savings to government- Incentive for super energy efficient AC taking the base price of 5 star fixed speed RAC

Description	With no incentive	With 50% incentive	With 100% incentive
Incentive to be given by the Government	0	12593	25186
Number of ACs (0.1 million)	100000	100000	100000
Total Incentive to be given by the Government (INR crores)	0	126	252
Avoided Peak generation capacity (MW)	64	64	64
Cost avoided for power generation (INR crores)	384	384	384
Net savings to government (INR crores)	384	258	132

Cost to consumer

With 50% incentive by the Government on the difference of the MRP of super energy efficient RAC and 5 star fixed speed RAC, to the cost to the customer for super energy efficient RAC will be INR 57920, which is INR 12593 more than the cost of 5 star fixed speed AC.

ii. Incentive for super energy efficient AC taking the base price of 5 star inverter speed AC

The incentive mechanism can have two different scenario as follows.

- **Scenario 1 -50% of price difference in average Maximum retail price (MRP) to be provided by the Government**

In this case, 50% of price difference (INR 7193) in average MRP between 5 star inverter speed AC and super energy efficient RAC (lowest cost bid by the manufacturer) will be provided by the Government. The impact on the MRP cost of super energy efficient RAC is explained below:

- Indicative MRP of super energy efficient RAC INR 70513
- Incentive to be provided by the government INR 7193
- Revised calculated MRP of super energy efficient RAC INR 63320

- **Scenario 2 Case 2-100% of price difference in Maximum retail price (MRP) to be provided by the Government**

In this case, 100% of price difference (INR 9302) in average MRP between 5 star inverter speed AC and super energy efficient RAC (lowest cost bid by the manufacturer) will be provided by the Government. The impact on the MRP cost of super energy efficient RAC is explained below:

- Calculated MRP of super energy efficient RAC INR 70513
- Incentive to be provided by the government INR 14386
- Revised calculated MRP of super energy efficient RAC INR 56127

Impact of incentive on payback period and net savings to Government

Impact on payback period is shown in the table 21 below:

Table 21: Impact on payback period with 5 star inverter speed RAC as base

	Cost of a 5 star inverter speed RAC (INR)	Cost of super energy efficient RAC (INR)	Cost increment per RAC (INR)	Monetary savings (INR/yr) per AC	Payback period (yrs.)
With no incentive	56127	70513	14386	2,361	6.1
With 50% incentive	56127	63320	7193	2,361	3.0
With 100% incentive	56127	56127	0	2,361	0.0

Impact on net cost to Government:

Assuming a cost for one lakh ACs, the total incentive and the net savings to government are presented in the table 22 below:

Table 22: Net savings to government- Incentive for super energy efficient AC taking the base price of 5 star inverter speed RAC

Description	With no incentive	With 50% incentive	With 100% incentive
Incentive to be given by the Government (INR)	0	7193	14386
Number of ACs (0.1 million)	100000	100000	100000
Total Incentive to be given by the Government (in INR crores)	0	72	144
Avoided Peak generation capacity (MW)	44	44	44
Cost avoided for power generation (INR crores)	264	264	264
Net savings to government (INR crores)	264	192	120

Cost to consumer

With 50% incentive by the government on the difference of the MRP of super energy efficient RAC and 5 star inverter speed RAC, cost to consumer for super energy efficient RAC will be INR 63320 which is INR 7193 more than the cost of 5 star inverter speed RAC.

A summary of various incentive options and net saving to the Govt. is given below in table 23-

