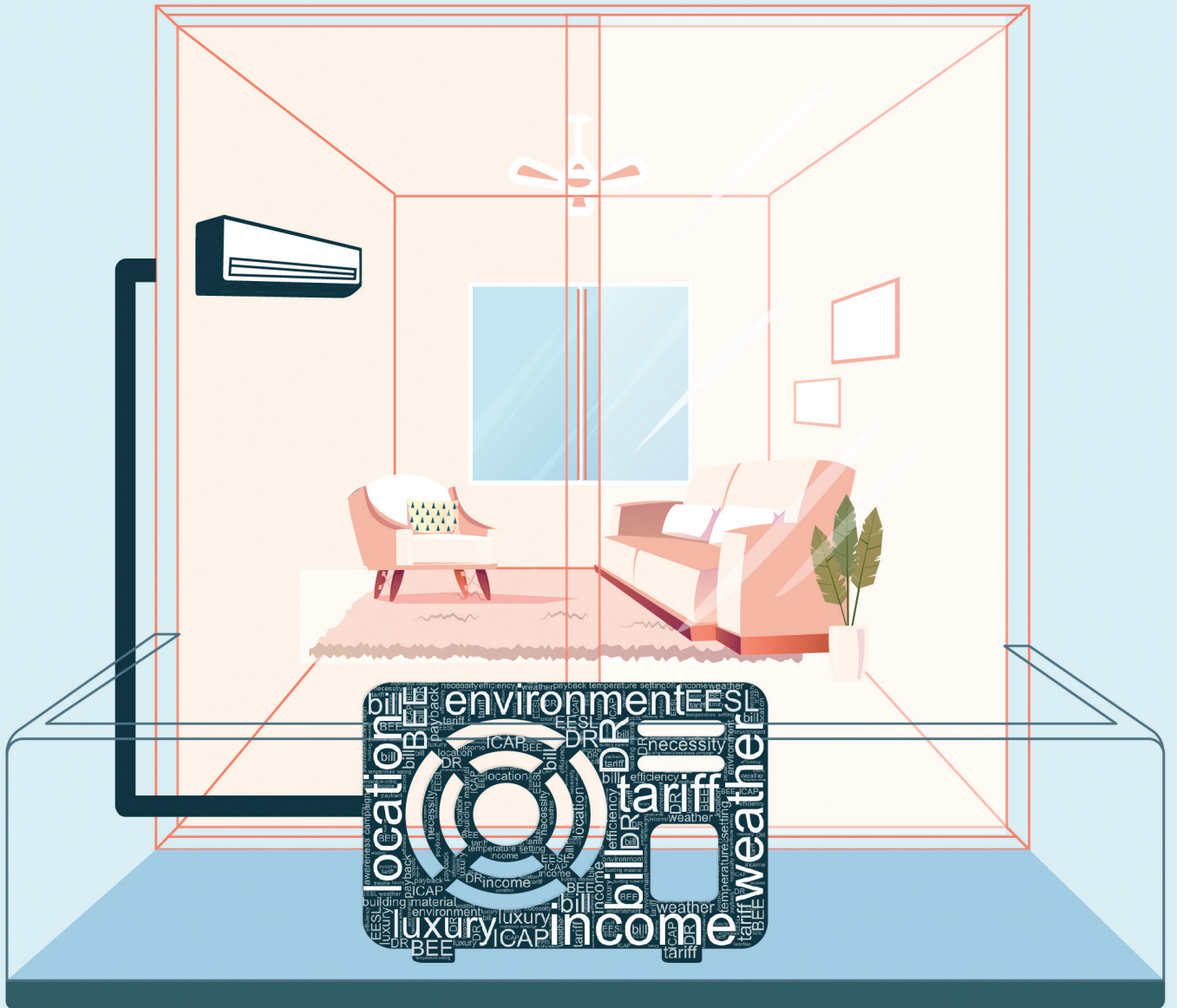# Conditioning Behaviour

Insights on use of air-conditioners in five Indian cities

प्रयास

Prayas (Energy Group)

Conditioning Behaviour

Insights on use of air-conditioners in five Indian cities

June, 2020

Prayas (Energy Group)

About Prayas

Prayas (Initiatives in Health, Energy, Learning and Parenthood) is a non-Governmental, non-profit organization based in Pune, India. Members of Prayas are professionals working to protect and promote the public interest in general, and interests of the disadvantaged sections of the society, in particular. Prayas (Energy Group) works on theoretical, conceptual regulatory and policy issues in the energy and electricity sectors. Our activities cover research and intervention in policy and regulatory areas, as well as training, awareness, and support to civil society groups. Prayas (Energy Group) has contributed in the energy sector policy development as part of several official committees constituted by Ministries and Planning Commission. Prayas is registered as SIRO (Scientific and Industrial Research Organization) with Department of Scientific and Industrial Research, Ministry of Science and Technology, Government of India.

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Executive Summary

India's energy requirement for space-cooling is expected to increase significantly. International Energy Agency (IEA) projects a 15-fold increase in India's cooling related electricity consumption from 2016 to 2050 in its reference scenario. India Cooling Action Plan (ICAP) launched by the Ministry of Environment, Forest, and Climate Change (MoEFF&CC) projects the space cooling energy requirement to grow to four times in 2037-38 as compared to the baseline in 2017-18 in its reference scenario. Room air-conditioners (ACs) in residential sector are expected to be the major contributors to this increase in demand.

Rising demand for space-cooling and particularly the use of ACs has the potential of putting enormous strain on India's power system by not only pushing up the overall electricity demand but also requiring to build generation and distribution capacity to meet the demand at peak times. India already has a few policies/programmes to address this increasing demand from ACs. A systematic understanding of consumer behaviour is crucial to design these interventions effectively and to periodically assess their outcomes. This study adds to the limited literature examining the household behaviour related to the purchase and use of AC in India.

We surveyed 1,500 households in five Tier-2 cities: Vadodara, Ghaziabad, Patna, Kochi and Nagpur. The survey was conducted between December 2019 and February 2020 and had detailed questions on AC stock attributes, buying behaviour, and usage patterns.

The survey was done before the Covid-19 pandemic. The prevailing suppressed economic activity and changes in work culture are expected to change the demand and use of ACs, atleast in the short term. Most probably, households will delay their purchase decisions of high ticket items like AC. This can be used as a window of opportunity to promote the use of alternative cheaper and low energy consuming appliances like air-coolers and fans and also push for uptake of more energy efficient ACs.

In this executive summary, we present key findings and policy recommendations from the study.

Key Insights

Average monthly per capita expenditure (MPCE) of sampled households is less than the average MPCE of top 20% of all the urban households

About 63% of the households in the sample own one AC, 33% own two ACs and only 4% own more than 2 ACs. The share of households owning multiple ACs is highest in Patna (51%) and the lowest in Nagpur (25%). The average MPCE of the households with 1 AC in four cities is less than the average MPCE of the top 5th quintile of all the urban households in the respective state whereas in Vadodara it is marginally higher. Although the decision to buy an AC maybe driven by a number of factors other than income, this indicates a possibility of more middle income urban households buying ACs in future.

Figure : Comparison of MPCE of sample with inflation-adjusted MPCE of urban households under NSS 68th round
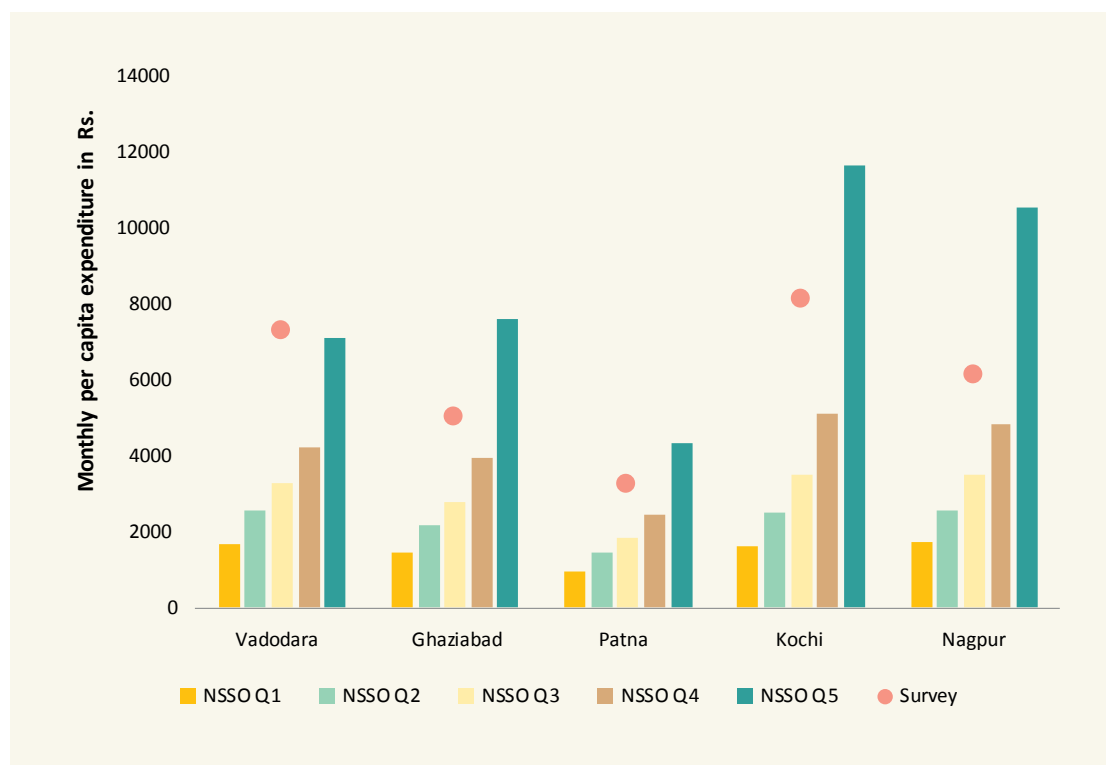
3-star rated models are more popular

About 44% of all the ACs owned by the households in the sample are 3-star rated, 29% are 5-star rated and 22% are 4-star rated. The share varies across cities: 3-star rated ACs form majority in Ghaziabad, Kochi and Nagpur; 4-star rated ACs in Vadodara; and 5-star rated ACs in Patna. Awareness about Bureau of Energy Efficiency (BEE)'s mobile app which helps consumer search and compare star-rated models and Energy Efficiency Services Ltd. (EESL)'s super-efficient AC programme was low (less than 10%) in all cities except Vadodara (about 40%). This suggests additional interventions are required to get households to buy higher rated efficient models. This would require carefully designed awareness and incentive programmes to promote uptake of higher rated models. We find that the electricity consumption of the most used AC in a sample household can reduce by an average of 35% if it is replaced by the EESL's super-efficient AC considering the reported usage hours. This potential reduction in consumption can be as high as 50% for households with higher usage hours.

Figure : Distribution of star-rated models in the AC stock
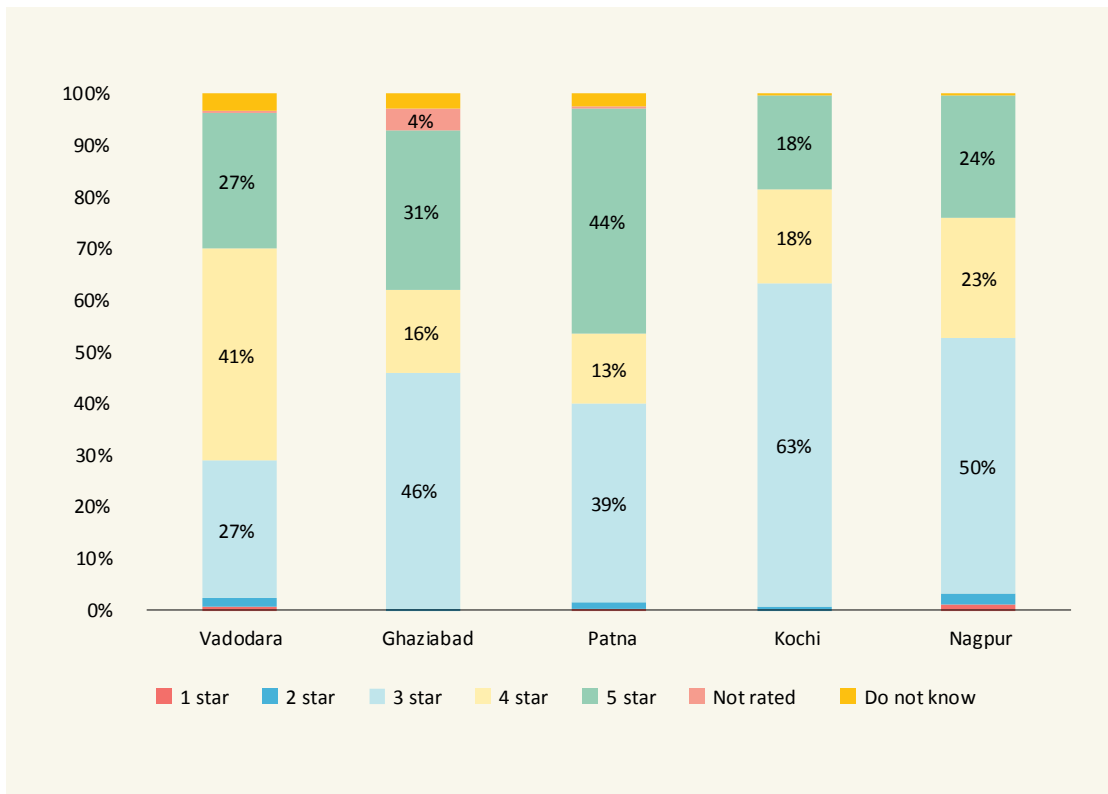
Multiple factors influence buying decision with varying relative importance across cities

There is no single dominant factor that influences a household's decision to purchase an AC. Multiple factors play a role and their relative importance varies across the cities. About 50% of the households in the sample identified insufficient cooling from an existing appliance either a ceiling fan or an air-cooler as one of the reasons for buying an AC. About 40% of the households in the sample identified with most friends and family owning an AC as one of the factors influencing their AC purchase decision. The factors affecting the choice of a particular model of AC also varies with cities. Brand emerged as an important factor across all five cities but more specifically so in Kochi. Price is the next most important factor for households in Kochi and Nagpur. In Vadodara, price is the most important factor followed by brand. Energy efficiency programmes should focus on localized awareness programmes focusing on locally relevant factors along with a general national level campaign.

