SHEETAL
Alliance for Sustainable Habitat, Energy Efficiency and Thermal Comfort for All

Alliance for an Energy Efficient Economy™

Behaviour Change Communications for PROMOTING OPTIMUM AIR CONDITIONER SETPOINT TEMPERATURE SETTINGS

24°C

September 2022

Behaviour Change
Communications for

PROMOTING OPTIMUM AIR CONDITIONER SETPOINT TEMPERATURE SETTINGS

September 2022

Project: Alliance for Sustainable Habitat, Energy Efficiency and Thermal Comfort (SHEETAL)

The Alliance for Sustainable Habitat, Energy Efficiency and Thermal Comfort (SHEETAL) is a consortium of civil society organisations led by The Energy and Resource Institute (TERI), with the Alliance for an Energy Efficient Economy (AEEE) and the Council on Energy, Environment and Water (CEEW) as partners. Supported by Children's Investment Fund Foundation (CIFF), SHEETAL facilitates the rollout of India's sustainable cooling agenda enshrined in the India Cooling Action Plan.

Prepared by: Alliance for an Energy Efficient Economy

Alliance for an Energy Efficient Economy (AEEE) supports policy implementation and enables the energy efficiency market with a not-for-profit motive. AEEE promotes energy efficiency as a resource and collaborates with industry and government to transform the market for energy-efficient products and services, thereby contributing toward meeting India's goals on energy security, clean energy, and climate change. AEEE collaborates with diverse stakeholders such as policymakers, government officials, business and industry, consumers, researchers, and civil society organisations. We believe that our work speaks for itself and we hold Respect, Integrity, and Synergy as central to our efforts.

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Acronyms

°C	Degree Celsius
°F	Degree Fahrenheit
AC	Air Conditioner
ATC	Adaptive Thermal Comfort
COVID-19	2019 Coronavirus Disease
FGD	Focus Group Discussion
GHG	Greenhouse Gas Emission
HER	Home Energy Report
ICAP	India Cooling Action Plan
IDI	In-Depth Interview
IMAC	India Model for Adaptive Thermal Comfort
INR	Indian Rupee
kWh	Kilowatt-Hour
NCR	National Capital Region
SEC	Socio-Economic Classification

Executive Summary

Currently, 8% of Indian households have air conditioners (ACs). By 2037, new demand from first-time purchasers of ACs, as well as additional purchases of new units by households who already have ACs, will increase AC penetration to 40%. This growth in the number of ACs poses serious threats to the energy consumption and greenhouse gas (GHG) emissions stemming from AC use.

Given the Indian climatic conditions, it has been empirically established that the optimum AC setpoint temperature settings lies between 24 and 26 degrees Celsius (°C), depending on the climate zone. However, recent surveys have indicated that 60% of Indian households run their ACs at a temperature setting of 23°C or less.

Among the prominent approaches to sustainably managing the cooling demand from the increasing stock of ACs is user behaviour adjustment for optimum AC setpoint temperature settings. A shift in AC user behaviour towards an optimum AC setpoint temperature setting of 24°C or above would generate both direct (comfort) and indirect benefits (electricity and emission savings). While efforts have been initiated to promote optimum AC setpoint temperature settings among Indian AC users, very little is understood about the dynamics of user behaviour with regards to AC setpoint temperature settings in India. Through primary research, the present study unpacks the user perceptions, preferences, and awareness related to recommended AC setpoint temperature settings.

The present study aims to study user behaviour and assess AC users' perceptions, attitudes, awareness and actions related to AC setpoint temperature settings. The study answers the following research questions:

i. What are the **existing user practices** in Indian homes related to AC use? What is the setpoint temperature at which users operate their ACs in their homes, and what are the associated practices related to AC use, including using a fan, shutting the doors and windows, wearing additional layers of clothing, etc.

ii. What is the **current level of awareness** regarding the Bureau of Energy Efficiency's (BEE) 'AC@24' campaign among AC users? Do users know about BEE's recommended AC setpoint temperature setting of 24°C?

iii. What are the monetary, environmental, health-related, comfort-related, and other **drivers/ motivators** that influence the AC setpoint temperature settings among Indian AC users? What are the perceived **barriers** that prevent users from using ACs at 24°C or above? What can be **enablers of behaviour change**?

Through 400+ quantitative and qualitative surveys, the present study compares the existing AC usage practices across three metropolitan cities – Delhi, Mumbai, and Kolkata.

3
Metropolitan Cities

Delhi | Mumbai | Kolkata

400+
Surveys

Quantitative surveys | Focus-Group Discussion | In-depth interviews

24
Data Points

Respondent details | Ownership & Usage | Awareness, perception & attitude | Psychographics | Communication awareness

The survey findings on AC ownership and duration of usage show that approximately 50% of households have just one AC in their homes; nearly 25% of the households have two ACs. ACs are predominantly used for 6-12 hours a day during the summer months (March-June), implying both daytime and nighttime usage. Approximately 70% of respondents use ACs at 23°C or below during the summer and monsoon season. The setpoint temperature settings are more clustered around lower temperature settings (18-22°C) in the summer, while during the monsoon, this largely shifts to 20-24°C. The results also indicate that only 26% of the respondents were correctly able to identify the recommended setpoint temperature of 24°C. Moreover, only 33% of respondents were correctly able to recall BEE's message about how raising the AC temperature by one degree leads to 6% electricity savings. Hence, the impact of BEE's campaign on user awareness seems to be limited, as seen from the low recall value.

The most commonly cited reasons for using ACs at 23°C or below were need for fast and quick cooling, high outside temperatures, high level of humidity, and being accustomed to lower temperatures. On the other hand, the underlying reasons for using ACs at 24°C or above included comfort, lower chance of getting sick, suitability to most family members, and convenience of not having to frequently change the temperature setting.

01 | Introduction

Being a sub-tropical country, India has a significant cooling challenge. It has among the most cooling degree days in the world – more than 3000 per year[1]. Average temperatures in the summer in the northern and western parts of the country range from 89.6 degrees Fahrenheit (°F) (32 degrees Celsius (°C)) to over 113°F (45°C), and exposure to rising heat stress has resulted in around 6000 deaths over the past decade[2]. Along with the climatic characteristics, evolving socio-economic drivers, such as population growth, rapid urbanisation, and economic growth, imply that an increase in AC ownership is inevitable. With rising temperatures and extreme heat events, access to cooling to ensure good health, productivity, and thermal comfort for all becomes critically important. It is estimated that currently 8% of Indian households have ACs. By 2037, new demand from first-time purchasers of ACs, as well as additional purchases of new units by households who already have ACs, will increase AC penetration to 40%[1]. This growth in the number of ACs poses serious threats to the energy consumption and greenhouse gas (GHG) emissions stemming from AC use. Moreover, due to ACs' high energy consumption compared to that of other cooling technologies such as fans, air coolers, etc., it is projected that cooling will account for 40-60% of the summer peak load[3]. If these growing cooling needs are not managed in a sustainable manner, the country's electricity infrastructure will face significant strain.

Among the prominent approaches to sustainably managing the cooling demand from the increasing stock of ACs is user behaviour adjustment towards optimum AC setpoint temperature settings. Given the Indian climatic conditions, it has been established that the optimum AC setpoint temperature setting lies between 24°C and 26°C, depending on the climate zone[11]. However, recent surveys have indicated that 60% of Indian households run their ACs at a temperature setting of 23°C or less[4]. Optimum AC setpoint temperature settings could therefore have a tremendous impact on comfort conditions in buildings and the resulting energy consumption—to the tune of an approximately 15% reduction[9].

A shift in AC user behaviour towards optimum AC setpoint temperature settings of 24°C or above would generate direct (comfort) and indirect benefits (electricity and emission savings). While efforts have been initiated to promote optimum AC setpoint temperature settings among Indian AC users, very little is understood about the dynamics of user behaviour regarding AC setpoint temperature settings in India. Through primary research, the present study unpacks the user perceptions, practices, and awareness related to recommended AC setpoint temperature settings.

1.1 Role of Adaptive Thermal Comfort (ATC)

The need for optimum AC setpoint temperature settings stems from ATC, which emphasises the fact that thermal comfort is a condition of the mind that expresses satisfaction with the prevailing thermal environment[5]. Such a condition is dependent on physical factors such as body temperature, skin moisture, and minimum psychological effort to regulate the surrounding temperature and is also driven by behavioural factors, including adjustments in clothing, activity, posture, and/or thermostat settings or opening a window[6].

