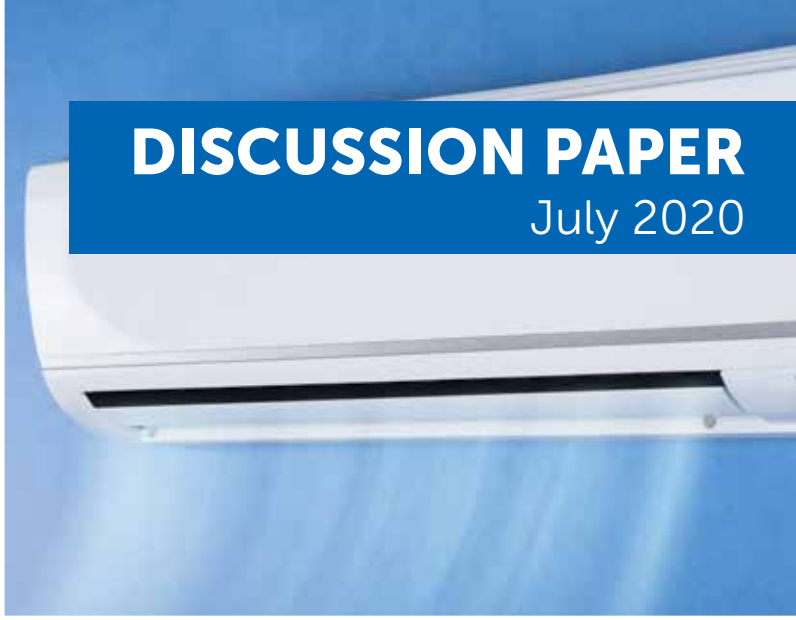

DISCUSSION PAPER
July 2020

Analysing the Barriers to Promote Energy Efficient Air-Conditioners in India

MacArthur Foundation

teri
The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

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ABBREVIATIONS

AC	Air-conditioner
AHP	Analytic hierarchy process
BEE	Bureau of Energy Efficiency
EER	Energy efficiency ratio
GWP	Global warming potential
ICAP	India Cooling Action Plan
MCDM	Multi-criteria decision making
RAC	Room Air Conditioner
S&L	Standards and Labelling
TERI	The Energy and Resources Institute

Background

India has been experiencing a high rate of urbanization from past few years and it is expected to have a population of over 876 million (over 52%) living in cities by 2050 [1]. The GDP of India is growing at a rapid rate and elevating millions of people out of the poverty every year. Owing to the heat island effect in cities and accelerated changes in climate which are triggering extremes of temperatures in many regions across India, people are turning to Refrigeration & Air-conditioning (R&AC) practice for better thermal comfort. The cooling sector in general is cross sectoral involving representation from a wide range of areas including space cooling, food security, transportation, technology, skill development and environment. The current penetration of Air-conditioners in India is merely between 7-9% which is very low [2]. Understanding the scope and unprecedented growth of cooling sector, the Government of India released a strategic document 'India Cooling Action Plan (ICAP)' in March 2019, explicating India's vision in reducing the refrigeration and its associated energy, emissions demands, along with building capacities of R&AC service technicians over the next 20 years. The India Cooling Action Plan (ICAP) projects the growth of operating Room Air-Conditioners (R&AC) from 39 million in 2017 to 350-400 millions in 2037-38. The energy consumption by Air-Conditioners has a major chuck in the monthly household electricity bills. In the past years the spike in the peak power demand in major cities during the summers had been due to increase penetration of air-conditioners usage. The energy efficiency practice can play a significant role in bring down this increasing power consumption and peak power demand caused by cooling load. The government through Bureau of Energy Efficiency (BEE), launched 'Standards and Labelling (S&L)' programme in May, 2006, promoting the star labelled appliances since last decade to bring about a change in the consumer's behavior on energy efficiency. The initiative currently provides ranking to 26 appliances (from 1 star to 5 star) based on its energy performance (energy efficiency, usage and energy cost). The room air-conditioners is one of the major power consuming appliance in Indian households is mandated with star labelling practices in the initial phase of S&L programmes. Minimum energy performance standards have been upgraded regularly with the average 3% energy efficiency ratio (EER) improvement annually. However, 3 star labelled products has major share in total annual production, since the inception of the program. The market share for the BEE 5-star labelled energy efficient ACs has been lower in the past years and had fluctuated around 20%[3]. A sharp increase in the share of 5-star ACs can produce many benefits such as minimal power consumption for operation, lower peak power demand, and lower GHG emissions. Regardless of numerous efforts in the form of capacity building & outreach exercises and regular communication the share of 5-star ACs to the total sales has been lower. The industry experts beliefs and secondary literature, foresees that there are critical intrinsic factors in the form of barriers attributing to poor uptake of higher order energy efficient ACs in the Indian market.