Figure : Factors influencing the choice of AC.
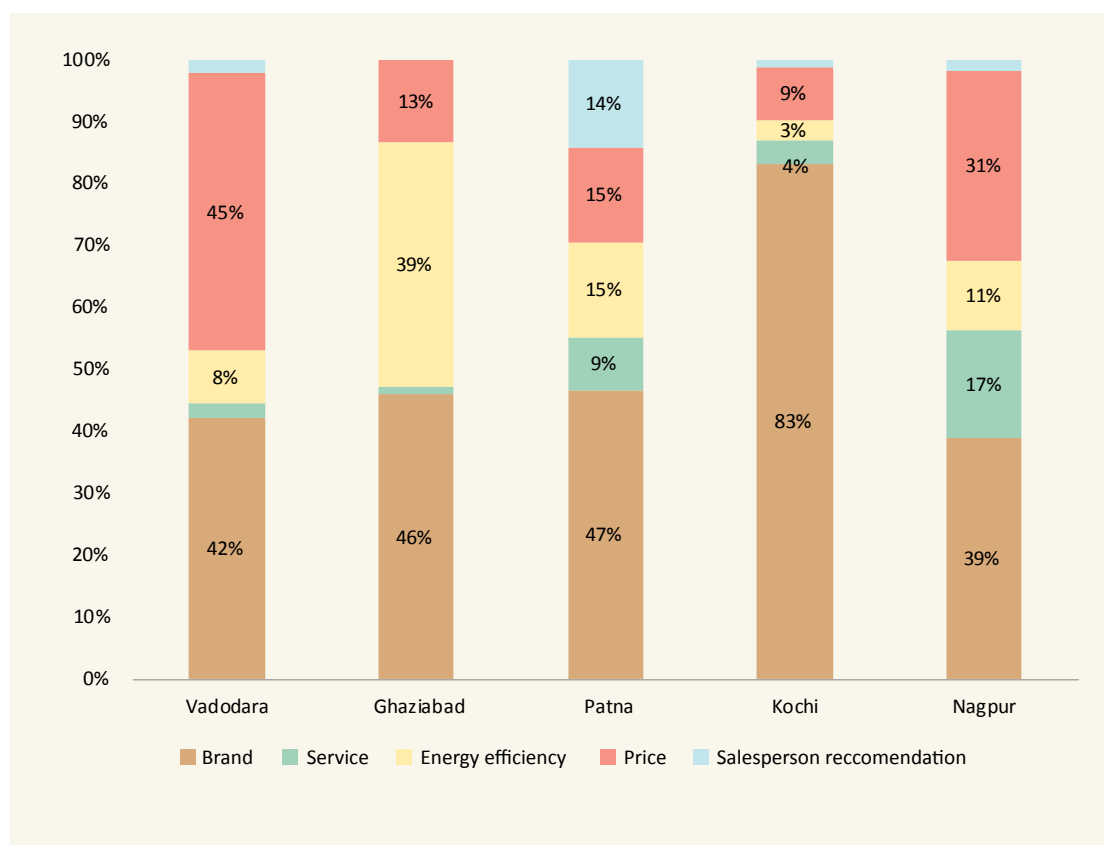
AC usage varies significantly within and across cities but average use is restrained

The average annual usage of the all the ACs in the sample stock is about 1,077 hours. The average annual usage of the most used AC is about 1,150 hours while that of the second most used AC is 977 hours. These numbers are significantly less than BEE's assumption of average annual usage of 1,600 hours. Although lower usage hours contribute to lowering the overall energy consumption from ACs, they also increase the payback period on the incremental price paid for energy efficient variant of an AC. High payback periods may deter households from buying energy efficient ACs. The use, however, varies both within and across cities. Households in Ghaziabad, Patna and Nagpur use their ACs for 4-5 months of the year whereas households in Vadodara and Kochi use their ACs for close to 7 months of the year. The hours of usage of ACs is slightly higher on weekends than weekdays in all cities. The varied and restrained use of AC needs to be factored in while developing standard payback period examples for consumer awareness or deciding the price points of any incentive programme.

Figure : Distribution of the annual usage hours of the most-used AC
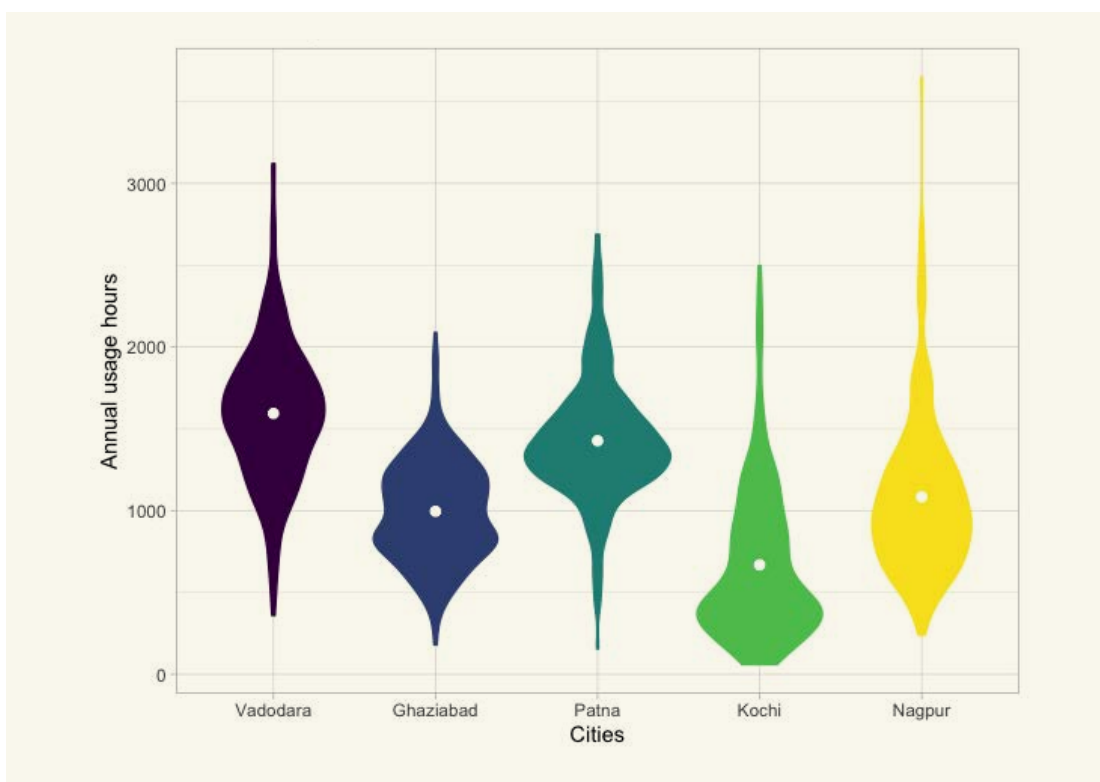
Average AC temperature setting is 21 degrees Celsius

Households in the sample, on an average, keep the temperature setting of their most used AC at around 21 degrees Celsius. This is lowest in Patna at 19 degrees Celsius and highest in Nagpur at 22 degrees Celsius. Only 19% of households in the entire sample set their ACs at 24 degrees Celsius or above. BEE's recent notification of mandating default AC setting at 24 degrees Celsius and increasing the awareness around it can result in households increasing the temperature setting and consequently reducing electricity consumption.

Table: Temperature setting

	Average temperature in degrees Celsius	Proportion of HH who set their AC temperatures at or above 24 degree Celsius
Vadodara	21.6	22%
Ghaziabad	21.8	22%
Patna	19.6	3%
Kochi	21	19%
Nagpur	22	24%

High awareness on negative impact of AC use on environment

About 62% of the households in the sample agree that use of ACs has a negative impact on environment. However, this does not seem to result in action as a regression analysis with usage hours as the dependent variable shows that these households actually consume more than the households do not agree with the negative impact of use of AC. Most households in Ghaziabad (91%) and Kochi (99%) categorize ACs as a necessity. The proportion of households who consider AC

as a necessity is lesser with 70% in Patna and 56% in Nagpur. Vadodara is the only exception where a majority of 55% households categorise ACs as a luxury.

High reliance on local companies for AC servicing

Regular servicing is important to maintain an AC's performance and reduce refrigerant leakage over its life. Majority of the households across the cities service their ACs at least once a year. This varies from 50% in Vadodara to 86% in Kochi. About 71% of all the households rely on local companies either through a contract or a needs-basis arrangement whereas 27% get the servicing done from the manufacturing company. The reliance on the local companies is particularly high in Ghaziabad (97%) and Nagpur (92%). The proposal under the India Cooling Action Plan (ICAP) to certify and train 1,00,000 AC service technicians can increase the adoption of good servicing practices in the local service sector.

Conclusion

India's energy requirement from air-conditioning is bound to grow in future. Policies/programmes developed to manage this burgeoning demand should be people centric to improve their effectiveness. Insights on human behaviour related to air-conditioning, as gathered from surveys like the one in this report, should inform the design of these policies/programmes as well as their periodic assessments to identify mid-course corrections if needed. This will be crucial for India to meet its increasing cooling demand in a sustainable manner and achieve the goals stated under India Cooling action plan.

1. Introduction

India's energy requirement for space-cooling is expected to increase significantly. The annual per capita space cooling energy consumption was estimated to be about 70 kWh in 2016 as compared to about 325 kWh in China, 840 kWh in Japan, and 1,880 kWh in the United States. International Energy Agency (IEA) projects a 15-fold increase in India's cooling related electricity consumption from 2016 to 2050 in its reference scenario (IEA, 2018). It also projects the contribution of space-cooling to India's peak electricity demand to increase from 10% to 45% in the same period. India Cooling Action Plan (ICAP) (MoEF&CC, 2019) was launched in 2019 by the Ministry of Environment, Forest, and Climate Change (MoEFF&CC) with a goal *to provide sustainable cooling and thermal comfort for all while securing environmental and socio-economic benefits for the society.* ICAP projects the space cooling energy requirement to grow to four times in 2037-38 as compared to the baseline in 2017-18 in its reference scenario. Room air-conditioners (ACs) are expected to be the major contributors to this increase in demand. ICAP projects ACs to contribute to 50% of the total space-cooling energy consumption in 2037-38. Furthermore, this demand for ACs is expected to be driven by the residential sector. This can be attributed to current low levels of AC ownership (about 7-9%) in Indian households coupled with increasing trends in urbanization, local temperatures, and household incomes.