ATC essentially recognises that people's thermal comfort needs depend on their past and present context and that these needs vary with outdoor environmental conditions, including temperature, relative humidity, and air movement. In other words, an average person's perception of thermal comfort will be affected by the average outdoor weather conditions that prevail in and around his/her geographical location[5].

The India Model for Adaptive (Thermal) Comfort (IMAC) was a pioneering study that collected data across naturally ventilated, mixed-mode, and air-conditioned office buildings across five different climate zones in India in the summer, winter, and monsoon seasons. As per IMAC, the occupants in air-conditioned buildings feel comfortable at temperatures of 24-25°C[7]. The Bureau of Energy Efficiency (BEE), India's nodal agency for energy efficiency and conservation, has also stated that the desired comfort level can be achieved at AC temperature settings of 24-25°C, at desired levels of humidity and air movement[8]. Ensuring a state of physiological comfort through ATC practices has been empirically established as a key strategy that entails higher productivity and well-being for the occupants. Promoting AC use at a recommended setpoint temperature through behavioural changes thus constitutes a low-cost intervention strategy to generate direct and indirect benefits[9].

1.2 BEE's AC@24 Campaign

BEE, the statutory body under the Ministry of Power, Government of India for creating awareness and disseminating information on energy and conservation, has been undertaking concerted efforts since 2019 to promote optimum AC setpoint temperature settings among Indian users through its AC@24 campaign. It has used a two-pronged approach to steer user behaviour towards optimum AC setpoint temperature settings, as discussed below:

Default Settings

In 2020, BEE notified new energy performance standards for ACs under which all brands and types of star-labelled ACs that are manufactured, commercially purchased, or sold in India have to have a default setting of 24°C [10]. Default setting denotes the setting at which the temperature of an AC is preset when it is switched on. However, the user still has the flexibility to change or adjust the setpoint temperature as they wish.

The use of defaults to enable behaviour change has had positive results in behavioural research. It stems from the *status quo bias,* i.e. the fact that people generally tend to avoid the hassle associated with changing the default. Maintaining the status quo requires little or no cognitive effort and hence eases the way of doing things[11,12]. Defaults, as a behavioural intervention, also have deep-rooted alignment with nudging theory[13]. Nudges aim to influence the choices made by people without taking away their power to choose[14]. By introducing a default temperature setting in ACs, BEE has taken a step towards steering behaviour though enablement, instead of enforcement, and thus maintains the freedom of choice for the consumer.

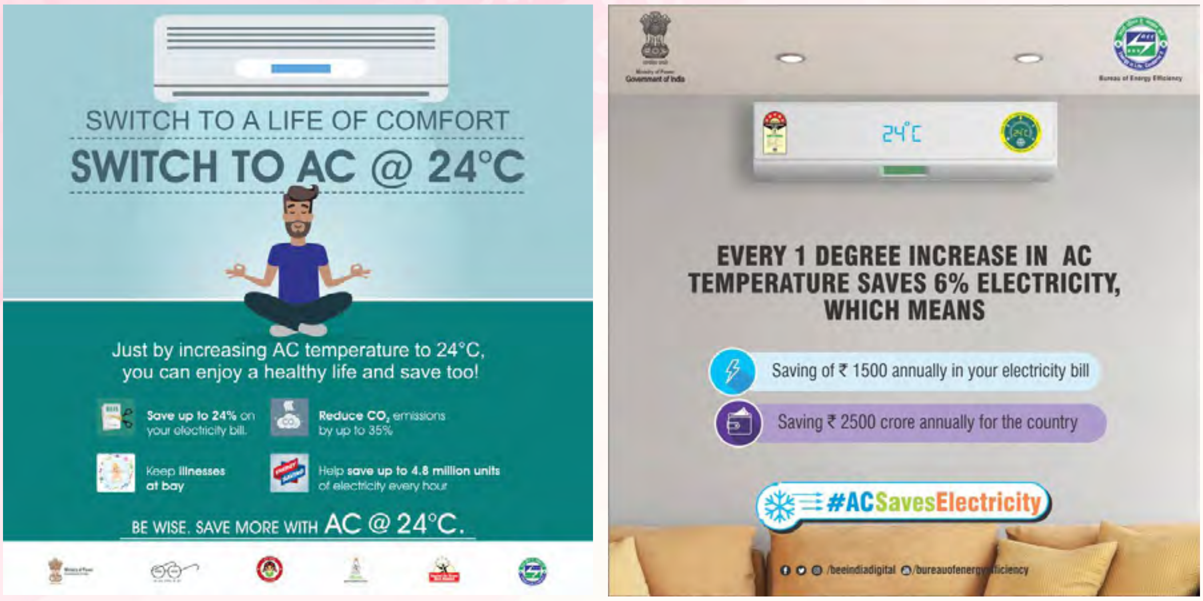


Figure 1: BEE's LinkedIn post from AC@24 campaign (Exhibit A and B)

BEE has also issued a voluntary advisory to commercial establishments in India, including airports, hotels, shopping malls, and offices, to run ACs at the recommended temperature setting of 24°C[7].

AC@24 Digital Campaign

BEE has also been raising awareness and promoting optimum AC setpoint temperature settings through the 'AC@24' campaign. BEE has been campaigning for the recommended AC temperature settings through social media posts on its Twitter and LinkedIn accounts. It has also developed several videos to highlight the benefits to users, using taglines such as:

a. "Every 1 degree increase in AC settings saves up to 6% electricity"
b. "Save more with AC@24"
c. "Stay healthy, do more. Switch to AC at 24°C"

The key messaging of BEE's campaigning has elements of monetary and environmental motives for running ACs at 24°C, as shown in the examples below:

Examples of ***monetary benefits*** communicated through BEE's 'AC@24 campaign':

- "Savings of ₹1500 annually in your electricity bill"
- "Savings of ₹2500 crore annually for the country".

Examples of ***environmental benefits*** communicated through BEE's 'AC@24 campaign':

- "Reduce CO_2 emissions by up to 35%"
- "Help save up to 4.8 million units of electricity every hour".

BEE estimates that the adoption of the recommended AC setpoint temperature settings by 50% of consumers would result in savings of 10 billion units of electricity, which is equivalent to a reduction of 8.2 million tonnes of carbon dioxide (CO_2) emissions per year. In monetary terms, this translates to savings of Indian Rupee (INR) 5000 crore annually[13].

Box 1: Japan's Cool Biz Campaign

JAPAN COOL BIZ CAMPAIGN

One of the most impactful success stories around optimum AC setpoint temperature settings comes from Japan. In an endeavour to reduce the country's carbon emissions and minimise the risks of energy crises after the Fukushima disaster, the Japanese Ministry of Environment launched the "Cool Biz" campaign in 2005. The Cool [15]Biz campaign encourages office workers to set their AC setpoint at 28°C or above, and in parallel, the Ministry of Environment introduced a simpler, more casual summer dress code for its workers. More specifically, in the summer, Japanese workers were encouraged to wear short sleeves and ditch ties and jackets when in the office. The government also advised the workers on other Cool Biz-related measures, including using blinds to keep the sun out and getting to office earlier when the temperature is lower.

Public reaction to the campaign

Breaking old traditions of appropriate formal clothing at offices in Japan, including wearing a tie and jacket, took some time. Initially, the campaign was met with some skepticism, as many felt it was impolite to not wear a suit to meetings.

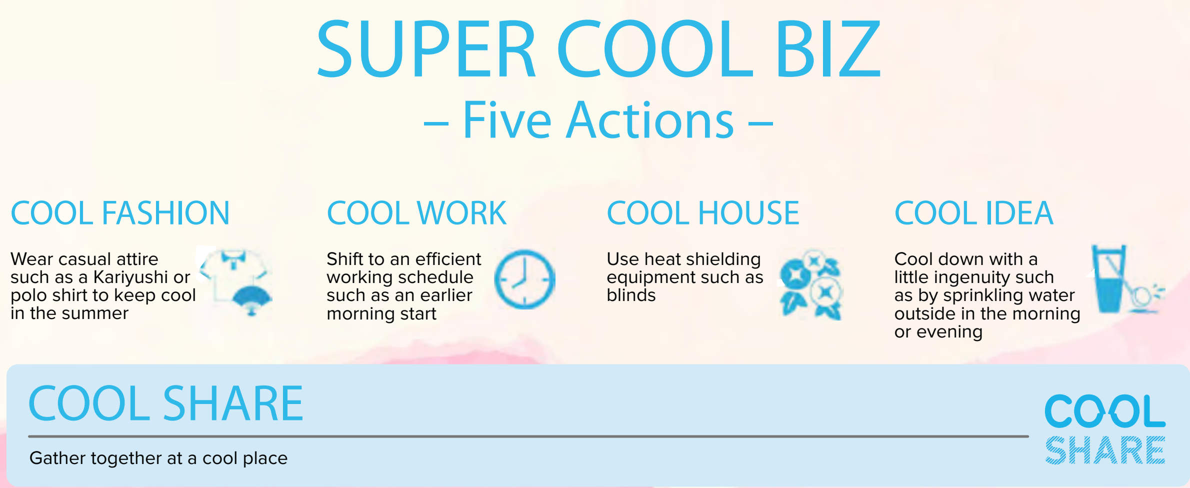
However, this cautious approach by workers was short-lived. Clothing retailers in Japan, which saw a new business opportunity, undertook aggressive marketing initiatives to promote the campaign, and prominent figures, including Prime Minister Junichiro Koizumi, were frequently spotted wearing casual wear. This shifted social perception to a positive attitude towards casual work wear.