Objective

The paper aims to analyze the key barriers hindering the uptake of energy efficient 5-star air-conditioners in the country. The three key objective of the study are (i) to recognize the barriers; (ii) to estimate its potential; (iii) to prioritize the identified barriers impeding the effective adoption of 5-star ACs. The preliminary study begins with identification of certain barriers from the secondary literature and interactions with relevant industry experts. In the light of estimating and prioritizing the identified barriers, the study employs Analytic Hierarchy Process (AHP) method for determining the relative importance of barriers.

Methodology & approach

Despite the numerous tangible benefits in context to energy saving, cost benefits and low GWP emissions the uptake of energy efficient 5-star ACs are stalled because of intrinsic barriers. In order to understand the weights of each barrier impeding the best practices, a pairwise comparison and ratio scaling approach (Analytic Hierarchy Process) is applied. Figure 1 elaborates the layout of the methodology adopted for this study.

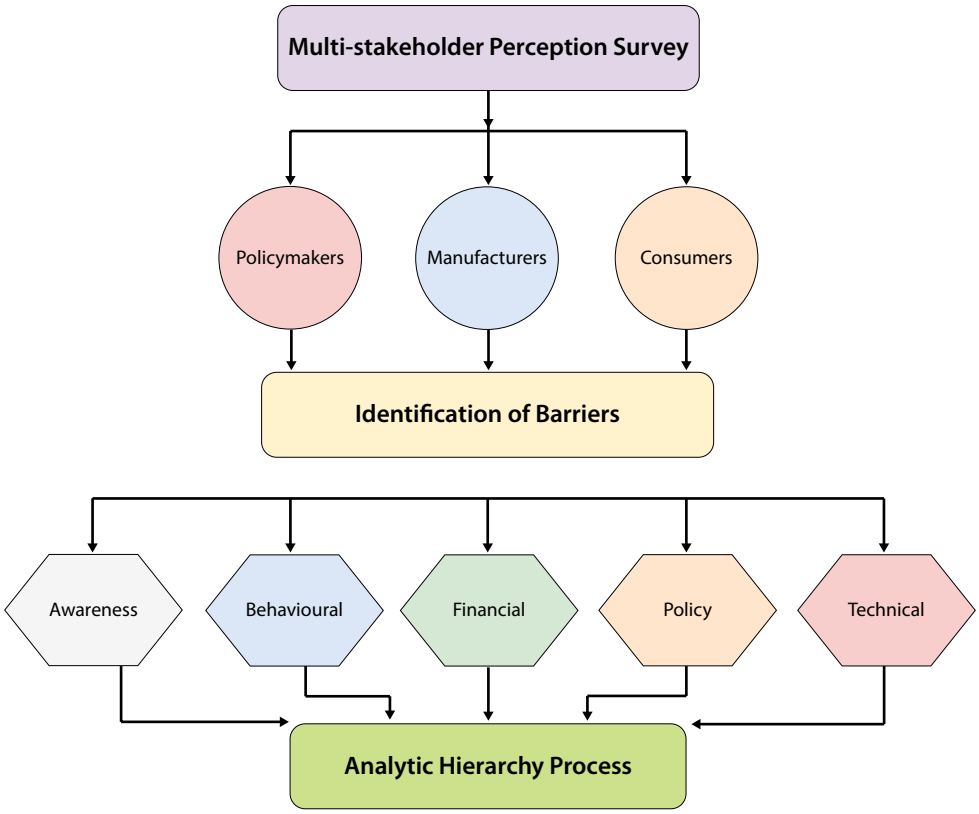

Figure 1: Methodology – schematic representation

i. Perception study & background research

The key data (see Figure 2) for the intended analysis study are sourced from TERI ongoing perception survey of cooling sector stakeholders. TERI has been involved in the conduction of national level perception survey of targeted cooling sector stakeholders, which intended to comprehend insights into the gaps between demand and supply, consumer preference, industry preference, perspective of policy makers and prevalent trends in the cooling sector. The research objectives for the perception study clearly set the intent and requirements of cooling sector for assessment of the needs and to take feedback from the different parties that impact the sector and all its components through a comprehensive multi-party stakeholder analysis. The perception study has been conducted through either survey of consumers and technicians, one to one interaction