Rising demand for space-cooling and particularly the use of ACs has the potential of putting enormous strain on India's power system by not only pushing up the overall electricity demand but also requiring to build generation and distribution capacity to meet the demand at peak. The increasing demand for energy from the use of ACs can be curbed by using passive cooling techniques that can eliminate or reduce the use of ACs, promoting the use of alternative, less energy consuming appliances like fans and coolers, and finally promoting the adoption of energy efficient ACs and their conservative use. India already has a few policies/programmes in this regard. The Bureau of Energy Efficiency (BEE), India's nodal agency for energy efficiency and conservation, launched voluntary Energy Conservation Building Codes (ECBC) for residential sector in 2018 (BEE, 2017). BEE also has a mandatory Standards and Labeling (S&L) programme for ACs since 2009 (BEE, 2019). The standards have been updated twice till date. Energy Efficiency Services Ltd (EESL), a public sector company, recently announced a programme to sell super-efficient ACs through its own e-commerce portal (EESL, 2019) at a discounted price. A few distribution companies (DISCOMs) have also been running small pilot-scale programme selling 5-star rated ACs at a discounted price (TPDDL, 2020). The success of these policies/programmes depend on people's response. Income, price, climate and other external factors can elicit different responses from different people and impact their behaviour regarding purchase and use of ACs. A systematic understanding of consumer behaviour can inform the design of policies/programmes as well as enable periodic assessment of the outcomes of these interventions and identify the need for mid-course corrections if any.

However, research on the household behavior related to AC is limited in India. Sachar et al.(2018) conducted a survey of 975 households from more than 100 cities and towns across India using a mix of online surveys and physical surveys to gain insight into AC usage patterns. They found that most of the households set AC temperature below 24 degrees Celsius and concluded that set points are more of psychological preference rather than a physiological response. CLASP in partnership

with the Bureau of Energy Efficiency (BEE) (EDS, 2019) conducted a detailed residential electricity consumption survey including AC usage patterns in about 5,000 households in 20 cities across India representing various socio-economic classes and climatic zones. Jain et al (2018) conducted a willingness to pay (WTP) study using both market data and primary data from survey of 148 respondents in Mumbai and concluded that respondents were ready to pay about 12% of mean price of AC more for a 5-star variant of AC. Indraganti (2011)in summer and monsoon seasons in 2008. The present paper discusses the occupants' methods of environmental control, behavioural adaptation and impediments. Due to poor adaptive opportunities, about 60% of occupants were uncomfortable in summer. The comfort range obtained in this study (26.0–32.5 °C) studied the thermal adaptation habits of about 45 households in Hyderabad and found that households with high income tend to switch on ACs at much lower outside temperature than those with lower income households.

This study adds to the limited literature on the household behaviour related to the purchase and use of AC in India. We focus on the households in Tier-2 cities as multiple studies show them as high growth centers. The Government of India categorises Indian cities into type "X" and "Y" for the purpose of granting house rent allowance to central government employees. Cities categorised as "Y" are also known as Tier-2 cities (MoF, 2015). This is the definition of Tier-2 cities which this report also utilises. They have also seen an improvement in electricity supply quality in recent times. A recent AC industry assessment report (Oswal, 2018) found Tier-2 cities contribute to about 50-55% of the total AC sales. We surveyed 1,500 households in 5 Tier-2 cities spread across India and asked detailed questions on their AC stock attributes, buying behavior, and usage patterns. In this report, we present key findings and policy recommendations from the study.

The survey was conducted between December 2019 and February 2020, before the Covid-19 pandemic. The prevailing suppressed economic activity and changes in work culture are expected to change the demand and use of ACs, at least in the short term. Most probably, households will delay their purchase decisions of high-ticket items like AC. This can be used as a window of opportunity to promote the use of alternative cheaper and lower energy consuming appliances like air-coolers and fans and also push for uptake of more energy efficient ACs.

2. Survey Details

In this section, we describe the sampling strategy, questionnaire, and key demographic & building features of the sample.

2.1 Sampling

The survey was conducted in five Tier-2 cities: Vadodara, Ghaziabad, Patna, Kochi and Nagpur. These cities were chosen based on multiple criteria including climatic zones, regions, and economic activity (see Table 1). India has five different climatic zones based on average temperature and humidity levels (BEE, 2017). We chose cities from three climatic zones excluding the cold climatic zone and temperate zones which have very low demand for air-conditioning.

Table 1: Surveyed cities with climatic zones and regions

City	Climatic Zone	Climate Zone Characteristics	Region
Vadodara	Hot and Dry	Summer: 20-45°C; Winter: 0-25°C Relative humidity: 55%	West
Ghaziabad	Composite	Summer: 27-43°C; Winter: 4-25°C Relative Humidity: 20-25% (dry) 55-95% (wet)	North
Patna	Composite		East
Kochi	Warm and Humid	Summer: 25-35°C; Winter: 20-30°C Relative humidity: 70-90%	South
Nagpur	Warm and Humid		Central

Vadodara is the third largest city in the western state of Gujarat with a number of petroleum refineries, chemical industries, and power sector equipment manufacturing industries. It has hot and dry weather. Ghaziabad is the third largest city in the northern state of Uttar Pradesh and is part of the National Capital Region (NCR) due to its proximity to Delhi. Ghaziabad has been an industrial hub and is home to steel industries, electronics industry and IT enterprises. It has seen rapid development in the last few years. Patna is the capital city of the eastern state of Bihar. Its exports primarily consist of agricultural produce but its economy also relies on the fast moving consumer goods industry, the service sector and more recently the IT industry. Patna has a composite weather and experiences hot summers. Kochi is a coastal city in the southern state of Kerala. Kochi's business sectors include ship-building, seafood and spices exports, chemical industries, information technology (IT), tourism, health services, and banking. Kochi has a moderately hot and humid weather across the year. Nagpur is located in central India and is the winter capital of Maharashtra. Nagpur is moderately rich in mineral reserves and known for mining as a part of its service industry. It is known for being a major exporter of agricultural products (such as oranges, rice) and steel bars, manganese oxide, spun yarn and aluminum sheets. It experiences warm and humid weather across the year with hot summers.

The survey sample consists of 1,500 households with 300 households in each of the 5 cities. Each city was divided into four zones (east, west, north and south). Purposive sampling was employed to identify households with ACs in all the four zones. In case of an apartment complex, maximum two households from the same complex were selected. Two criteria were used to select a household for the survey to meet the research objectives. First, the household must have at least one AC which is used for more than two months in a year. Second, the respondent must be an adult over 18 years with involvement in the purchase decisions of ACs bought by the household. We also did not consider the households that use rented ACs. The survey was conducted between December 2019 and February 2020.

2.2 Questionnaire

The survey questionnaire focused on AC stock attributes in the households and behaviour related to purchase and usage of AC. Respondents were asked questions about the tonnage, type, and efficiency for their entire AC stock. The purchase related questions were asked for the most recently bought AC and the usage related questions were asked for the most used AC. The survey also gathered details on demographic features and building characteristics as they can influence AC purchase and usage decisions. Finally, questions were asked on awareness of environmental impact and energy efficiency of ACs. The survey questionnaire can be found in Appendix B.

Figure 1: Survey questionnaire framework

Demographics	AC Ownership Attributes	Buying Behavior	Usage Patterns
• Family Size • Building • Characteristics • Window types • Carpet Area	• Number of ACs • Age of ACs • Tonnage • Star Rating	• Online or Offline • Sizing • Influencing factors • Awareness of • Govt. programs	• Hours & Months of usage • Temperature Setting • Servicing • Control to reduce environmental impact
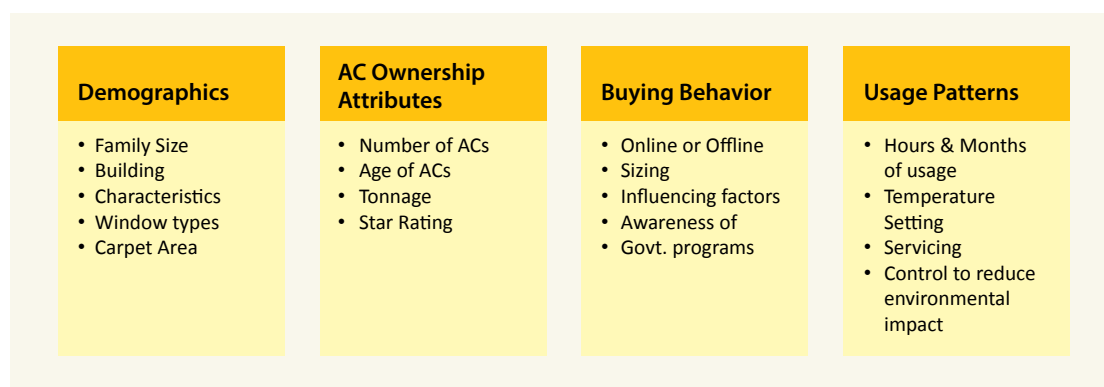
2.3 Demographics & Building Characteristics

We briefly describe the demographics and the building characteristics of the households in the sample provides the context to the survey findings. The average household size of the sample for the five cities varies between 4 to 6 people per household. The average age of the respondent is around 38 years in Ghaziabad, Patna and Nagpur. It is the lowest in Vadodara at 32 and highest in Kochi at 40. The education level of most respondents is graduate level, with the exception of Kochi where majority of the respondents have studied up to 12th grade. About 69% of the respondents are male and 31% are female. The proportion of female respondents is the lowest in Patna at 12% and the highest in Vadodara at 43%.

The households were also asked about their monthly expenditure on food, fuel, electricity and other miscellaneous goods and services such as rent and school fees for children. The monthly per capita expenditure (MPCE) can also be used as a proxy for income. The MPCE varies significantly across the cities as well as within the city (see Figure 2). The average MPCE is the lowest in Patna at Rs. 3,268 and highest in Kochi at Rs. 8,067.

Figure 2: Monthly Per Capita Expenditure (MPCE) distribution of the sample
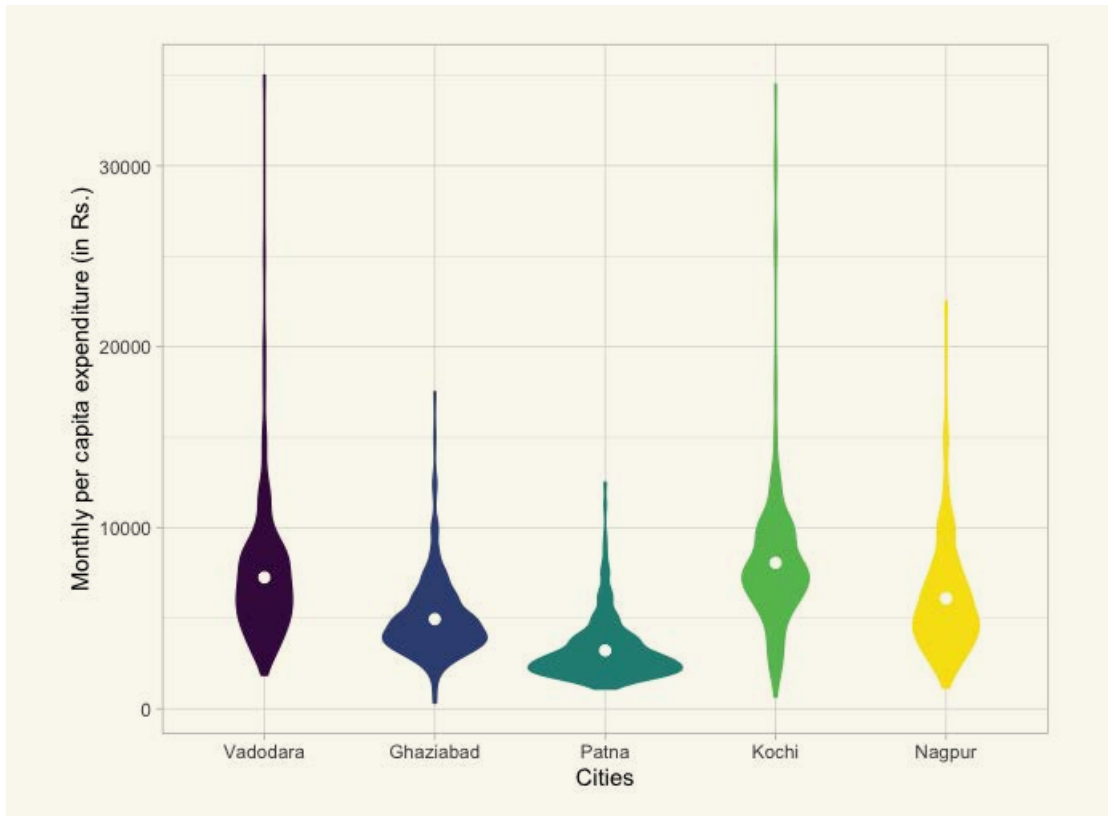
Table 2: Summary of demographics and housing features of the sample

City	Average MPCE (Rs)	Average household size	Average carpet area (sq.ft)	Avg. number of rooms
Vadodara	7,261	4	801	4
Ghaziabad	4,960	5	1,089	5
Patna	3,228	6	804	5
Kochi	8,067	4	1,051	4
Nagpur	6,106	4	1,171	5

Building characteristics play an important role in helping regulate indoor air temperature and humidity and consequently affecting AC usage hours. In all the cities except Ghaziabad, more than 75% respondents reside in bungalows/independent houses. In Ghaziabad, 63% respondents live in bungalows while the rest (47%) live in apartments. The carpet area of a house varies across the cities as well as within a city (see Figure 3). Vadodara and Patna have smaller houses with an average of around 800 sq. ft. while those in Ghaziabad and Kochi have an area of around 1,000 sq. ft. The largest houses are in Nagpur where the average carpet area of all the houses is around 1,200 sq. ft.