Impact of the campaign

The level of awareness of the Cool Biz campaign was reported at 96% in 2015. In the first year of the campaign, the Japanese Ministry of Environment estimated a reduction in carbon emissions of 460,000 tonnes, equivalent to the power used by around one million households over the course of a month. By 2012, [16]the amount of reduced carbon emissions thanks to the initiative was estimated at 1,690,000 tonnes[16].

Super Cool Biz

In 2011, The Cool Biz campaign was expanded further in the form of the Super Cool Biz Campaign, with a similar premise, i.e., casual office wear, but it moved from a 'no-tie, no suit' style to mainstreaming more casual wear, including casual pants, shoes, and polo shirts.



02 Objective

For the purposes of developing effective communication, it is essential to gain insights into existing AC consumer behaviour, including the reasons for and factors influencing this behaviour. The primary objective of the study was to collect consumer information to inform the design of an effective behaviour change strategy and campaign for promoting optimum AC setpoint temperature settings among Indian AC users. The research's aim is to study user behaviour and assess AC users' perceptions, attitudes, awareness, and actions related to AC setpoint temperature settings. The study answers the following research questions:

i. What are the **existing user practices** in Indian homes related to AC use? What is the setpoint temperature at which users operate ACs in their homes, and what are the associated practices related to AC use, including using a fan, shutting doors and windows, wearing an additional layer of clothing, etc.?

ii. What is the **current level of awareness** regarding BEE's 'AC@24' campaign among AC users? Do they know about the BEE recommended AC setpoint temperature setting of 24°C?

iii. What are the monetary, environmental, health-related, comfort-related, and other drivers/motivators that influence AC setpoint temperature settings among Indian AC users? What are the perceived barriers that prevent users from using ACs at 24°C or above? What can be the enablers of behaviour change?

Based on the research and findings, the study puts forward recommendations to steer AC user behaviour towards optimum AC setpoint temperature settings and further strengthen BEE's campaign for maximum reach and impact.

03 | Approach and Methodology

The study is based on a mixed methodology approach, and a combination of qualitative and quantitative research methods were deployed to gain inputs related to the research questions. Considering the nature of the study, it was vital to collect data from respondents who have exposure to AC ownership and usage in an individual or shared capacity to determine their awareness, access, and use of ACs, which are crucial to shaping AC-related behaviour and attitudes. Thus, the respondents of the study have been filtered based on the criteria of Indian nationality, completion of 18 years of age, owner of at least one AC at home (individually or shared), and affiliation with households in Socio-Economic Classification (SEC) A1, SEC A2, and SEC A3[17]. SEC classification divides the households into 12 sub-categories in rural and urban India based on the chief wage earner's education and the ownership of various assets covered in the pre-defined list of 11 assets. A chief wage earner who is a graduate and owns nine assets is classified in category A1, whereas other households with ownership of 7-8 assets and education up to graduation or a diploma is classified in category A2. A3 households include chief wage earners with a qualification ranging between basic literacy and college diploma and ownership of 6-9 assets.

The survey was designed to seek direct information at an individual level and indirect/reported information at the group level (household). A structured questionnaire with closed-ended questions was used for quantitative interviews. This was developed on the software platform Decipher—the respondent was sent a survey link that directed her/him to the questionnaire. A semi-structured guide was used to conduct the in-depth interviews (IDIs) and focus group discussions (FGDs), in order to probe and understand the nuances of the responses being given.

3.1 Sample size

To provide reliable estimates with a certain precision level, the study's sample size was calculated using the following formula:

$$n = \frac{t^2 \times p\,(1-p)}{m^2} \times df$$

Where n = estimated sample size

t = z-score at 95% confidence level (1.96)

p = percentage of target respondents aware of the AC temperature to be kept for energy conservation (50% to get the maximum sample size)

m = margin of error (taken as 5%).

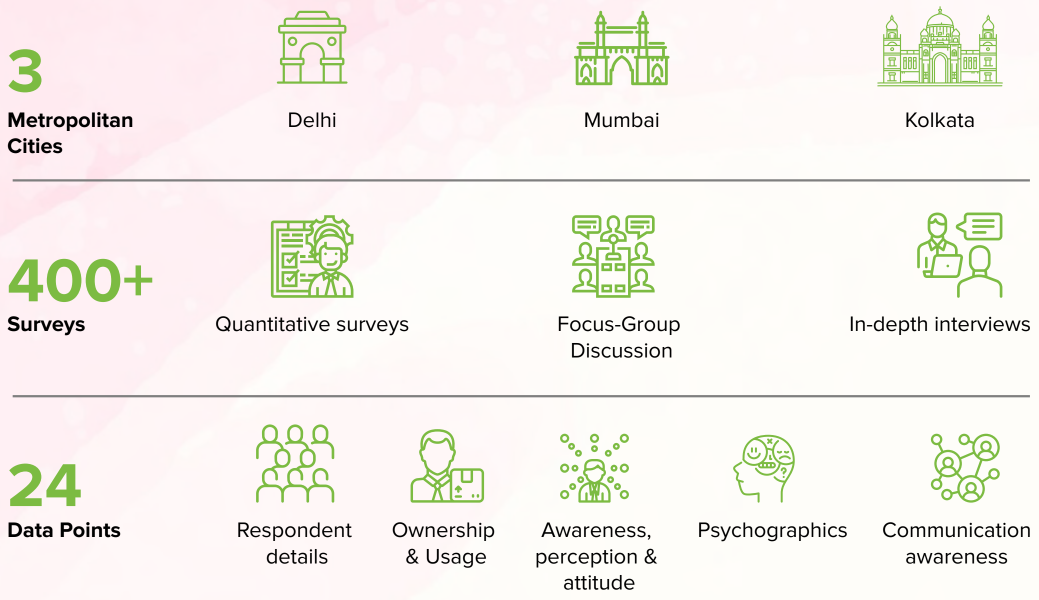


Figure 2: Survey design

The sample size, coming to 385, was rounded off to 390.

The sampling for the qualitative component was done using purposive sampling and the principle of maximum variance [18]. Respondents with variations in terms of climate zone, gender, and number of ACs in the household were chosen. The qualitative research involved 12 IDIs and 6 FGDs (with a 50:50 breakup of male and female respondents). The respondent distribution is elaborated in Table 2.

The sample size in the quantitative survey was 423 (against the planned sample of 390), with a sample in each city, i.e. Mumbai, Delhi, and Kolkata, in excess of 130. The temperature and relative humidity characteristics of the three cities are shown in Table 1. The profile of the respondents covered had a balance across gender, age group, education level, marital status, type of household, SEC, and current type of house.

Table 1: Temperature and relative humidity characteristics of India's climate types in target cities[19]

City	Climate Type	Summer Temperature Range	Winter Temperature Range	Relative Humidity
Mumbai	Warm and Humid	25-35°C	20-30°C	70-90%
Kolkata				
Delhi	Composite	27-43°C	4-25°C	20-25% (Dry) 55-95% (Wet)

The final survey was also preceded by a pilot survey of 32 respondents spread across the cities, gender, and age groups to be covered in the final survey. The pilot survey involved testing the survey instruments and examining the internal validity of the questions included on AC features, usage, and behaviour for consistency with each other, as well as attitude scale items to validate the comprehensibility of both sets of questions. The pilot survey also entailed a pilot run of the app to check for any operational or technical issues.