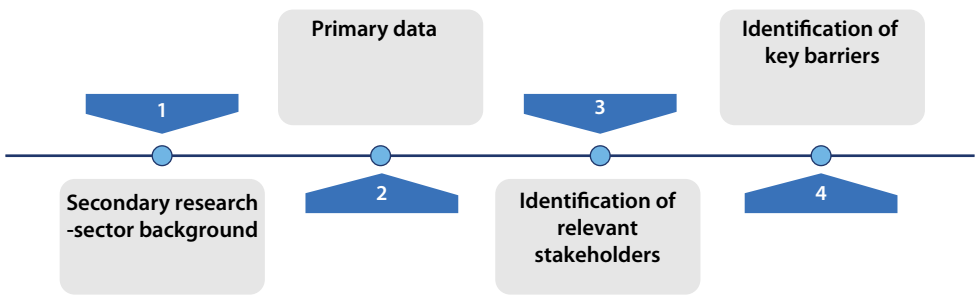

Figure 2: Primary data collation

with policy makers and manufacturers, focused group discussions with various other stakeholders based on the questionnaires. The pipeline study focuses on various front of cooling and intends to inform relevant players to achieve the sustainable cooling targets to facilitate the implementation of India Cooling Action Plan. One of the fragments of the study focused on the probes pertaining to barriers hindering the uptake of energy-efficient ACs in India.

ii. Barriers identification

As per the preliminary findings of the study, there are a various barriers hindering the uptake of energy efficient ACs in India. These barriers have been identified here through the secondary literature and rationalized through perception study with various stakeholders (see Figure 3) including the policymakers (both at center and

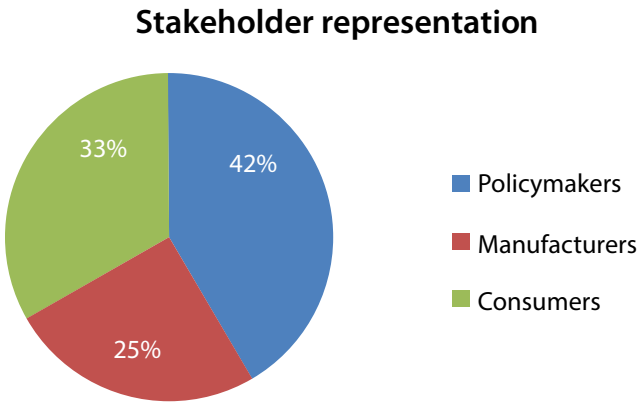

Figure 3: Stakeholder representation

state level), leading AC manufacturers and consumers at pan India level. These barriers were classified into five categories (explicated in Figure 1) namely: (i) technical; (ii) financial; (iii) behavioral; (iv) awareness; (v) policy. The brief descriptions of identified barriers are summarized below:

1. **Technical barrier** – The technical barrier includes unavailability of the highly energy efficient products in the market. The lower motivation to produce energy efficient products by the manufacturers hinders their availability in the market owing to very low demand for such products.
2. **Financial barrier** – The high upfront costs associated with highly energy efficient products at the time of introduction in the market proves to be a financial burden on the pocket of the consumers. The incremental improvements in efficiency accounts for the high investment requirements and the production associated expanses for the manufacturers which boils down to high costs for end users to balance the expenditure incurred.
3. **Behavioral barrier** – The consumers tends to have behavioral biases and try to maintain status quo. The sources of information for the consumers in making purchasing decision often mislead them because of the lack of clear understanding of the life cost implications and GHG emissions from the inefficient product.
4. **Awareness and Capacity barrier** – There is a large gap in the awareness levels about the benefits of energy efficiency among various stakeholders. The monetary and environmental benefits of the energy efficient products are unknown to most people. There is lack of knowledge about the impact of low energy consumption and low GHG emissions by the energy efficient products among the consumers.
5. **Policy barrier –** There are gaps between the policy at center and state level. The policies adopted at center level for energy efficiency take time for the states to adopt and notify. There are monitoring and verification gaps as well pertaining to the implementation of the policies at ground level.