Figure 3: Household carpet area distribution of the sample
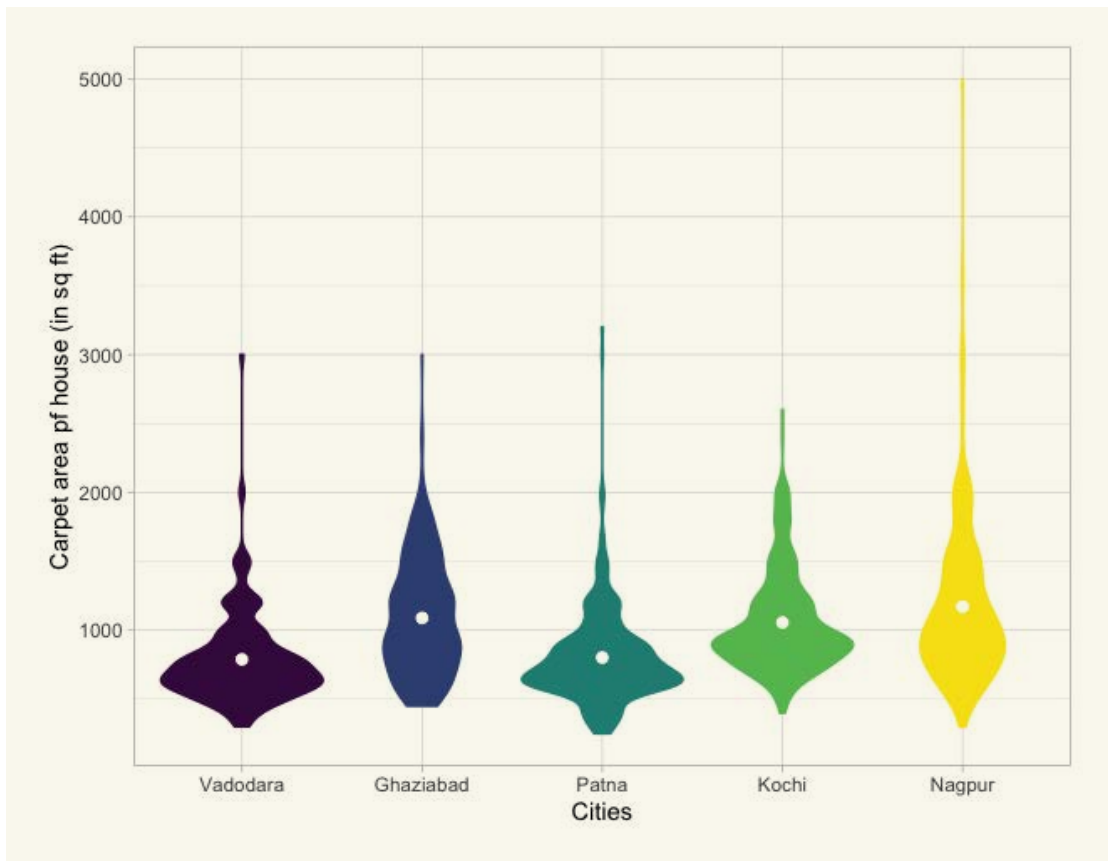
Almost all houses in the sample have roofs made of cement. In all 5 cities, except for Kochi, more than 85% households report using burnt clay bricks for building their houses. In Kochi, half of the houses use bricks and the other half uses concrete blocks.

3. Survey Findings

In this section we discuss key survey findings related to ownership of ACs and behaviour related to the purchase and usage of ACs.

3.1 Ownership Attributes

Room ACs bought by the households in India are typically of two types: split AC which has an indoor unit and an outdoor unit; and a window AC which has a single unit fitted in the window. In both these types there are two options: a fixed speed compressor and a variable speed compressor. An AC with a fixed speed compressor has a fixed cooling capacity and the compressor runs at a constant speed whenever activated by the thermostat. An AC with a variable speed compressor, also called inverter AC, has a variable cooling capacity and can adjust its speed according to the actual cooling requirement. Split ACs are usually more energy efficient and expensive than the window AC. Inverter ACs are more efficient and expensive than fixed speed ACs. Most of the inverter ACs available in market are split type ACs.

Bureau of Energy Efficiency (BEE)'s Standards and Labeling programme (S&L) (BEE, 2019) is mandatory for ACs since 2009. Under this program, BEE gives 5-star rating to the most energy efficient models and 1-star rating to the least efficient model. In the mandatory programme, like that for AC, product below 1-star rating cannot be sold. BEE periodically tightens the standards to keep up with and promote the most efficient commercially available technologies. BEE has revised the standards for ACs twice since its launch to date. BEE introduced a separate voluntary standard for inverter ACs in 2015. In 2018, BEE merged both the standards to make a single mandatory standard for all the ACs. A third revision was expected in 2020 but was postponed to 2021.

3.1.1 Number of ACs

About 63% of the households in the sample own one AC, 33% own two ACs and only 4% own more than 2 ACs. The share of households owning multiple ACs is highest in Patna (51%) and the lowest in Nagpur (25%). As expected, the average Monthly Per Capita Expenditure (MPCE) of the households, a proxy for income, increases with increase in the number of ACs owned.

We compared the average MPCE of the households in each city with the average MPCE of the urban households of the state the city lies in, as recorded by the latest available National Sample Survey (NSS) 68th round of Household Consumer Expenditure (NSSO, 2014). We adjusted the MPCE values from the NSS 68thround which was conducted in 2012 to 2019 by applying inflation rates. We do not consider any growth in the MPCE given the recent uncertainty about the latest NSS household consumer expenditure survey (Seshadri, 2019). Figure 4 shows the average MPCE of households from the sample compared to the average inflation-adjusted MPCE values of urban quintiles from the NSS 68th round. We find that the average MPCE of the households with 1 AC in four cities is less than the average MPCE of the 5th quintile in the respective state whereas in Vadodara it is marginally higher. Although the decision to buy an AC maybe driven by a number of factors other than income, this indicates a possibility of more middle-income urban households buying ACs in future.

Figure 4: Comparison of MPCE of sample with projected NSS 68th round values
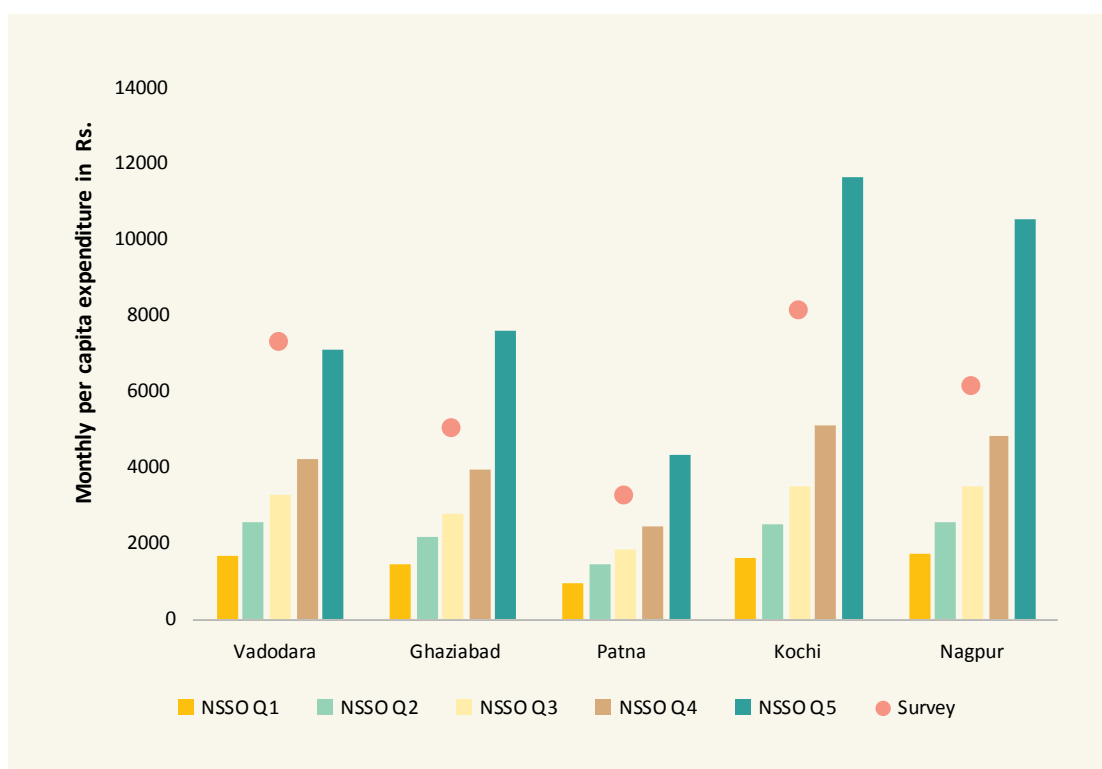
Note: The quintiles within the NSSO data have been computed for the urban sector in the states where the surveyed cities lie.

3.1.2 Stock Features

About 70% of the total stock of the ACs owned by the households in the sample are split type ACs with the rest being window type ACs. Little more than half of the split type ACs are inverter type ACs. Split type ACs dominate in all the cities except for Ghaziabad where about 64% of the total AC stock are window type ACs. In Kochi, about 99% of the AC stock are split type.

Majority (68%) of the ACs in the stock are 1.5 ton in size. About 25% are 1 ton in size with the balance being of different sizes. This pattern is more or less similar in all cities except Kochi where 78% of the ACs are 1 ton in size. Most of the ACs (from 73% in Kochi to 91% in Nagpur) have been bought in last 5 years. Inverter ACs are relatively newer with average age being 3 years. This is expected as inverter ACs were launched only 5-6 years back in Indian markets.

Figure 5: Distribution of types in the AC stock
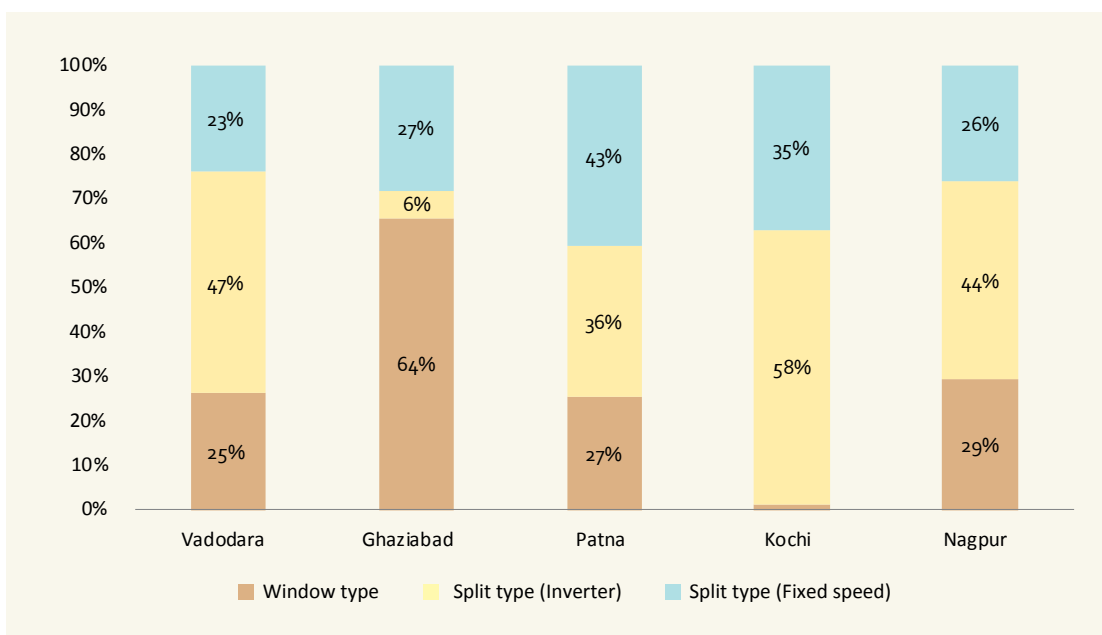
About 44% of the ACs in the stock are 3-star rated, 29% are 5-star rated and 22% are 4-star rated. The share varies across cities: 3-star rated ACs form majority in Ghaziabad, Kochi and Nagpur; 4-star rated ACs in Vadodara; and 5-star rated ACs in Patna. The share remains more or less same for split and window type ACs.