3.2 Survey Methods

To facilitate the collation of qualitative and quantitative responses in the final survey, three types of survey methods were used:

i. Online self-administered quantitative surveys

423 online quantitative surveys were carried out. Respondents were asked to answer the questions related to key topics mentioned above via an online survey. The survey was self-administered, and the link to access the same was shared through each respondent's email id.

ii. In-depth interviews

To capture the nuances of AC usage and related attitudes and behaviour, twelve IDIs were conducted across Delhi (National Capital Region (NCR)), Kolkata, and Mumbai. The purpose of these qualitative interviews was to get into the why, what, and how of the responses received on various aspects and a holistic understanding of factors that are important from a consumer's perspective, thereby getting insight into the consumers' psyche and factors that can potentially trigger behavioural changes.

iii. Focus group discussions

A total of six FGDs were carried out with groups of 6-8 respondents each in Delhi, Kolkata, and Mumbai. The discussions focused on aspects such as awareness and recall of messaging related to energy efficiency, general attitudes towards using ACs at the individual and household level, various factors influencing and affecting such behaviour, and so on. For the purpose of comfort and ease of sharing information, the groups were segregated into male and female respondents.

3.3 Respondent Selection

As mentioned above, respondents were selected based on the criteria of Indian nationality, 18 years of age, ownership of at least one AC at home (individually or shared), and SEC A1, SEC A2, and SEC A3 households (Figure 3).

The respondent gender distribution is summarised in Table 2 below:

Table 2: Survey respondent gender distribution

Gender	Surveys Targeted	Surveys Completed
Quantitative: Self-administered online questionnaires		
Men (spread across the 3 metros)	195	214
Women (spread across the 3 metros)	195	209
Total (Quantitative)	**390**	**423**
Qualitative: Online FGDs (2 male and 2 female groups in each zone)		
Men	3	3
Women	3	3
Total (Qualitative - FGDs)	**6**	**6**

Gender	Surveys Targeted	Surveys Completed
Qualitative: Online IDIs with target respondents		
Men	6	6
Women	6	6
Total (Qualitative - IDIs)	**12**	**12**

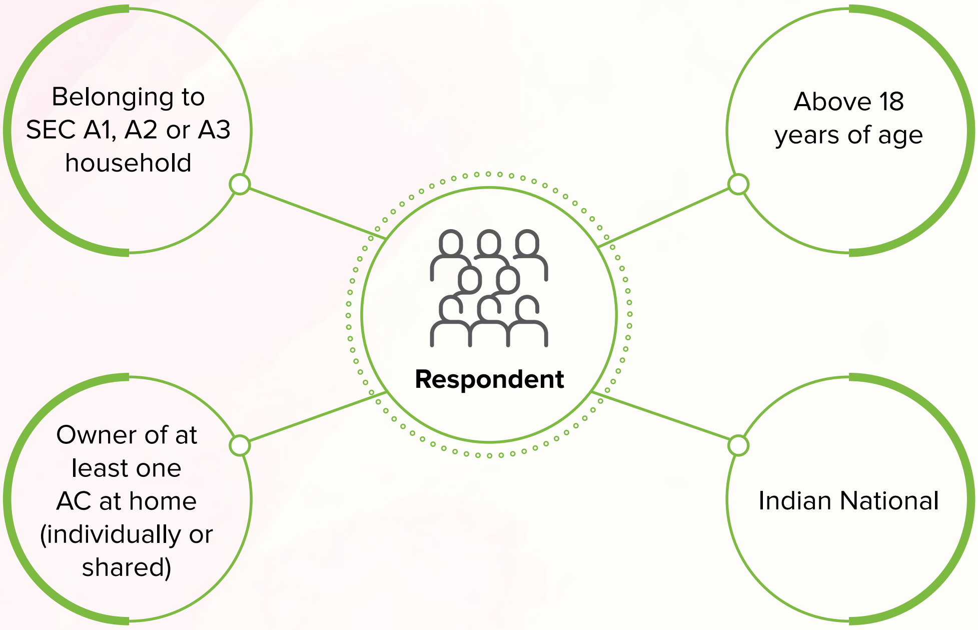


Figure 3: Respondent selection criteria

3.4 Questionnaire Design

As mentioned above, a structured online questionnaire with closed-ended questions developed on the software platform Decipher was used.

A discussion guide was used to conduct the IDIs and FGDs. The research tools—i.e. the quantitative questionnaire and IDI agenda—were pre-tested with sample sizes of 30 and 2, respectively. An online survey link was generated for the quantitative self-administered surveys, which was later modified based on the pilot test results. Additionally, cues from the IDIs were used as inputs in designing the online survey questionnaire.

Figure 4: Stages of enabling behaviour change

The key areas of inquiry covered in the questionnaire, which align with the main stages of enabling behaviour change, are summarised in Figure 4.

3.5 Data Collection Process

Quantitative study: A survey link was sent to the selected respondents from the panel via email to enable them to access the survey. On completion of the questions, the user had to click on the 'submit' button to submit their responses.

IDIs: Empanelled respondents were approached to gauge their interest in participating in the survey. If they agreed, an appointment was fixed with them, and a Google Meet link was shared accordingly. The interviewer and interviewee joined the link, and the interview was conducted through this online interface. Any rescheduling of the interviews was incorporated as part of the completion process.

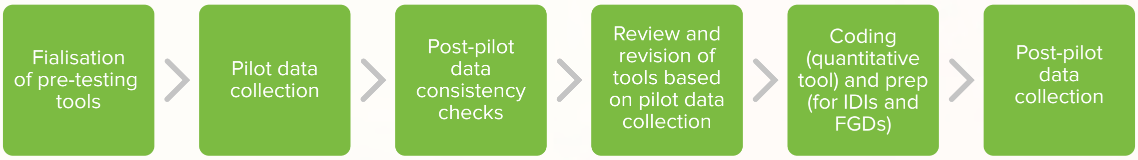


Figure 5: Data collection steps

3.6 Quality Control

Several steps were taken to ensure the high quality of the data collected, both throughout and after the data collection process. Besides the standard processes of filtering, verification, and validation, the quantitative pilot data collected was used to test the questions for internal and external validity. For the perceptual statements used in the tool, the pilot data was checked for internal validity, which was found to be good (Cronbach's Alpha = 0.78).

Based on the pilot data, since the number of ACs owned per household was reported to be on the higher side (mean=2.94, median=3), it was decided that a minimum within-SEC quota of at least 30% would be imposed on coverage of SEC A3 to make the sample more representative. A few IDIs were also conducted in the pilot, in which specific probes were included to check for the generalisability of the findings, as well as potential confounders. The IDIs and FGDs were conducted by highly trained personnel with extensive experience in conducting qualitative interviews.

04 | Key Findings

4.1 Respondent Profile

The respondent profile had a balance across gender, age group, education level, marital status, type of household, and SEC. The total sample size of 423 respondents was almost equally divided into male and female. Forty-nine percent of the respondents are in the 26-35 age group; 30% belong to the 36-45 age group, and 10% each are in the 18-25 and 46-60 age groups. Of the total sample, 88% of the respondents are married. Twenty-three percent live in joint families, while 77% have nuclear families.

4.2 AC Ownership and Duration of Use

The data on AC ownership and duration of usage is shown in Figure 6. There are similar trends in AC ownership in all three metropolitan cities – Delhi, Mumbai, and Kolkata. Approximately 50% of households have just one AC in their homes, whereas nearly 25% have two ACs, and another quarter have three or more ACs. Currently, AC penetration in India is relatively low, with less than 10% of Indian households owning an AC[1]. It should be noted that the respondent profile for our study consisted of individuals who owned at least one AC. The survey results indicate that most Indian households that own ACs are predominantly single AC ownership households.

The average number of ACs in a household in the warm and humid zone, i.e. Mumbai and Kolkata (mean: 1.68, median: 1, n= 293) is lower than that in the composite zone, i.e. Delhi (mean: 1.93, median: 2, n=130). The difference in the number of ACs owned across the two zones can mostly be attributed to the difference in the number in the bedrooms (mean – bedrooms, warm & humid zone = 1.16; mean – bedrooms, composite zone = 0.82), while the numbers of ACs in common or other areas are very similar across zones (mean – common areas, warm & humid zone = 0.79; mean – common areas, composite zone = 0.73; mean – other areas, warm & humid zone = 0.07; mean – common areas, composite zone = 0.04).