iii. Model - Analytic Hierarchy Process

The Multi-Criteria Decision Making (MCDM) method is applied in solving the quandary scenario of qualitative and/or quantitative data. Among the various MCDM methods, Analytic Hierarchy Process (AHP) happens to be the most preferred method in deriving ratio scales from both discrete and continuous paired comparisons. The AHP [4] method was developed by T.L. Satty in early 1970s at Wharton School, University of Pennsylvania. The AHP is an effective tool for dealing with complex decision making, and may aid the decision maker to set priorities and make the best decision. By reducing complex decisions to a series of pairwise comparisons, and then

synthesizing the results, the AHP helps to capture both subjective and objective aspects of a decision. AHP supports the decision maker to solve the problem and rank the best alternative in-order to reach the best decision. In this study, AHP method is used to estimate and rank the key barriers weightage that are challenging the uptake of highly efficient ACs. The AHP analysis is built by going through the transcripts from the one to one interactions with the policymakers, consumers and the manufacturers. The findings from the survey of consumers were analyzed to pin down their perceptions about the barriers. Figure 4 explicates the steps involved with the conduction of AHP exercises for prioritizing the identified barriers. Step 1 to Step 3 involves the required data collation, decomposing the problem to hierarchical barrier categorization and questionnaire structuring. Step 4 involves the formulation of pairwise comparison matrix based on the inputs recorded from various stakeholder representation based on the nine point scale [4]. Step 5 computes criteria weights for each barrier based on the arrived point scale data from preceding step. The last two Steps 6 & 7 involves in calculating the consistency index and the verify the intended estimation results are acceptable and consistent.

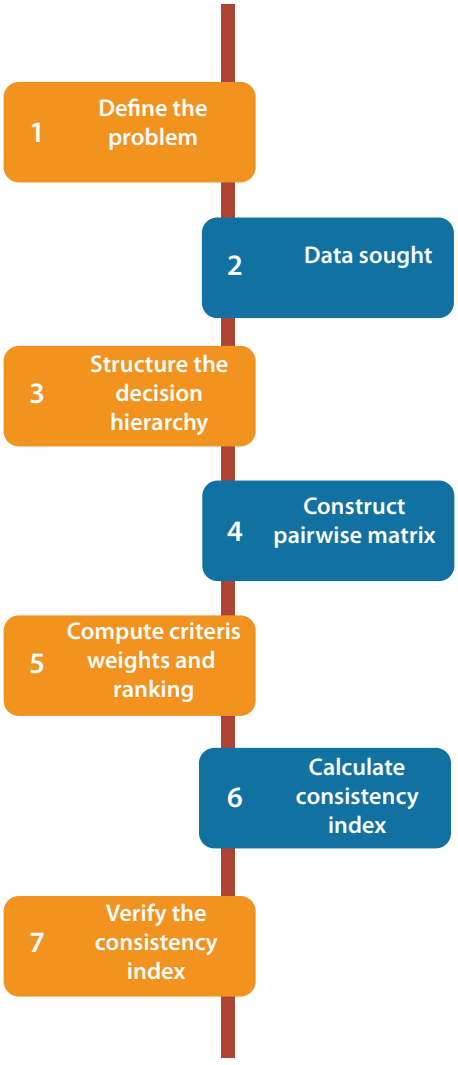

Figure 4: Steps in AHP

Discussion and Results

The weights of the barriers within each category in terms of the degree to which they hinder the uptake of 5-star energy efficient ACs were calculated and the barriers ranked based on the results. From the Table 1, the most prominent barrier that came out from this AHP analysis was financial barrier which accounts almost 40% of the total weight. The financial barrier was followed by behavioral, awareness, policy and technical of the total weight. Figure 5 elucidates the variation of the perception among various stakeholders about the most critical barrier for the uptake of energy-efficient ACs. Figure 5 also represents the average perception from all stakeholders on the raking of various barriers. *Table 1* below represents the ranking of barriers based upon the average percentage perception from various stakeholders. The top two barriers that are financial and behavioral (jointly account 60% of the total weight) are holding back the uptake of highly energy efficient 5-star ACs. The next barrier is the lack of awareness and capacity that is limiting the uptake and when combined with top two barriers, it accounts for over 80% of the weight. These three barriers call for the special attention for action to tackle the challenge of accelerating the uptake of energy efficient ACs.