Table 23: Summary of various incentive options and net saving to the Government

	Incentive to be provided by the government/manufacturer	Incentive per unit of RAC	Total incentive cost for 0.1 million RACs	Total savings to the government	Net savings to the government	Additional cost to the manufacturer	Revised MRP of super-efficient RACs	Avg MRP of 5-star fixed-/variable-speed RACs	Payback period
Units		**INR**	**Crore INR**	**Crore INR**	**Crore INR**	**Crore INR**	**INR**	**INR**	**In years**
	Option 1: Incentive on CRV to be borne by the government and manufacturer								
	Scenario 1: Incentive for super energy efficient ACs taking the base price of 5-star fixed-speed ACs								
50% incentive by Govt	Govt	8,143	81	384	303	NA	45,327	45,327	0
	Manf	8,143	81	NA	NA	81			
100% incentive by Govt	Govt	16,286	163	384	221	NA	45,327	45,327	0
	Manf	0	0		NA	NA			
	Scenario 2: Incentive for super energy efficient ACs taking the base price of 5-star variable speed ACs								
50% incentive by Govt	Govt	4,651	47	264	218	NA	56,127	56,127	0
	Manf	4,651	47	NA	NA	47			
100% incentive by Govt	Govt	9,302	93	264	171	NA	56,127	56,127	0
	Manf	0	0	NA	NA	NA			
	Option 2: Incentive on MRP to be borne by the Govt								
	Scenario 1: Incentive for super energy efficient ACs taking the base price of 5-star fixed-speed ACs								
50% incentive by Govt	Govt	12,593	126	384	258	NA	57,920	45,327	2.8
	Manf	0	0	NA	NA	NA			
100% incentive by Govt	Govt	25,186	252	384	132	NA	45,327	45,327	0
	Manf	0	0	NA	NA	NA			
	Scenario 2- Incentive for super energy efficient AC taking the base price of 5 star variable speed AC								
50% incentive by Govt	Govt	7,193	72	264	192	NA	63,320	56,127	3
	Manf	0	0	NA	NA	NA			
100% incentive by Govt	Govt	14,386	144	264	120	NA	56,127	56,127	0
	Manf	0	0	NA	NA	NA			

4. Rules for the AC challenge program

This section discusses the proposed rules for the implementation of the AC Challenge program. The rules have been framed for both the Bulk procurement option and the incentive based option for implementation. The framework of the rules includes:

- Program scope
- Key stakeholders Who Should Apply
- Business models/mechanism for the program
- Overall program structure for Bulk procurement and Incentive Model
- Program duration
- How to participate in the program
- Technical specification for super energy efficient AC
- Selection of manufactures
- Monitoring and Verification
- Incentive Disbursal
- Action for non-compliance

4.1.1. Program scope

The program scope covers **RACs (window or fixed speed or variable speed split AC)** with capacity of 1.5 TR and above. The targeted numbers of super energy efficient RAC of ISEER 5.5 or above to be covered under this program is 0.1 million for a period of at least 2 years (number of units and period will be the discretion of the implementing agency).

4.1.2. Key stakeholders of the program

The key stakeholders of the program are:

- Administrator- The organization/body responsible for management, operation and implementation of the program- Bureau of Energy Efficiency or any other agencies authorized by GoI/MoP/BEE
- Bidder- Manufacturer who shall participate in the program

4.1.3. Who can participate

AC manufactures with company incorporated under companies Act 1956 and manufacturing ACs in India as per Indian factory Act, 1948 can participate in the program (collectively the manufacturer and any other nominating party are hereby referred to as “bidders”).

4.1.4. General Requirements and Technical specification

Products eligible for the program shall meet the following minimum requirements as presented in the table 24 below.

Table 24: General requirements and Technical specifications for super energy efficient RAC

S.No.	Description	Requirement
General requirements from the Manufacturer		
1	Bidder should be a company incorporated under companies Act, 1956	Certificate of Incorporation issued under Indian Companies Act, 1956 from Registrar of Companies
2	Bidder should be a manufacturer of Room Air conditioner in India	The Bidder should submit an Excise registration documents to support that they are manufacturers of Room Air Conditioners in India. The bidder should be registered under Indian Factories Act, 1948 or certificate of incorporation or SSI certificate. The products may be manufactured in India or imported.
3	Manufacturing set up in India	Location and in-house production capacity
4	Bidder should have registration with BEE star labelling program for air conditioners	The bidder shall furnish details of models of approved BEE star labelled RACs.
5	Bidder should have an experience of manufacturing and supply of at least 0.1 million RACs in India	Documentary proof to show sales number-
6	Profitable business and Income tax returns certificate of last three years	CA certified
7	Certificate of Net worth (5 Cr) in the immediate proceeding financial year	CA certified
Technical specifications of super energy efficient AC[2]		
1	Minimum Indian Seasonal Energy Efficiency Ratio (ISEER)	5.5 and above
2	Rated power factor	Should be greater than 0.85
3	Rated voltage	Single phase up to 250 V
4	Rated Frequency	50 Hz or variable frequency drive with maximum frequency up to 50 Hz
5	Maximum Cooling Capacity	Measurement of capacity test allowing some maximum tolerance on the declared or measured capacity which can be not less than 90 percent of the measured/declared capacity
6	Super energy efficient RAC specification certificate	Third Party NABL accredited Lab testing certificate
Warranty		
7	Warranty period	Minimum 2 years pan India[3]
Health and Environment		
8	Use of Refrigerant	Refrigerant with Ozone Depletion Potential (ODP) and lower Global Warming Potential

[2] The various standards to be followed based on the "Schedule 19-Variable Capacity Air Conditioners" and "Schedule 3(A) - Room air conditioners" for testing of super energy efficient AC is presented below.