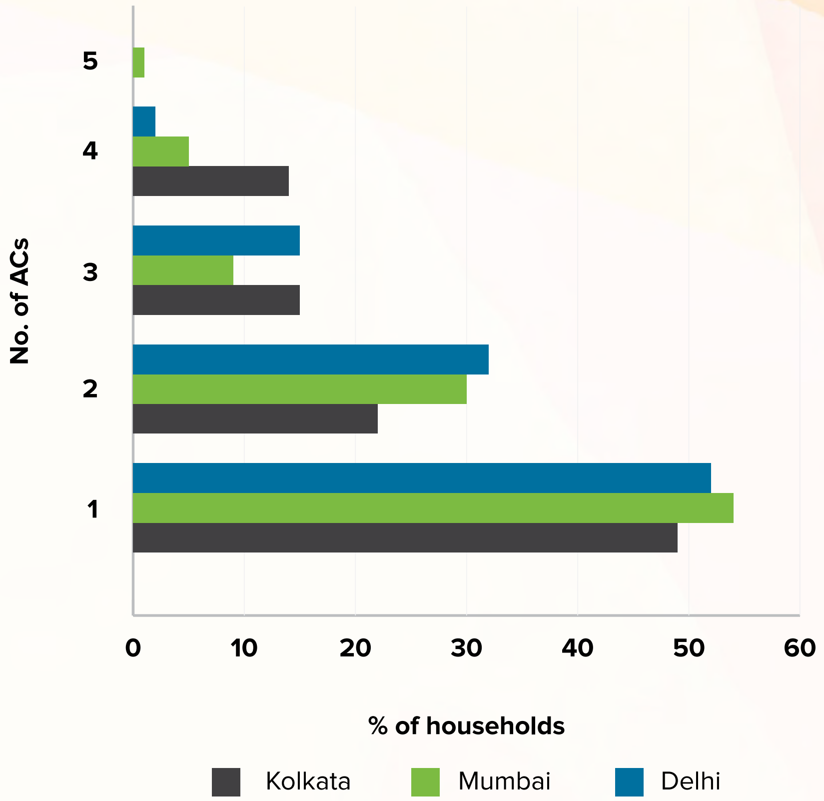


Figure 6: AC ownership per household

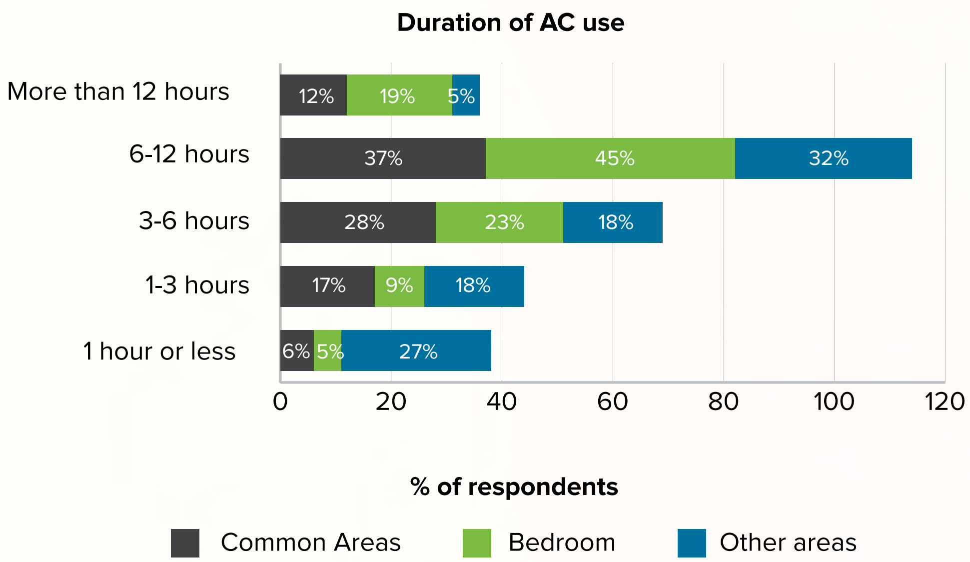


Figure 7: Summertime AC usage

AC ownership has also been tested against parameters such as the *type of house* and *floor level*. The average number of ACs reported in flats is significantly higher (*n=155, mean=2.01*) than in independent houses (*n=179, mean=1.8*) and row-houses (*n=88, mean=1.28*). Furthermore, the number of ACs owned by households living in flats on the ground floor is the lowest (*n=50, mean=1.7*), followed by those on the middle floors (*n=78, mean=1.97*) and top floor (*n=27, mean=2.67*).

The duration of AC use is measured as the typical cumulative number of hours per day (24-hour period) the AC is on. The results indicate that ACs are most commonly used for 6-12 hours in a day in the summer (March-June), implying both daytime and night-time usage (Figure 7). The use of ACs for a longer duration (i.e. over six hours) is more common in bedrooms, while in other areas of the house, AC is used for fewer hours (less than 3) per day.

The results on single AC ownership, duration of operation, and location in the home reflect the fact that, typically, the decision on AC setpoint temperature settings is made collectively by different household members. The comfort needs, as well as preferences, of occupants across different age groups or genders might differ. Gender differences in thermal comfort have been investigated in several studies, and it has been empirically established that women tend to be more sensitive than men to deviations from an optimal temperature and also tend to express more dissatisfaction, especially in cooler conditions[20][21]. With the high prevalence of single AC ownership seen in the survey results, as well as the use of ACs in shared spaces, including common areas, it can be inferred that the individual preferences of all household members are considered in selecting setpoint temperature settings.

4.3 Thermostat Settings Across Seasons

AC setpoint temperature settings have been investigated in all three cities in the summer (March-June), monsoon season (July-August), and winter (September-October). While AC usage is the highest in India in the summer and monsoon season, ACs are also used in the early winter months, especially in the warm and humid zone. The results indicate that approximately 70% of respondents use ACs at 23°C or below in the summer and monsoon season (Figure 8 and Figure 9). The setpoint temperature settings are more clustered around lower temperature settings (18-22°C) in the summer, while in the monsoon season, this largely shifts to 20-24°C. There is a higher skew towards lower temperature settings in Mumbai. In the winter, the total proportion of respondents using ACs at 23°C or below falls from 70% to around 50% (Figure 10).