The Indian air-conditioners stocks are anticipated to witness quadrupled growth [5] by 2027 with respect to 2017 levels. Deployment of energy efficient ACs based on low-GWP refrigerant could bring substantial emission reduction from the sector along with monetary savings for

Table 1: Ranking of barriers using AHP

Rank	Barriers	%
1 ★★★★★	Financial	36.3
2 ★★★★☆	Behavioral	24.3
3 ★★★☆☆	Awareness	23.6
4 ★★☆☆☆	Policy	8.0
5 ★☆☆☆☆	Technical	7.8

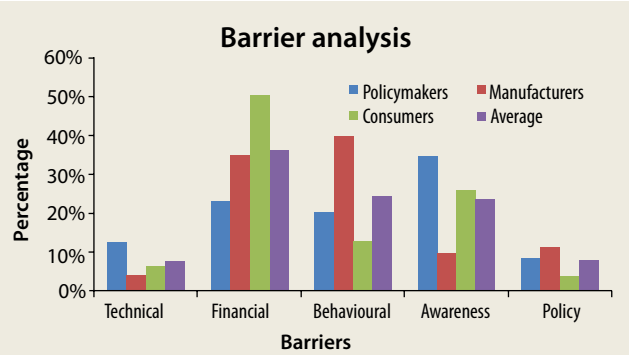

Figure 5: Barrier analysis

the consumer and overall maximize the climate benefit. The intended perception study trends suggests that better stakeholder outreach plays crucial role in achieving desired outcomes from any regulatory framework. Anticipating the massive air-conditioners usage in India, it is very important to look at the perspectives of various key stakeholders for the effective formularization of key policies promoting the high-energy efficient air-conditioners. It is vital to exercise an ideal analysis tool like AHP to analyze the various perceptions and choices recorded from relevant stakeholder representatives to compute a numerical representation from the qualitative data and supports in ranking the proposed parameters. The usage of these tools with an ideal mathematical analysis supports in designing effective regulatory, capacity, institutional and incentive instruments. The ranking of barriers helps the nodal organization to address the greatest obstacles affecting the uptake of 5-star ACs in India. The higher penetration of super energy efficient 5-star ACs helps in achieving lower electricity consumption, lower peak demand, reduced energy bills and lower carbon-footprints.

References

[1] United Nations Department of Economic and Soical Affairs, "World Urbanization Prospects 2018," Webpage, 2018. .

[2] "India Cooling Action Plan," New Delhi, 2019.

[3] M. Singh and G. Phore, "Accelerating the Uptake of Energy-Efficient Air Conditioners in India," New Delhi, 2020.

[4] R. W. Saaty, "The analytic hierarchy process-what it is and how it is used," Math. Model., vol. 9, no. 3–5, pp. 161–176, 1987, doi: 10.1016/0270-0255(87)90473-8.

[5] G. Kumar, S., Sachar, S., Kachhawa, S., Goenka, A., Kasamsetty, S., George, "Demand Analysis for Cooling by Sector in India in 2027," no. June, p. Alliance for an Energy Efficient Economy, 2018.

About TERI

The Energy and Resources Institute (TERI) is an independent, non-profit organization, with capabilities in research, policy, consultancy and implementation. TERI has multi-disciplinary expertise in the areas of energy, environment, climate change, resources, and sustainability.

With the vision of creating innovative solutions for a sustainable future, TERI's mission is to usher in transitions to a cleaner and more sustainable future through the conservation and efficient use of the Earth's resources and develop innovative ways of minimizing waste and reusing resources.

TERI's work across sectors is focused on:

- Promoting efficient use of resources across sectors
- Increasing access and uptake of sustainable practices
- Reducing the adverse impact on environment and climate

TERI works with a diverse range of stakeholders across governments, both at the national and state levels, international agencies, and civil society organizations to help deliver research-based transformative solutions. Headquartered in New Delhi, TERI has regional centres and campuses in Bengaluru, Gurugram, Guwahati, Mumbai, Nainital, and Panaji.

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- Climate
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- Habitat
- Health and Nutrition
- Resources

TERI brings out Discussion Papers on key contemporary issues in sectors such as energy, agriculture, water and environment with multi-disciplinary and multi-sectoral implications for use by policy makers, legislators, researchers and practitioners. This Poicy Brief has been brought out by the Earth Sciences and Climate Change Division as a part of TERI's work on refrigerant transition and cooling sector.

For more information, please visit: **http://www.teriin.org/**

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