Figure 6: Distribution of star-rated models in the AC stock
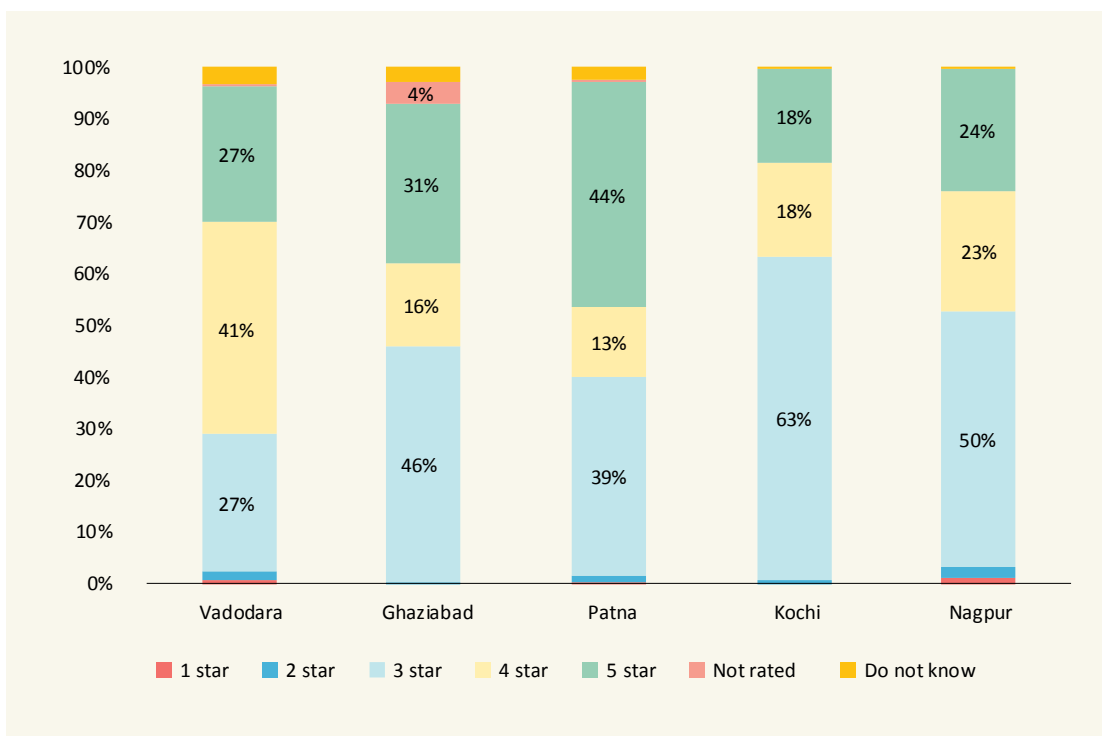
3.2 Buying Behaviour

In this section we discuss the households' behaviour related to the purchase of their most recently bought AC. Almost all recently bought ACs in the sample are new purchases, with only 7 households in the entire sample purchasing a second hand AC.

3.2.1 Factors influencing AC purchase decision

There is no single dominant factor that influences the household's decision to purchase an AC. Multiple factors play a role and their relative importance varies across the cities. We asked a question where people could chose more than one option to elicit these factors from the households (see Figure 7).

Figure 7: Factors influencing AC purchase decision
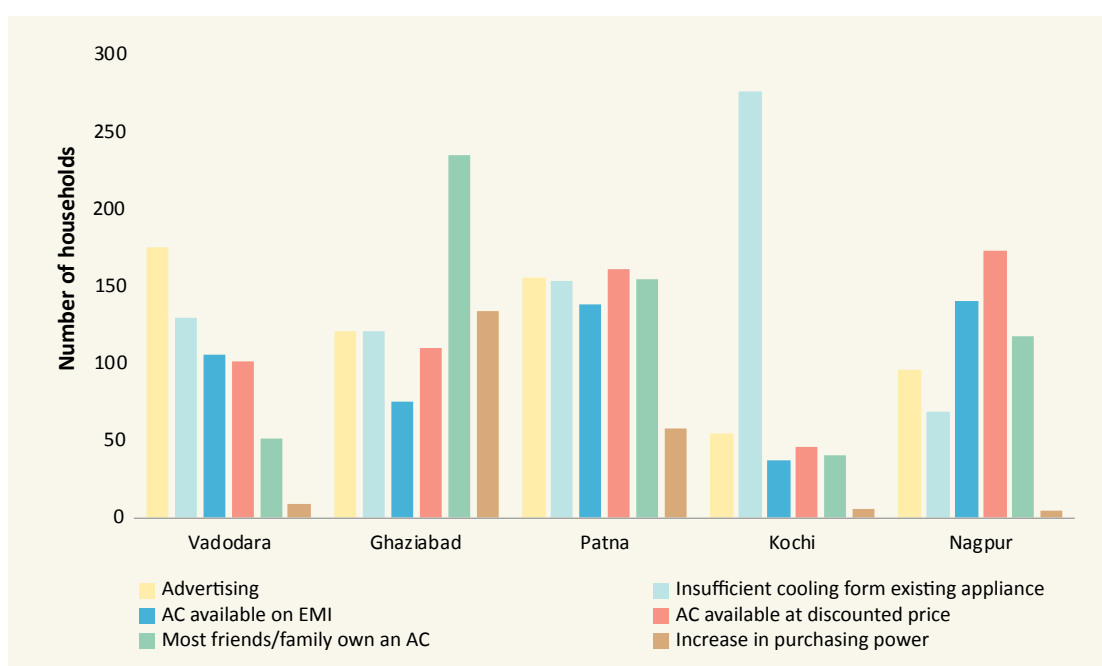
Legend:
- Advertising
- AC available on EMI
- Most friends/family own an AC
- Insufficient cooling form existing appliance
- AC available at discounted price
- Increase in purchasing power

About 50% of the households in the sample identified insufficient cooling from an existing appliance as one of the reasons for buying an AC. This was particularly important in Kochi where 92% of the households identified this reason. Almost all the households used ceiling fans before they purchased AC. This is expected as air-coolers are not effective in a coastal city like Kochi with high humidity. But they can provide better thermal comfort than ceiling fans in hot and dry climate and can be a good alternative for ACs. Air-coolers are also considerably cheaper than ACs, both to buy and to operate. However, in cities like Vadodara, Ghaziabad, and Patna where air-cooler can work as an alternative, we find that the number of households that moved from ceiling fans to AC and those that moved from air-coolers to AC are almost similar. This suggests that quite a few households move directly from ceiling fans to air-conditioners without even considering air-coolers.

About 40% of the households in the sample identified with most friends and family owning an AC as one of the factors influencing their AC purchase decision. This is particularly important in Ghaziabad (78%), Patna (52%), and Nagpur (39%) while not so much in Vadodara (17%) and Kochi (14%). This effect is called the bandwagon effect where consumers demand a commodity in order to conform

with their peers or the people they wish to be associated with, thereby increasing the demand for the commodity.

About 40% of the households in the sample identified advertising as one of the reasons for buying an AC. This is particularly important in Vadodara, Ghaziabad and Patna while not so much in Kochi and Nagpur. Households also cite availability of EMI option (33%) and a price discount (39%) as one of the reasons for buying an AC. This is more dominant in Patna and Nagpur. Only 14% of the households in the sample cite increase in purchasing power as a factor influencing their AC purchase decision. However, the share is high (45%) in Ghaziabad.

3.2.2 Factors influencing the choice of AC

Households were also asked to rank factors such as brand, price, service, energy efficiency and salesperson recommendation in order of importance for their choice of AC. Brand emerged as an important factor across all five cities but more specifically so in Kochi. Price is the next most important factor for households in Kochi and Nagpur. In Vadodara, price is the most important factor followed by brand.

Figure 8: Factors influencing the choice of AC
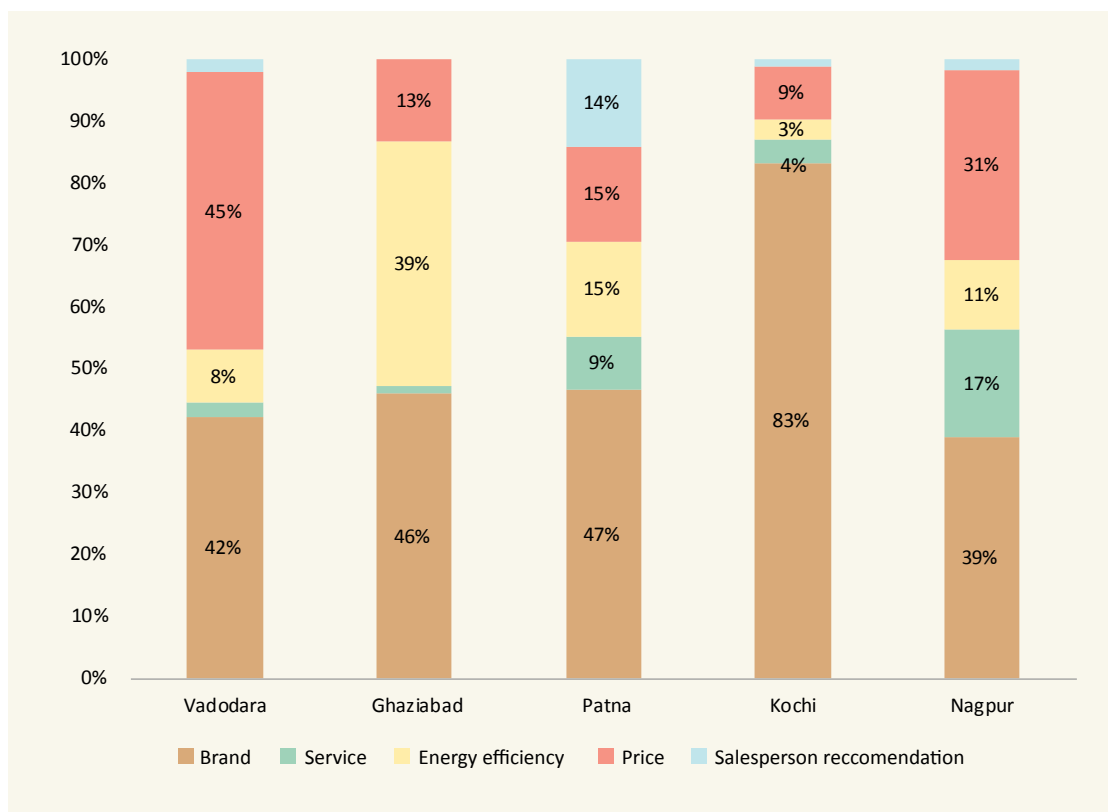
Respondents in Ghaziabad report energy efficiency (star rating) as the second most important factor after brand. However, analysis of the star rating of stock of ACs in Ghaziabad (as discussed earlier) shows that majority ACs (46%) are actually 3-star and 5-star ACs form a much lesser share at 31%. On the other hand, 48% of the households that ranked energy efficiency as the most important variable in their choice of AC purchased a 5-star AC. In contrast, only 28% of the households who did not rank energy efficiency as the important variable purchased a 5-star AC. Salesperson recommendations are hardly significant in any city except for Patna.

21% of the entire sample, availed of an EMI option while purchasing their AC. 64% of the people who availed of the EMI option actually considered EMIs as an important factor in the purchase of an AC. Thus the availability of an EMI option may influence a household's decision for purchasing an AC and a household is quite likely to avail of one if offered. The proportion of households who availed of an EMI option while purchasing their AC is highest in Nagpur at 52% and lowest in Ghaziabad at 3%.

3.2.3   Online or Offline

Only 12 households in the entire sample of 1,500 households purchased their AC online. We asked the rest of the households whether they would like to purchase an AC online in the future. Only 8% of the households said that would buy an AC online in the future. The share is higher in Ghaziabad (18%) and Kochi (10%). There was a sizeable share of households in Patna (56%), Vadodara (40%) and Nagpur (33%) who responded with a 'maybe' to the question. This indicates that with some persuasion they may actually buy an AC online. However, majority of the households in almost all the cities would not want to buy an AC online in the future. This share is highest in Kochi at 83%.