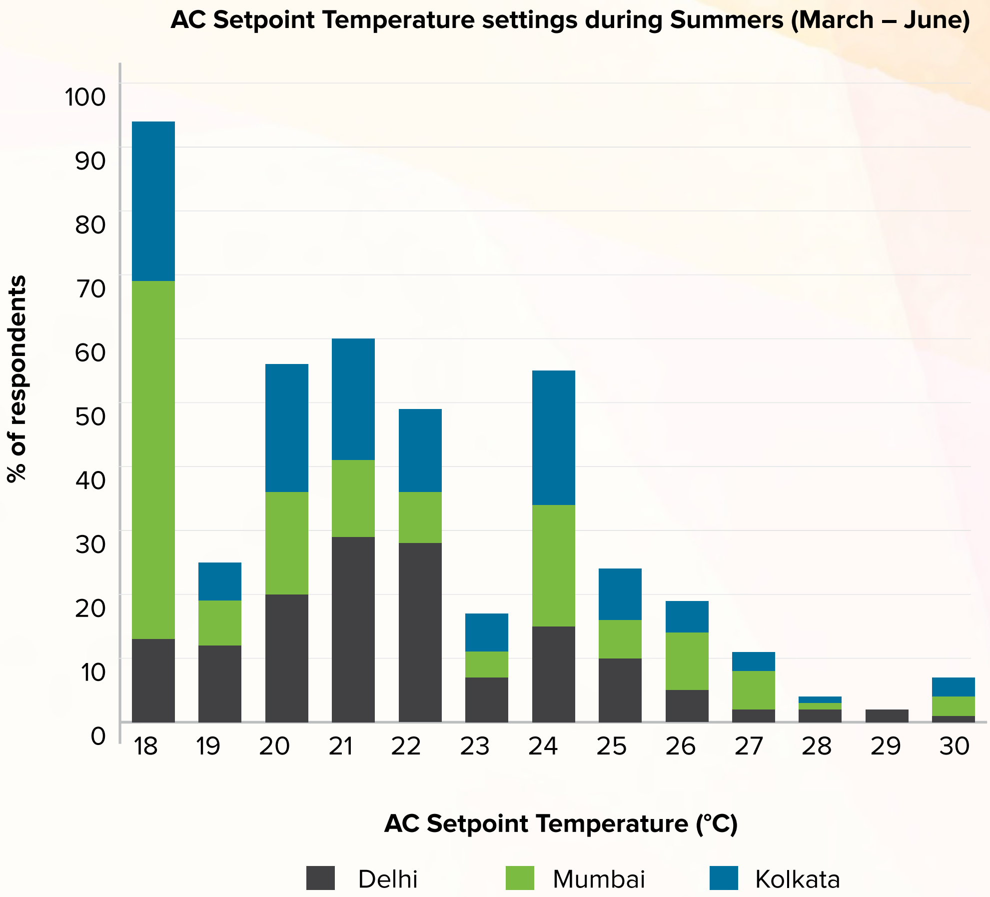


Figure 8: Summer AC setpoint temperature settings

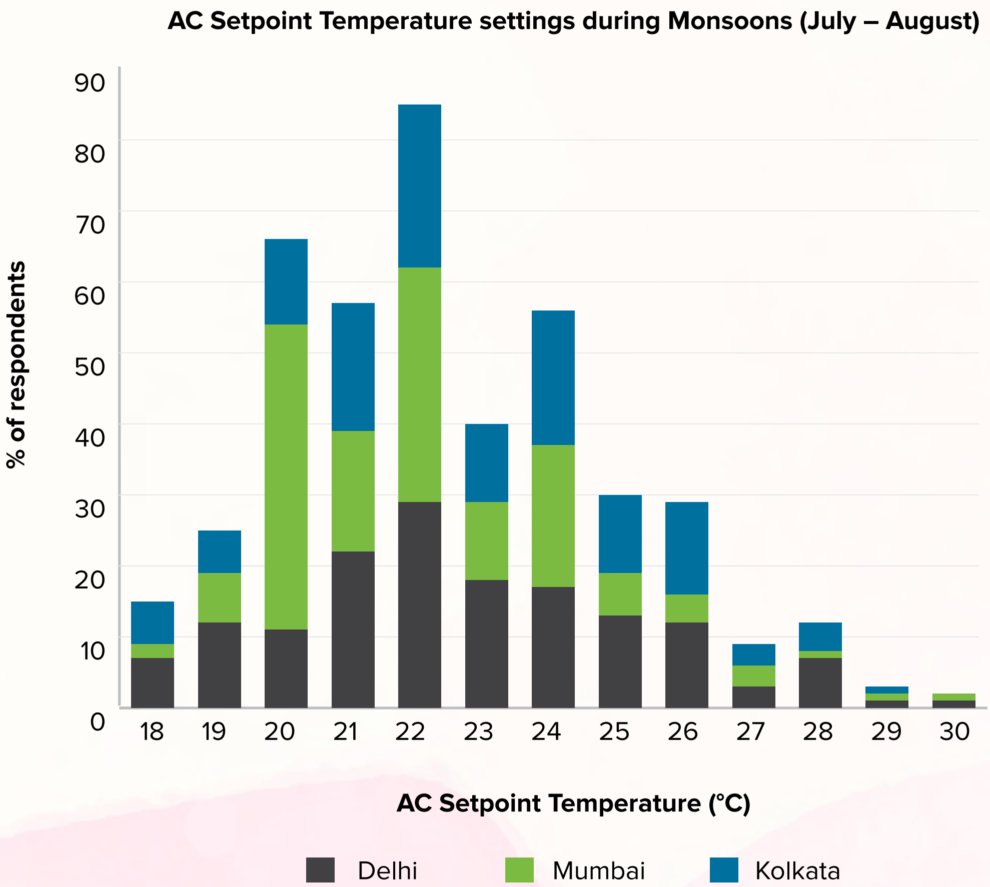


Figure 9: Monsoon AC setpoint temperature settings

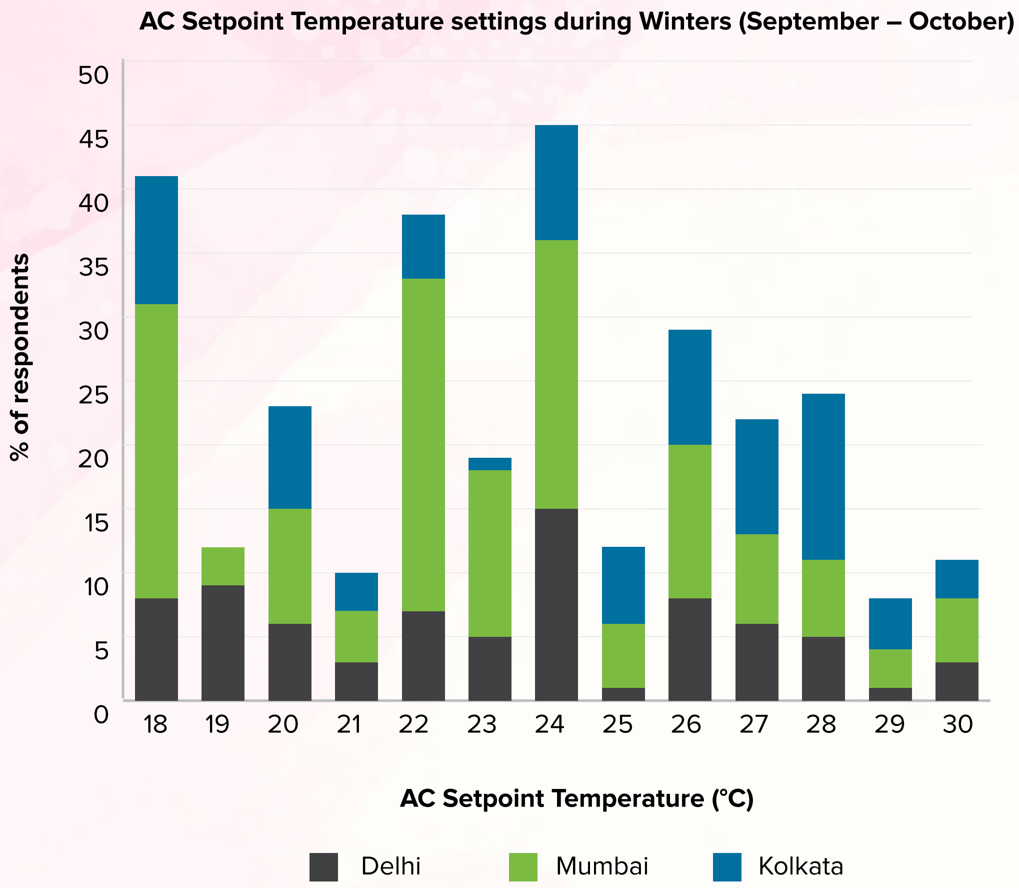


Figure 10: Winter AC setpoint temperature settings

4.4 Thermostat Settings: Doer/Non-Doer Analysis

The survey corroborates findings from other studies that have investigated AC setpoint temperature settings in other Indian cities[22,23]. The behavioural perceptions and attitudes regarding setpoint temperature settings were further probed through qualitative interviews. The reasons behind temperature settings were compared through a doer/non-doer analysis between two groups of respondents: respondents who prefer to use ACs at 23°C or below and respondents who prefer to use ACs at 24°C or above. The main reasons cited by the former group of respondents for their AC temperature preference are:

- **Need for fast and quick cooling:** It was observed through IDIs and FGDs that many respondents associated a lower temperature setting with quicker cooling. However, a lower temperature setting requires the AC compressor to run for a longer time and does not actually lead to faster cooling. There was a belief among respondents that the best way to achieve faster cooling is to initially turn on the AC at a lower temperature and then increase the temperature after the room has cooled to some extent, which is not scientifically effective[24].
- **High outside temperatures:** Growing heat stress as a result of climate change was also cited as one of the major drivers prompting respondents to shift towards lower temperature settings. Paradoxically, literature on ATC[6,25] recognises that a person's thermal comfort preferences are positively correlated with outdoor environmental conditions. However, a reverse trend was observed in the survey, as rising outside temperatures were positively correlated with the need for lower temperature settings.

- **High level of humidity:** The need for a lower temperature setting was also emphasised by respondents during the monsoon season, when the level of humidity spikes.
- **Being accustomed to lower temperatures:** Higher expectations for cooler temperatures were reported by respondents who live in year-round air-conditioned spaces and have become accustomed to lower temperature settings in their entire ecosystem, including offices, movie theatres, restaurants, and so on.

On the other hand, the underlying reasons for higher temperature settings cited by respondents who prefer to use ACs at 24°C or above included:

- **Comfort:** Respondents who prefer to run their ACs above 24°C stated that they feel neither too hot nor too cold with ACs running above 24°C.
- **Lower chance of getting sick:** Some respondents felt that the probability of catching a cold/cough is lower at higher temperature settings. The likelihood of such health concerns arising was perceived to be higher amongst respondents living with children or the elderly.
- **Suits most family members:** Referring to the heterogeneous comfort needs of different household members, certain respondents felt that a higher temperature setting better suits all members of the household, including the elderly and children.
- **Frequent change in temperature setting not required:** Respondents who use ACs above 24°C felt that there is less of a need to frequently change the setpoint temperature at higher temperature settings. Hence, a higher setpoint temperature is more convenient for the occupants.