Cooling output	IS 1391 Part I and II
Cooling Seasonal Energy Consumption (CSEC)	Clause No. 6.7.4 of ISO 16358-1:2013
Maximum operating condition test	IS 1391 Part 1 & Part 2
Power factor test	Clause 10.3 of IS 1391 Part 1 and as per Clause 9.3 of IS 1391 Part 2.
Indian Seasonal Energy Efficiency Ratio (ISEER)	Clause 6.1 and clause 6.7 of ISO 16358 – 1:2013

[3] In case of distributor, the distributor shall be wholly and fully responsible for the manufacturer's warranty in respect of quality of all material

S.No.	Description	Requirement
		(GWP) levels as specified in relevant Indian standard (or as per Montreal Protocol requirements)
Other Requirements		Test certificates for cooling capacity, cooling seasonal energy consumption (CSEC), maximum operating conditions, power factor test, ISEER as per the test standards defined in AC schedule 3 A and 19 or the latest schedule for RACs The test reports should be from a NABL accredited test laboratory. The test reports should be recent not older than three months.

4.1.5. Selection of bidders

4.1.5.1. Prescreening

The administrator shall constitute a panel of experts. The "Expert Panel" shall pre-screen all the bidders for the relevant documents listed in table 23.

4.1.5.2. Selection of bidders

The selection of bidders may be done with two set of approaches:

4.1.5.2.1. *Approach 1- based on the quoted price of RACs*

This approach will focus on selection based only on the financial quote given by the individual bidders. Bid with the lowest price (L-1) shall be awarded with 50% of the total quantity of RACs to be procured under the program. The L-2 and L-3 bidders shall be asked to match the lowest price (L-1) and shall be awarded with 30% and 20% of the total quantity respectively.

4.1.5.2.2. *Approach 2- Technical and financial evaluation*

In this approach, combined evaluation (technical and financial) shall be used to identify the winner. The weightage for technical and financial evaluations shall be 40% and 60% respectively.

Technical score (P_T)

The maximum marks that can be awarded are 40 and the points allotted for the various criteria are explained and presented in the table below.

a) Improvement over 5.5 ISEER

This criterion is targeted at motivating manufacturers to move beyond 5.5 ISEER. Every 2% improvement over 5.5 ISEER shall fetch additional 3 points up to a maximum of 15 points by achieving 10% improvement over 5.5 ISEER.

ISEER	Marks
5.5	0
5.61	3
5.72	6
5.83	9

5.94	12
6.05 & above	15

b) Extended warranty period-

This is intended to motivate/reward manufacturers who provide extended warranty

Warranty required	Marks
2 years	0
3 years	4
4 years	8
5 years	12

c) Promoting manufacturing in India

Super energy efficient ACs manufactured in India shall be given 5 points to support 'Make in India 'campaign, whereas RACs imported shall not be awarded with any point.

Manufactured in India (Make in India)	
Products manufactured in India	6
Products imported to India	No additional marks

d) **Promoting lower Global Warming Potential Refrigerants**

This program intends to promote use of low GWP Refrigerants. Manufacturers using lowest GWP refrigerants shall be awarded maximum of 4 points. Others shall be awarded points on pro-rata basis.

Refrigerants with lower Global Warming Potential	
Products with lowest GWP	5
Products with high GWP refrigerants	On prorate basis

Scoring criteria:

P = 4* Co/C, with

P = attributed Final point (points),
C = bidder's GWP,
Co = lowest GWP

e) **Promoting Demand Response ready products**

This program intends to promote demand response ready RACs. Manufacturers using demand response features shall be awarded maximum of 2 points. Others shall not be awarded any points.

RACs with Demand response features	
Products with Demand response	2
Products without demand response	0

Financial evaluation score (P_F):

The maximum marks that can be awarded are 60 and the financial score shall be calculated based on the following

$P_F = 60 * Co/C$, with

P_F = attributed score for the Financial Proposal (points),
C = bidder's Financial Proposal,

Co = lowest Financial Proposal
The total score of the bidder is $P = P_F + P_T$.

The bidder with the maximum combined score shall be declared as the winner.