Figure 9: Household response on online AC purchase in future
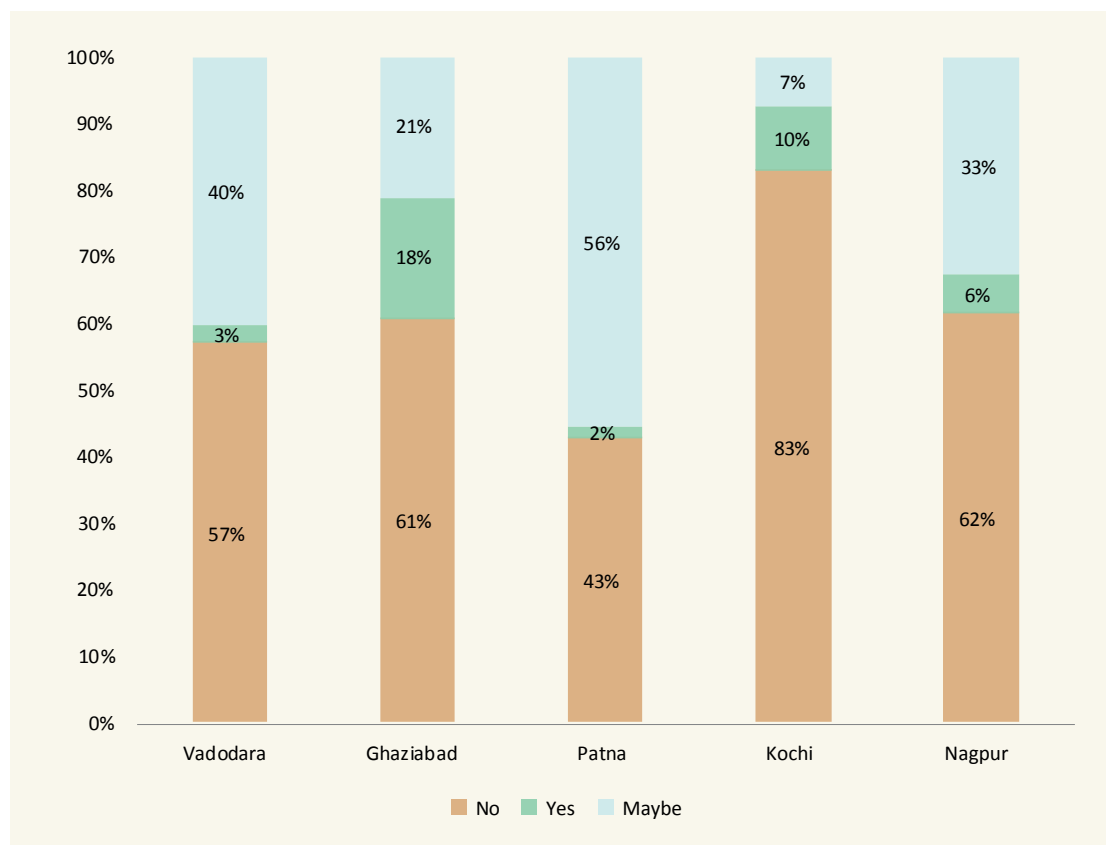
Amongst the households that do not wish to buy their future AC online, 77% said they trust in-store purchases since they get to see the AC and its features in-person. The survey also found that in Ghaziabad, Kochi and Nagpur the average age of the respondent who would like to purchase their AC online is lower than the average age of the respondent who would not consider it.

3.2.4 Price

Prices of some of the common types of ACs bought by the households are given in Table 3. Interestingly, average prices of split (non-inverter) and window type of AC seem to be mostly similar while inverter ACs are expensive. However, the prices vary significantly as indicated by the difference between average and median. The price variation can also be attributed to varying date of purchase and variation in individual features of AC.

Table 3: Prices of ACs bought by the households in the sample

Type of AC	Average Price (Rs)	Median Price (Rs)	No. of ACs in the sample stock
Window – 3 star	31,600	30,000	193
Window – 4 star	32,800	35,000	123
Window – 5 star	30,850	30,500	93
Split (non-inverter) – 3 star	29,700	31,000	192
Split (non-inverter) – 4 star	30,700	33,000	71
Split (non-inverter) – 5 star	33,200	35,000	120
Split (inverter) – 3 star	31,700	30,500	240
Split (inverter) – 4 star	33,800	35,000	125
Split (inverter) – 5 star	37,750	39,000	170

3.2.5 Awareness on Energy Efficiency Programs/Initiatives

Energy Efficiency Services Ltd. (EESL), a public sector company, recently launched a programme for selling super-efficient ACs at a discounted price (EESL, 2019). Consumers can order the AC online on EESL's e-commerce website or also purchase it from selected vendors in some cities. However, less than 10% of the households knew about this programme in all the cities except Vadodara where 44% of the households were aware of the programme.

Bureau of Energy Efficiency (BEE), the government agency that runs the Standards and Labeling programme, has a mobile app which can help consumers search and compare star rated appliances in order to make a better informed purchase decision (BEE). About 41% of the households in Vadodara knew about this app while the share was 12% in Ghaziabad and 10% in Patna, and less than 5% in Nagpur and Kochi.

3.2.6 Size

The right size of AC is an important factor in its operation. An under-sized or over-sized AC can consume more electricity. In all the cities, most households reported relying on their own calculation or guess for the size/tonnage of their most recently purchased AC. Ghaziabad reports the highest percentage of such respondents. In Vadodara, Kochi and Nagpur salesperson's recommendation for size was the next most used method for choosing the AC size. Around 20% households in Ghaziabad and Kochi and 38% in Patna, relied on an on-site visit by technicians. This number is the lowest in Nagpur at 10% and highest in Vadodara at 41%. A preliminary calculation done based on the room

sizes mentioned in the survey and using a web-based calculator available on http://www.bijlibachao.
com [1] indicates that about 64% of the most used ACs are incorrectly sized. About 62% of the
incorrectly sized ACs are under-sized while the rest are over-sized. A regression analysis to examine
the impact of various factors on AC usage hours (more details in Appendix A) shows that over-sized
AC is not a statistically significant factor in explaining the variation in the AC usage hours. However,
the under-sized AC is a significant factor and results in an increase of about 55 hours of usage
annually over a correctly sized one.

Figure 10: Size of AC
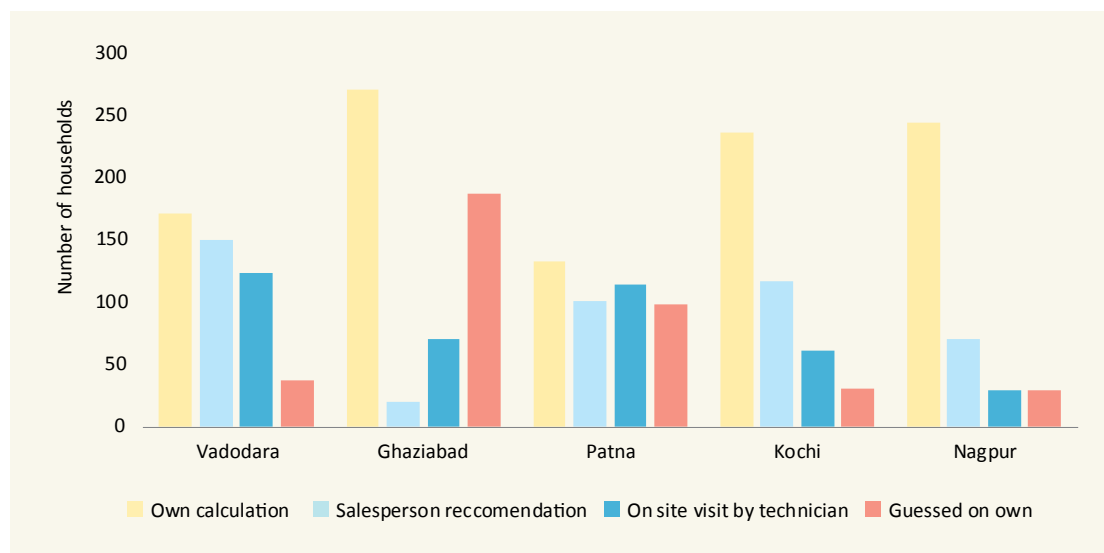
3.3   Usage Patterns

We now discuss aspects related to the usage patterns of the ACs. In case of households that own
multiple ACs, the detailed questions related to the usage were asked only for the most used AC.

3.3.1   Usage hours

The average annual usage of the all the ACs in the sample stock is about 1,077 hours. The average
annual usage of the most used AC is about 1,150 hours while that of the second most used AC is 977
hours. These numbers are significantly less than BEE's assumption of average annual usage of 1,600
hours. BEE uses this assumption to calculate the Indian Seasonal Energy Efficiency Ratio (ISEER)
which is used as a criterion to determine star ratings. The number has also been used by quite a few
studies that estimate present and future energy consumption from ACs as well as potential savings
from energy efficiency models.

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1.   https://www.bijlibachao.com/air-conditioners/air-conditioner-selection-understand-tonnage-eer-cop-and-star-
      rating.html

Figure 11: Distribution of the annual usage hours of the most-used ACs
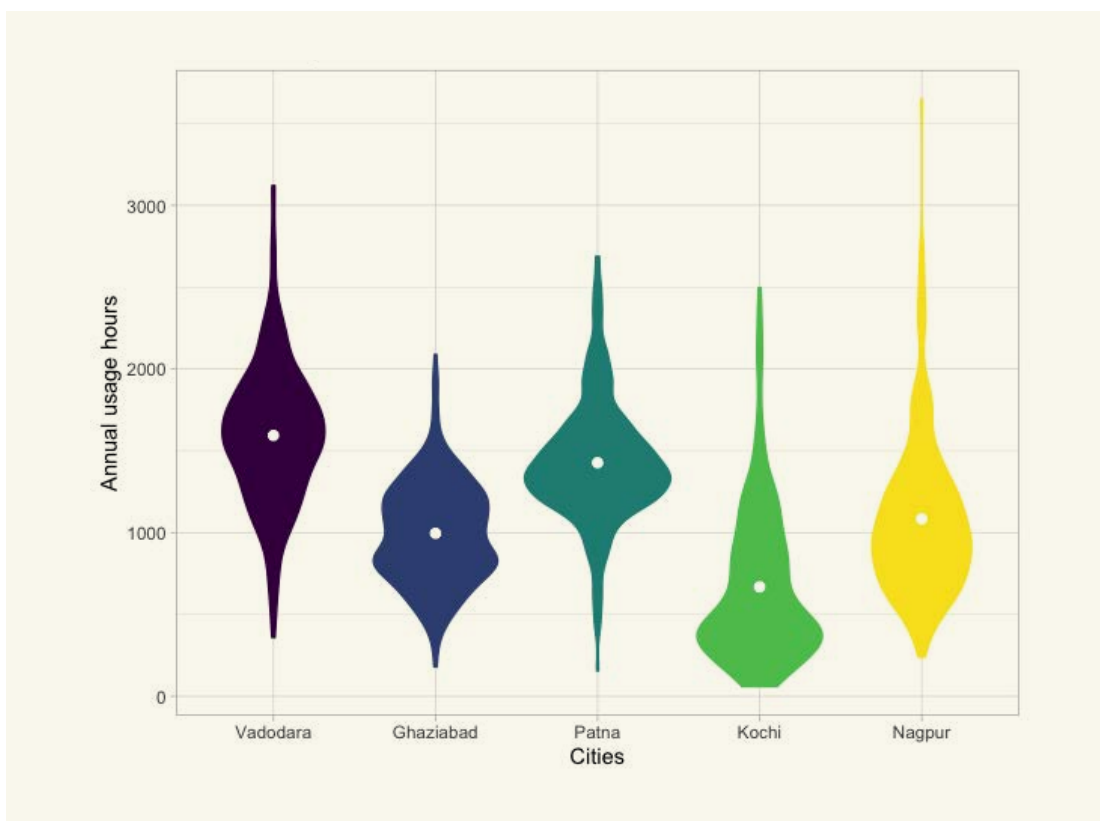
There is significant variation in the usage of ACs both across the cities and within each city (see Table 4). Average annual hours for the most used AC varies from 668 hours in Kochi to 1,593 in Vadodara. Households in Ghaziabad, Patna and Nagpur use their ACs for 4-5 months of the year whereas households in Vadodara and Kochi use their ACs for close to 7 months of the year. Furthermore, households in Kochi use AC for 4 hours per day whereas it varies from 8 hours per day in Ghaziabad to about 12 hours per day in Patna. The usage is also observed to be higher on weekends as compared to weekdays.

Table 4: Summary of months and hours/day of usage

City	Average number of months of usage	Average number of hours of usage / day (weekday)	Average number of hours of usage / day (weekend)	Annual usage hours
Vadodara	7	9.4	9.9	1593
Ghaziabad	4	8	8.8	995
Patna	4	11.5	11.8	1427
Kochi	7	3.9	4.3	668
Nagpur	5	8.3	8.9	1083

3.3.2   Electricity Consumption, Efficiency & Payback Period

We estimate the annual electricity consumption by all the ACs in the sample stock using the type of AC, tonnage, age, efficiency rating and hours of usage as per the survey responses.