The observed heterogeneity in respondents' preferences can be explained by ATC theory, which emphasises the fact that an individual's past and present exposure to varied temperatures has a bearing on that individual's thermal comfort needs. People's thermal comfort needs vary with the outdoor environmental conditions of their location. This implies that people living year-round in air-conditioned spaces are likely to develop high expectations for homogeneity and become accustomed to cooler temperatures. In contrast, people who live or work in naturally ventilated buildings are more likely to develop preferences that are reflective of the variable indoor thermal conditions due to local patterns of daily and seasonal climate changes. In this case, individual thermal perceptions, preferences, and tolerances are likely to extend over a wider range of temperatures.

The majority of the factors mentioned above relate to the 'comfort' and 'convenience' of using ACs above 24°C. Surprisingly, the *economic benefits*, such as reduction in electricity bills, or *environmental benefits*, such as reduction in CO_2 emissions, were not mentioned by the respondents as the motivators for using ACs above 24°C. There are two plausible explanations for this. First, among the sampled respondents, the level of awareness regarding the economic and environmental benefits of recommended AC setpoint temperature settings is very low. Alternatively, this indicates that 'comfort and convenience' are more important drivers of AC usage behaviour than economic and environmental benefits.

4.5 Associated Practices with AC Use

Associated practices with AC usage, such as the use of fans, shutting doors and windows, and wearing an additional layer of clothing have, also been investigated. Empirical research on ATC shows that the use of a fan in combination with ACs set at a higher temperature can provide a level of thermal comfort similar to that achieved by only using an AC at a lower temperature[26].

In the survey, 55% of households reported using a fan along with AC. Furthermore, 98% of respondents kept their windows and doors completely shut when using an AC. The need for an additional layer of clothing or using blankets/quilts while using an AC in the summer was only reported for children and the elderly. The results on associated practices with AC use are indicative of efficient AC usage practices and are relatively more encouraging than the findings on AC setpoint temperatures.

4.6 User Perceptions Regarding AC Use During COVID

The 2019 coronavirus disease (COVID-19) pandemic and the ensuing lockdowns and work-from-home resulted in extended domestic use of ACs. However, the pandemic also impacted the way ACs were used, given their perceived negative impacts, which spread through social media and word-of-mouth. There were fears regarding the spread of the virus through recirculated air, which decreased the overall usage of ACs during the pandemic. Furthermore, it was observed from the qualitative interviews that due to the fear of catching a cough/cold during the pandemic, ACs were used minimally.

4.7 Enabling Factors

The factors that would enable respondents to start using ACs at the recommended setpoint temperature of 24°C or above were investigated through a set of multi-select options that were presented to the respondent.

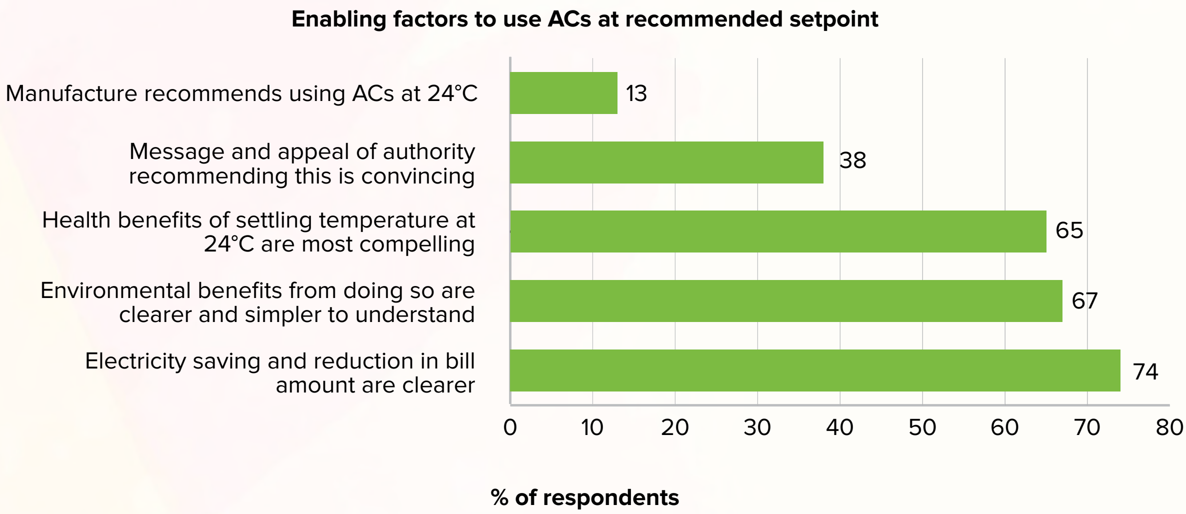


Figure 11: Enabling factors for using ACs at 24°C or above

The strongest motivation for using ACs at 24°C or above was the clear messaging on electricity savings from using ACs at higher temperatures (Figure 11). As per BEE, a one-degree increase in AC setpoint temperature leads to 6% electricity savings[5]. BEE messaging has already been emphasising a reduction in electricity bills in their 24°C campaign. For instance, social media posts on BEE's Twitter handles include messaging such as "Every 1-degree increase in AC temperature saves 6% electricity", "Savings of ₹1500 annually in electricity bill", and "Help save up to 4.8 million units[1] of electricity every year". However, such messaging on electricity savings in percentages and energy units might be too statistical in nature to make an impact on user behaviour. The messaging also restricts an individual's ability to link their actions to resulting electricity savings.

1 Units of electricity here refer to kWh

The level of awareness of BEE's campaign promoting the use of ACs at 24°C or above has been checked by asking respondents about the AC setpoint temperature setting recommended by BEE (Figure 12). The results indicate that only 26% of the respondents were able to correctly identify the recommended setpoint temperature of 24°C. Furthermore, only 33% of respondents were correctly able to recall BEE's key message that raising the AC temperature by one degree leads to 6% electricity savings. Hence, the level of user awareness regarding this campaign currently remains limited, as seen from the low recall value.

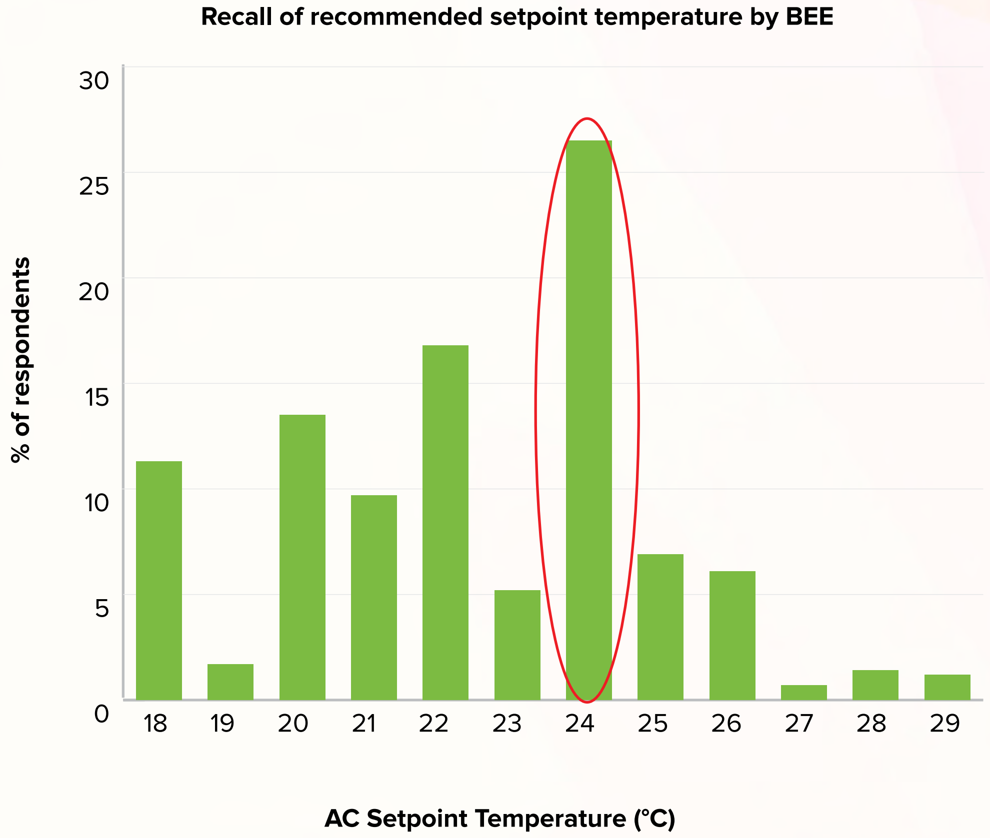


Figure 12: Recall of BEE's recommended AC setpoint temperature setting

Clear messaging on the health and environmental benefits of using ACs at higher setpoint temperatures seemed to be stronger enablers for using ACs at 24°C or above. Interestingly, there is a strong perception of a link between AC usage and negative health impacts among the respondents. This corroborates the findings related to the use of ACs during the pandemic, as well as the use of quilts/blankets among the elderly and children to avoid the risk of catching a cough/ cold.