The winner with highest marks (H-1) shall be awarded with 50% of the total quantity of air conditioners to be considered under the program. The H-2 and H-3 bidders shall be awarded with 30% and 20% of the total quantity respectively.

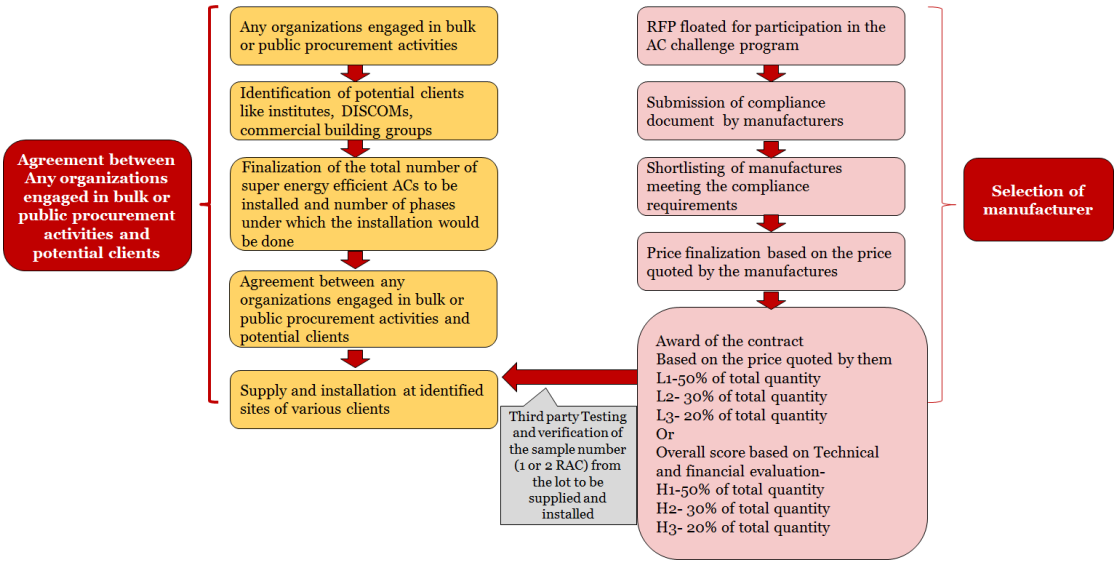
The Administrator reserves the right to adjust, strike, or redefine any of the programs terms and conditions at any time and for any reason. Should no manufacturer satisfy the program requirements, the Administrator reserves the right to not name a winner.

4.1.6. Methodology for bulk procurement

Under this option, bulk procurement volumes are assured to manufacturers. Any organization engaged in bulk or public procurement activities may procure the super-energy efficient RACs in an aggregated manner and distribute to the consumers at a rate which is comparatively lower than the market price.

The organization shall identify potential clients where super energy efficient RAC would be supplied and installed. The total number of RACs to be installed and phases of installation shall be defined in consultation with clients. An agreement shall be made between procurement agencies and potential clients regarding the supply and installation at pre-identified sites of the client. The installation shall be done by the bidder under the direct supervision of the administrator.

The overall program structure for AC challenge program with bulk procurement model is presented below