Figure 12: Distribution of aggregate AC consumption in households
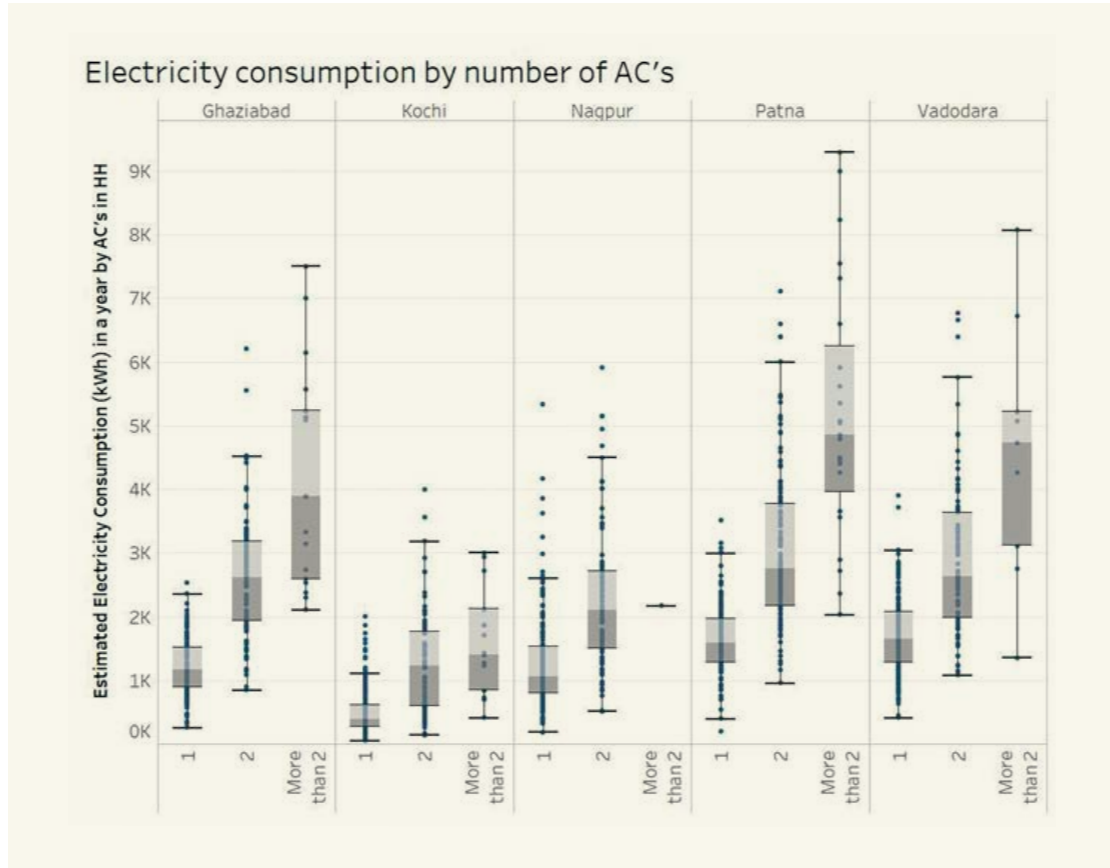
The average annual electricity consumption an AC in the stock is about 1,250 kWh. The average annual electricity consumption of the most used AC is 1,300 kWh and the second most used AC is 1,100 kWh. The aggregate electricity consumption of a household due to ACs increases with increase in number of ACs. Households with one AC consume about 1,250 kWh per year as compared to 2,650 kWh by households owning two ACs and 4,300 kWh by households owning more than 2 ACs. The variation in the usage hours observed across the cities and within the city is reflected in the variation of annual electricity consumption of the ACs (see Figure 12). Kochi consumes the least at about 800 kWh per year due to higher share of 1 ton sized AC, higher efficiency models, and lesser annual usage hours as compared to other cities. Patna is the highest with households consuming about 2,550 kWh per year.

As mentioned earlier, EESL is selling super-efficient ACs with ISEER 5.4 through its bulk procurement programme. We find that the electricity consumption of the most used AC can reduce by an average of 35% across all the sample households if it is replaced by the super-efficient AC considering the reported usage hours. This number varies slightly with 33% in Vadodara to 40% in Ghaziabad. This potential reduction in consumption can be as high as 50% for some households. If the most used AC is replaced by a 5-star AC with ISEER 4.5, the average potential reduction is about 22% considering the reported usage hours.

We also estimate the approximate simple payback periods based on the reported usage hours if the households plan to buy a new energy efficient AC as compared to a new 3-star AC. We assume three options available to the households as shown in Table 5 and assume a tariff of Rs 6/kWh for the marginal electricity saved due to an energy efficient AC. We find the average payback period to be 4.6 years for a 5-star AC and 6.4 for the super-efficient AC. The median is less at about 2.9 years for 5-star AC and 4 years for the super-efficient AC, suggesting a wide variation. The variation in the payback periods is due to the variation in the usage hours across the households in a city and also within cities. As expected, the payback period is higher for the cities with lower average usage hours like Ghaziabad, Nagpur, and Kochi while lower for cities with higher usage hours like Vadodara and Patna. Households expect the AC to run for 10 years on an average across the cities. The expected life is slightly less in Ghaziabad (9 years) and higher in Patna (11 years). Households were not asked whether the estimated payback periods are within an acceptable range. However, the payback periods appear to be on the higher side compared to the expected life.

Table 5: Payback periods & Assumptions

AC	ISEER (kWh/kWh)	Price (Rs.)	Average Payback period (years)	Median Payback Period (years)
3-star AC	3.7	30,000		
5-star AC	4.5	35,000	4.6	2.9
Super-efficient AC (EESL)	5.4	41,000	6.4	4.0

3.4 Usage behaviour

We now discuss few behavioral aspects related to the use of AC. We also briefly discuss the results of a regression analysis we conducted to examine the impact of some of the factors on the AC usage. More details of the analysis are available in Appendix A.

3.4.1 Weather, Income, and Tariff

Weather is the primary driving factor for the use of ACs. However, it also interacts with household income, electricity tariff, and other local cultural factors to influence the actual usage hours. The regression analysis, as expected, shows city as a statistically significant factor explaining the variation in the AC usage. We did not collect the monthly or daily AC usage data due to the challenges involved in respondent recollection of this data. Such data can be used to examine the relationship between AC use and local weather. We use the average annual usage hours and normalize it with Cooling Degree Days (CDD) to make some broad comments on the impact of weather. CDD measures how much the mean temperature exceeds a reference temperature each day over a given period and is generally used to identify the cooling requirements. The reference temperature is typically the temperature beyond which the AC would be switched on. We estimated the CDDs for each city for 2019 using the website www.degreedays.net and assuming a fairly high reference temperature of 28 degrees Celsius for Indian context. We also used the electricity tariff data from the local distribution companies (DISCOMs) to identify the tariff for the 350th unit of electricity per month.

Table 6: Cooling degree days, Income, and Tariff[2]

City	CDD	Average MPCE (Rs)	Tariff (Rs/kWh)	Annual Usage (hours)/CDD
Vadodara	761	7,152	5.2	2.1
Ghaziabad	775	4,871	7.0	1.3
Patna	651	3,277	6.67	2.1
Kochi	359	8,309	6.9	1.9
Nagpur	897	5,944	11.77	1.2

Vadodara and Patna have the highest values for annual usage hours per CDD. The average MPCE (proxy for income) is higher in Vadodara while the tariff is lowest among all the cities. The average MPCE is the lowest in Patna among all the cities but the tariff is also on the lower side. Nagpur has the highest number of CDDs but the lowest value for annual usage hours per CDD. The tariff in Nagpur is significantly higher than all the other cities. This indicates that tariff may actually impact the use of ACs but it needs to be investigated more.

The regression analysis shows MPCE as a statistically significant factor in explaining the variation of AC usage. However, the annual usage hours seem to be decreasing with increase in MPCE by a very small magnitude which needs further examination through a larger sample.

3.4.2 Building Characteristics

Building characteristics play an important role in helping regulate indoor air temperature and humidity and consequently affecting AC usage hours. We asked questions related to building type, building material, roof material, and glazing of windows. In the regression analysis, we find building material to be a variable with statistical significance. Different construction materials have different thermal conductivity. Lower the thermal conductivity of the building's fabric, lesser energy is required to maintain comfortable temperatures and thus lower the use of ACs for cooling needs. Autoclaved concrete (siporex) has lower thermal conductivity than brick which in turn has lower thermal conductivity than concrete. This is also confirmed from survey responses where households report increasing AC usage hours as the material of their houses changes from siporex to bricks to concrete block. The regression analysis shows that wall material is a statistically significant factor in explaining the variation in AC usage hours. Households with siporex walls use AC for 120 hours less compared to those with brick walls. On the other hand, households with concrete walls use AC for 182 more hours as compared to those with brick walls. We also find the floor level is not a statistically significant factor. However, that may be because 85% of the households in the sample live in independent bungalows. Type of glazing of windows is also an important factor. Double glazed windows significantly reduce the requirement for air-conditioning as compared to single glazed windows. The survey had a question on type of glazing but post survey we found some issues in its interpretation by surveyors and hence we are not considering the data.

3.4.3 Awareness on environmental impacts of AC

About 62% of the households in the sample agree that use of ACs has a negative impact on environment. The awareness is high in Vadodara and Ghaziabad, medium in Patna and Kochi, and least in Nagpur (see Figure 13).

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2. Tariff is for 350th unit of monthly electricity consumption.

Majority of these households claim to reduce their AC usage either 'always' or 'sometimes' out of concern for the environment (see Figure 14). However, the regression analysis shows that although this is a statistically significant factor in explaining the variation of AC usage hours, there is a negative co-relation. Households who are aware of the environmental impacts of AC use it for 141 hours more than those who are not aware.

Figure 13: Awareness on impact of AC use on environment
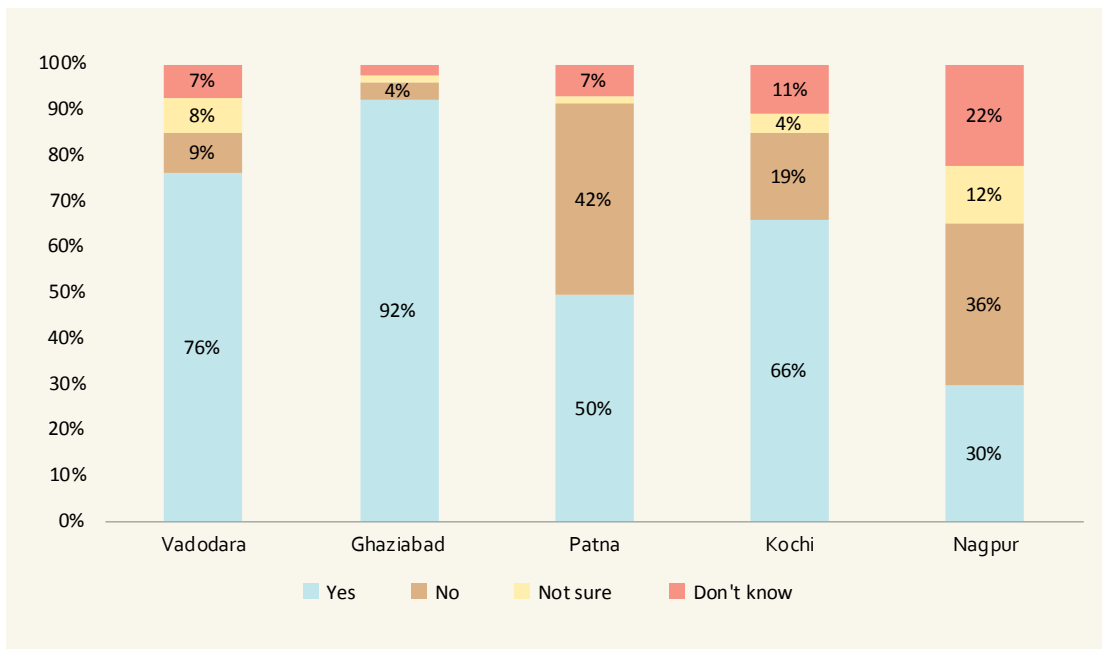
Figure 14: Control of AC usage due to environment concerns
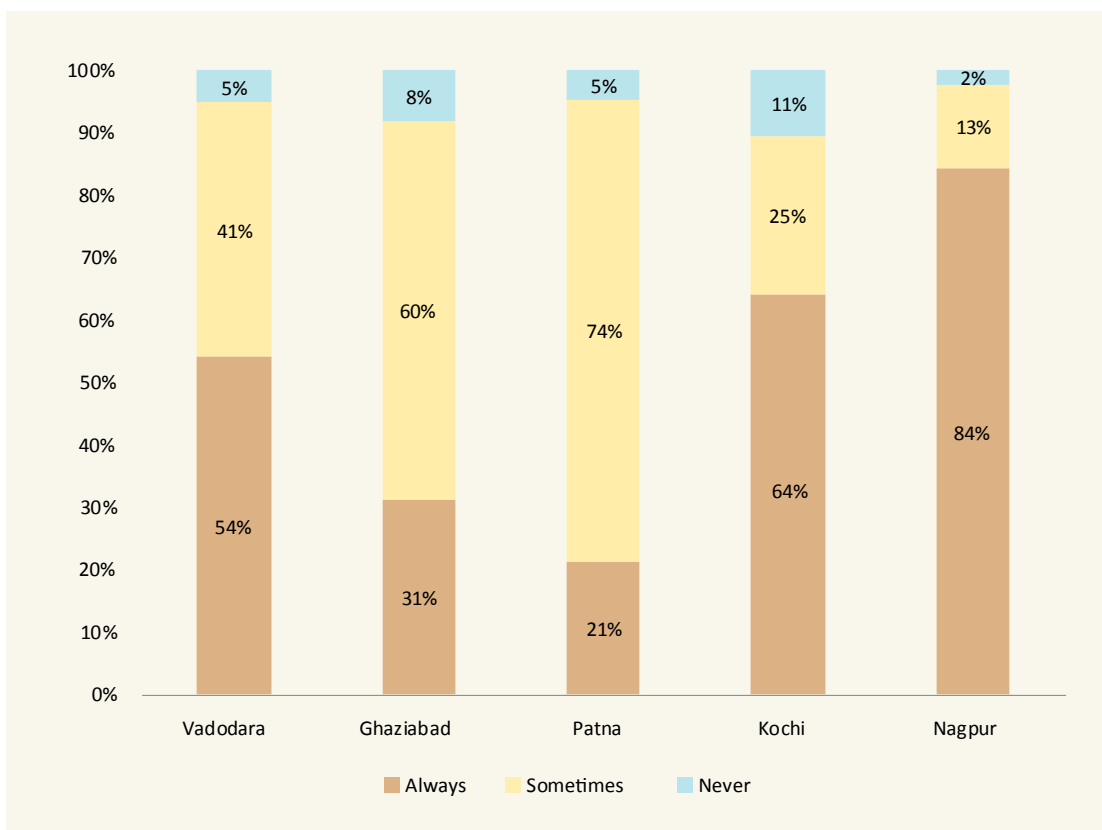
A related question is whether households consider AC as a luxury or necessity. Most households in Ghaziabad (91%) and Kochi (99%) categorize ACs as a necessity. The proportion of households who consider AC as a necessity is lesser with 70% in Patna and 56% in Nagpur. Vadodara is the only exception where a majority of 55% households categorise ACs as a luxury.