Only 13% of respondents agreed that they would move to higher temperature settings if communicated by the manufacturer, indicating a low level of impact if the AC manufacturers act as messengers for the campaign. Against this, the level of user trust in celebrity endorsements as a means to change behaviour was also tested. About 75% of respondents agreed (or strongly agreed) that celebrity endorsement does not influence their behaviour or attitude towards a social issue. The general view observed is that as celebrities work for their own profit and money, the cause that they stand for does not matter. Thus, celebrities can be used to attract the attention of the masses towards a cause, but this might not necessarily trigger a change in attitudes, behaviour, and practices.

4.8 Study Limitations

The limitations of the study are as follows:

- With the self-administered online survey format, respondents did not have the option of asking about or clarifying any aspect of a question; they had to depend on their own understanding of each question to respond to it.
- The study was restricted to metropolitan cities, given the time and cost constraints. For generalisability across India, a larger study, including non-metro cities and towns, will be required.
- The respondents were only from SEC A1, SEC A2, and SEC A3 and all had basic English literacy, as well as a fair degree of digital/internet literacy.
- The study included only current AC owners, not potential future owners.
- The group decision-making in a household has been captured indirectly, as reported by the respondent, and may therefore have associated reporting errors or bias.

05 | Recommendations

Based on the present study's findings, a few recommendations are detailed below to design behaviour change communications for promoting optimum AC setpoint temperature settings among AC users:

Enhancing the awareness of the recommended AC setpoint temperature setting of 24°C by leveraging different mediums

The present study shows that the current level of awareness amongst people regarding the BEE recommended optimum AC setpoint temperature is fairly low. So far, BEE has been mainly running this campaign on its social media handles. For wider reach of the messaging, we recommend leveraging various other mediums, including the following:

- The message can be incorporated into electricity bills during the summer months. This can serve as an immediate reminder to consumers of how they can reduce their energy consumption and electricity bills by adjusting their thermostats. Moreover, awareness campaigns can be further expanded to institutions such as kindergartens, malls, hospitals, and offices, where booklets and pamphlets can be distributed.
- There is also an opportunity to incorporate this messaging into Home Energy Reports (HERs). While HERs are still a novel concept in India, BSES Rajdhani Power Limited (BRPL), together with Oracle Utilities, has already run a pilot programme with two lakh domestic customers in BRPL's Delhi service area to test the HER programme for the first time in India. If HER programmes become more mainstream in the near future in India, messaging on the recommended AC setpoint temperature can be incorporated into the reports. HERs effectively demonstrate that how people feel they compare to their peers is a very strong determinant of their behaviour[20]. This behavioural tendency can be leveraged to promote optimum AC setpoint temperatures. Consumers can be given feedback through HERs in two forms. First, the recommended setpoint temperature can be directly positioned as an ***actionable tip*** for consumers to reduce their energy consumption during the summer. Alternatively, a ***normative comparison*** of a consumer's AC setpoint temperature setting with that of their neighbours could also be effective in steering consumer behaviour.
- There are also opportunities to strengthen the reach of the messaging through social media. There is potential to enhance the reach of the messaging by promoting it beyond BEE's social media accounts. Collaboration with key AC manufacturers in India could be leveraged to promote the campaign on their social media accounts, which usually tends to have greater following.

- Furthermore, announcements and advertisements on traditional media such as radio channels, print media, and TV can be another important channel to steer behaviour towards optimum AC set point temperature settings.

Positioning health and comfort fulcrums to enhance the messaging's impact

A doer/non-doer analysis between respondents who chose to use their ACs at 24°C or above (doers) and those who use their AC at 23°C or below (non-doers) reveals that the key motivators for using ACs at or above 24°C are the following:

- **Convenience**, as there is less need to frequently keep changing the setpoint if it is 24°C or above.
- **Comfort**, as respondents cited that they feel neither too hot nor too cold with ACs running above 24°C.
- **Health**, as the perceived probability of catching a cold/cough is lower at higher temperature settings. The likelihood of such health concerns arising was perceived as higher by respondents living with children or the elderly.

A reformulation of the key messaging in the AC@24 campaign based on the *convenience, comfort*, and *health* benefits of recommended AC thermostat settings in India could be impactful in steering consumer behaviour and promoting the adoption of optimum AC setpoint temperature settings.

Busting myths around fast cooling

Behaviour change communications for promoting optimum setpoint temperature settings should try to debunk people's perceptions around quick cooling through lower setpoint temperature settings. The present study reveals that many respondents associated a lower temperature setting with quicker cooling, even though this is not scientifically an effective strategy.

Managing expectations for cooler temperatures

Aligning with ATC theory, which links a person's comfort needs with their immediate environment, it is likely that that people who work in air-conditioned spaces develop preferences for cooler temperatures. Hence, promoting optimum AC setpoint temperature settings in Indian homes requires optimum AC setpoint temperature settings to also be adhered to in commercial spaces, including offices, airports, malls, theatres, and so on.

06 Conclusion and Way Forward

Operating ACs at setpoint temperatures conforming to ATC guidelines in India could not only enhance the thermal comfort and productivity of occupants, but also has the potential to optimise the cooling energy demand and associated CO_2 emissions in India and provide comfort and monetary savings to the stakeholders/users. While user behaviour change with respect to AC setpoint temperature settings is widely recognised as a low-cost intervention opportunity to achieve energy savings, very little has been explored with respect to the behavioural determinants that shape user decisions related to AC usage. The Government of India has already shown commitment to driving a national campaign towards optimum AC setpoint temperature settings. However, the findings of the present study indicate that the current level of awareness regarding the recommended setpoint temperature remains low in the country, and 70% of respondents use their ACs at or below 23°C, reflecting a need to bridge this gap and encourage action on this front through enhanced policy focus and/or an altered policy approach.

The study's findings show that the observed preference for lower temperature settings is driven by the desire for fast and quick cooling, high outside temperatures, high humidity, and being accustomed to lower temperatures. These results align with ATC theory, which states that people who live in air-conditioned spaces all year round become accustomed to cooler temperatures. In contrast, concerns for comfort, health, suitability for members of different age groups, and reduced need for frequent temperature changes were identified as the key factors motivating respondents to use ACs at 24°C or above. Monetary and environmental 'motivations' for using ACs at or above 24°C were not reported by the respondents; however, these factors did emerge as strong 'enablers' for steering users towards optimum setpoint temperature settings. The results further confirm a low level of awareness—26% and 33% awareness of the BEE recommended AC setpoint temperature setting and '24-degrees campaign', respectively.

The survey findings reinforce the need to further strengthen BEE's campaign in its reach and key messaging. The present study's findings indicate that apart from the monetary and environmental benefits of using ACs at recommended temperature settings, which are already included in BEE's social media campaigns, an emphasis on the comfort, convenience, and health benefits could be impactful in steering user behaviour. Moreover, apart from social media, which has been the most prominent medium in BEE's awareness campaign so far, other accessible informational platforms such as print media, radio, and TV can be used/explored to expand the reach of the campaign. The survey findings also indicate that use of celebrity endorsements for the optimum AC setpoint temperature campaigns holds limited potential, as the general perception among respondents is that such endorsements are driven by celebrities' personal motivation to earn money.

This study has scope for scale-up across different geographic/climate zones to craft a broad, data-driven framework to design behavioural energy efficiency interventions. There is also a need to revamp the campaign with respect to the target audience (who), creative concepts (what), appropriate platform (where), timelines (when), and distinct goals (why) to inform the design of behaviour change communications to steer user behaviour towards optimum AC setpoint temperature settings. A follow-up assessment of the resulting impacts of the revamped campaign would also be beneficial.

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