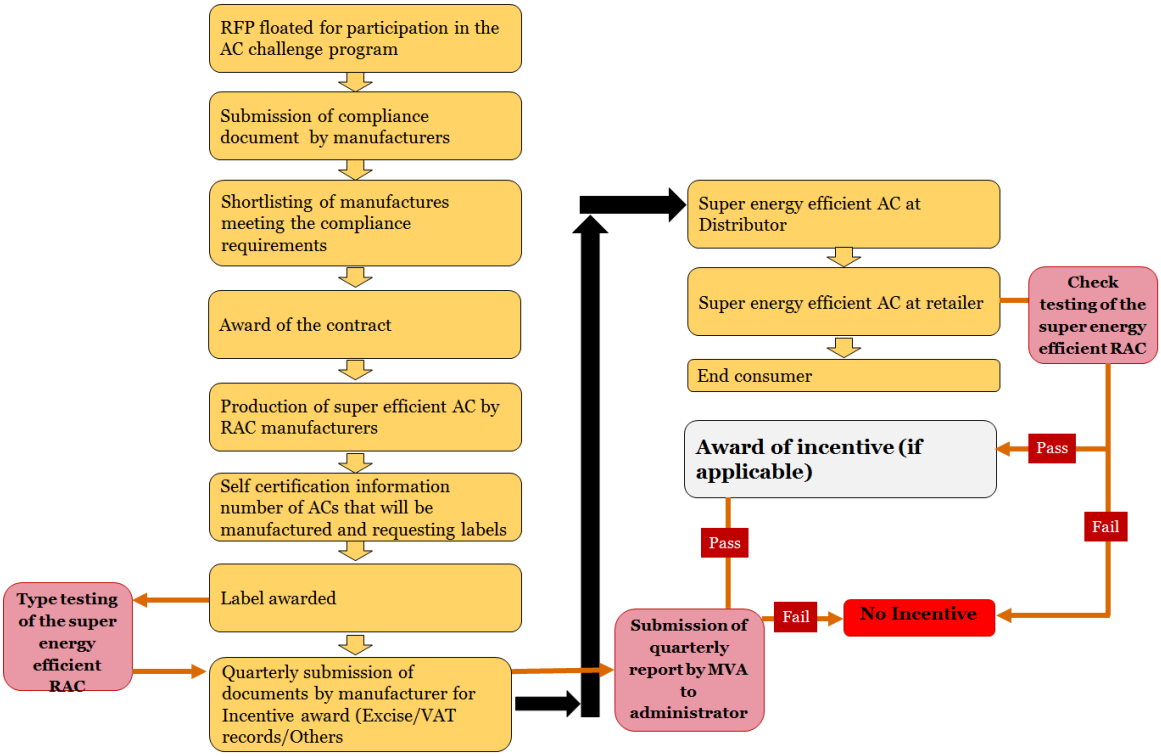
L1, L2, L3- The manufactures with lowest financial bid
H1, H2, H3- The manufactures with highest combined technical and financial score

4.1.7. Methodology for Incentive based model

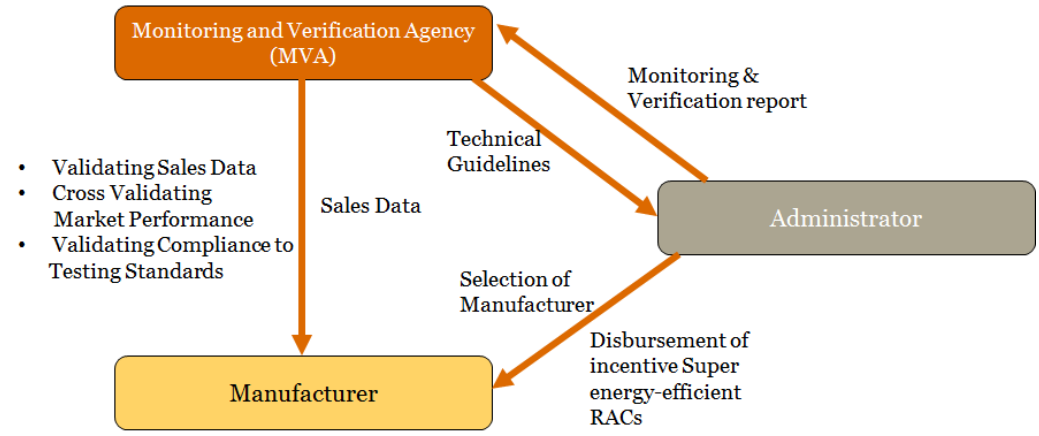
In this model, incentive on the difference between the company realization value or maximum retail price of the super-energy efficient RAC and 5 star fixed/inverter speed RAC shall be given by the government. The incentive provided by the government could be 50% or 100% of the difference between the costs.

1. Although we have attempted to establish average MRP of 5 star fixed speed as well as 5 star inverter RAC and indicative price of super-efficient RAC, it is important to discover actual price to decide the fund required to give incentives to the manufacturer and/or consumer.

The overall program structure is shown in the figure below:



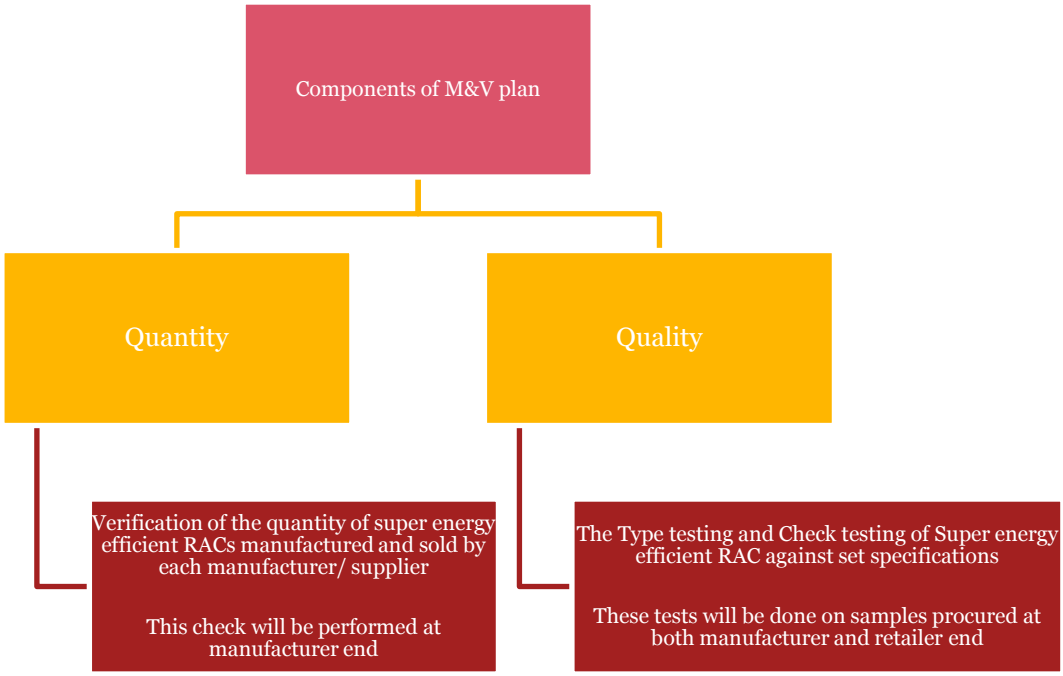
4.1.7.1. Framework for implementation of program



The Administrator may appoint Monitoring and Verification Agency (M&V Agency or MVA) for validation of sales and quality of super energy-efficient RAC.

4.1.7.2. *Monitoring and Verification Framework*

The overall approach of the M&V framework include specified Quantity and Quality checks as depicted below.



4.1.7.2.1. *Quantity Check*

The quantity check will be in the form of quarterly verification of Excise and VAT records of the manufacturer on sale of super energy efficient RAC. The Manufacturer will provide access to the MVA to access to this activity with the following documents

- Daily Stock Account
- Excise invoices
- GAR-7 challan
- Excise returns
- Invoices for sale
- Challan for tax payment
- C-Form
- VAT returns & Annexure

The quantity check performed by MVA will not be restricted to these documents. In case any other document is required for the purpose, the manufacturer will be obliged to provide the same to the MVA.

4.1.7.3. *Incentive Disbursal mechanism*

- Manufacturers may claim for their incentive for lots sold in every quarter.
- The incentive shall will be released once manufacturers comply with all the minimum as well as performance requirements.

4.1.7.3.1. *Performance Verification for both the options:*

The performance testing of super energy efficient RAC shall be contacted at the following stages of the program:

- Type approval sampling for testing – This shall be done after the award of the contract to the manufacturer. The manufacturer will inform the administrator about their production schedule. The administrator's representatives shall visit the manufacturing facility and select two samples for each model from the lot offered for inspection/testing by the bidder.
- Verification sampling for testing – This shall be performed at the warehouse/installation site where RACs have been provided by the manufacturer. The administrator's representative will visit the sites and select two samples randomly from the lot.

Type approval and the verification testing shall be done at NABL accredited empaneled laboratories as per the latest BEE's schedule for RACs. All expenses towards testing shall be borne by the Administrator.

Initially first sample of each RAC model shall be tested to check the compliance. The second sample shall be tested by the test laboratories in case:

- If the first sample is damaged, the second sample shall be used for verification testing;
- If the test results for the first sample fails to meet the compliance, the second of sample shall be tested in presence of manufacturer's representative, provided the ISEER demonstrated by the first sample is at least 95% of the manufacturer's claimed ISEER after taking into account any laboratory uncertainty. If second sample also fails the compliance criteria, it would be considered non-compliant Action against non-compliance

The manufacturer would be asked to replace the complete lot in case of two incidents of noncompliance.

If there are three or more than three incidents of noncompliance, the administrator may cancel the bulk procurement order to the concerned manufacturer.

4.1.7.4. Disqualification

Administrator may in its sole discretion disqualify any bidder that fails to comply with the any requirements or contractual obligations.