Figure 15: AC as Luxury or necessity
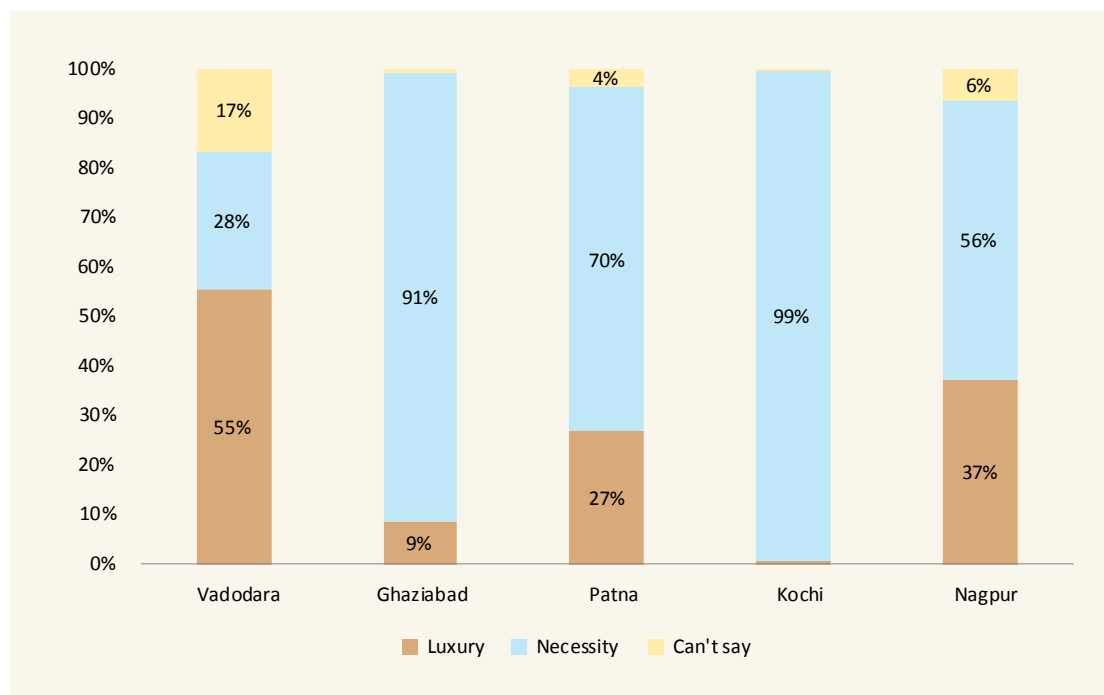
3.4.4 Temperature setting

The temperature setting of an AC significantly affects its electricity consumption. A lower temperature setting requires the compressor of an AC to run for longer time resulting in higher electricity consumption. According to the BEE, one-degree increase in the temperature setting of AC reduces its electricity use by 6% (PIB, 2018). BEE has also mandated the default temperature setting in all room ACs to be 24 degree Celsius from 1st January, 2020 (PIB, 2020).

Table 7: Temperature setting

City	Average temperature in degrees Celsius	Proportion of HH who set their AC temperatures at or above 24 degree Celsius
Vadodara	21.6	22%
Ghaziabad	21.8	22%
Patna	19.6	3%
Kochi	21	19%
Nagpur	22	24%

In the sample, the average temperature at which households set their most used AC is around 21 degrees Celsius. This is lowest in Patna at 19.6 degrees Celsius and highest in Nagpur at 22 degrees Celsius. Only 19% of households in the entire sample set their ACs at 24 degrees Celsius or above, this percentage is lowest in Patna at 3% and highest in Nagpur at 24%.

3.4.5   Demand Response Programme

A number of utilities across the world conduct demand response programmes focusing on residential air-conditioning (ClearlyEnergy, 2016). In these programmes, utilities install a device on the AC and control the load during the peak times through various mechanisms. The consumers are given financial incentives for participating in the programme. We asked consumers if they would be interested in participating in such a programme in future. We made sure that surveyors explain the programme in detail and also mention that such a programme would be voluntary and consumers can over-ride utility control at any given time. We find that majority of households in Ghaziabad (42%) and Nagpur (40%) are willing to take part in such a programme with a further 20-27% responding with a 'maybe' (see Figure 16). The share of the 'maybe' response is high in Vadodara (61%) and Patna (59%). However, almost all the households in Kochi (93%) opposed such a programme.

Figure 16: Willingness to participate in Residential AC Demand Response programme
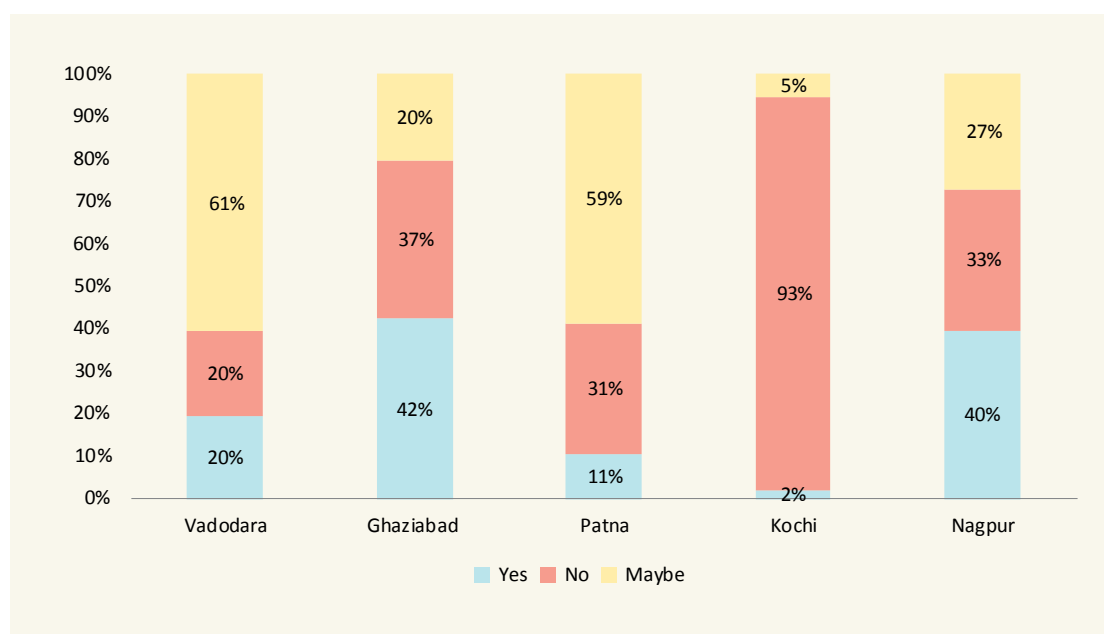
Across the sample, privacy was the biggest concern followed by concerns about possible damage to AC and finally possible inconvenience caused due to the programme. A quarter of the households were not clear on how this programme will actually work. Demand Response programmes can be beneficial for utilities particularly because the use of AC coincides with the peak demand. The survey responses indicate that although there is some willingness to participate in such programmes, utilities will need to design the programme carefully and effectively communicate the roles, responsibilities, and rights of consumers to ensure its success.

3.4.6 AC Servicing

Regular servicing is important to maintain an AC's performance and reduce refrigerant leakage over its life. It can curtail up to 50% reduction in AC's performance over its life (MoEF&CC, 2019). Majority of the households across the cities service their ACs at least once a year. This varies from 50% in Vadodara to 86% in Kochi (see Figure 17).

Figure 17: Frequency of AC servicing
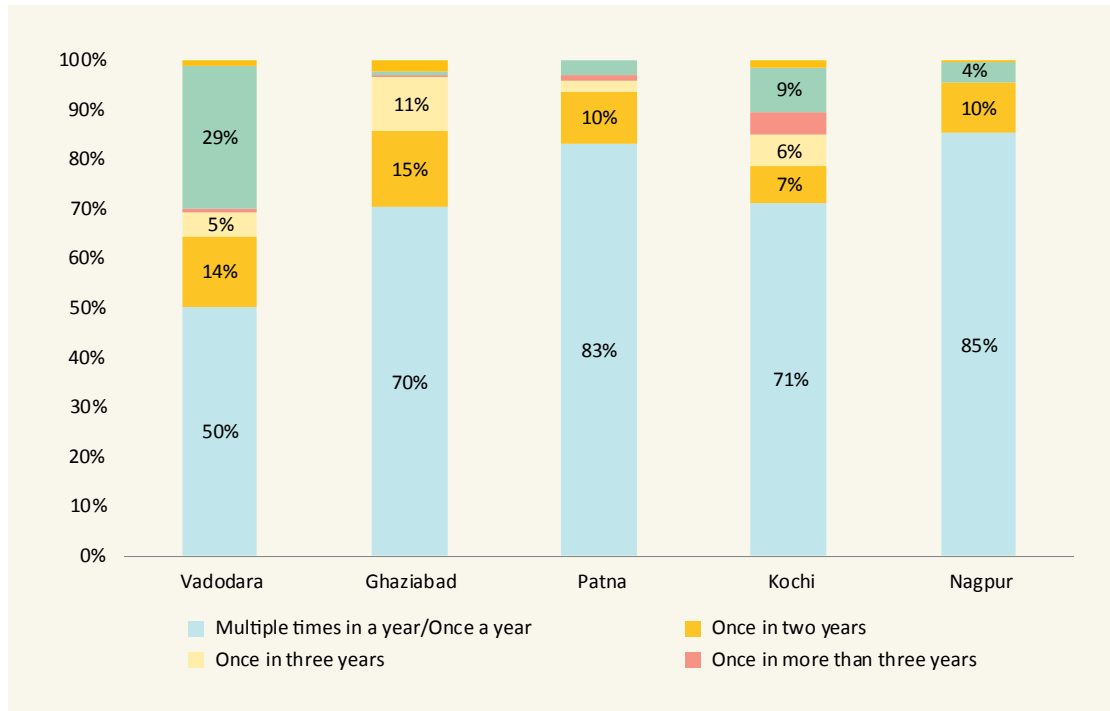
Figure 18: Mode of AC servicing
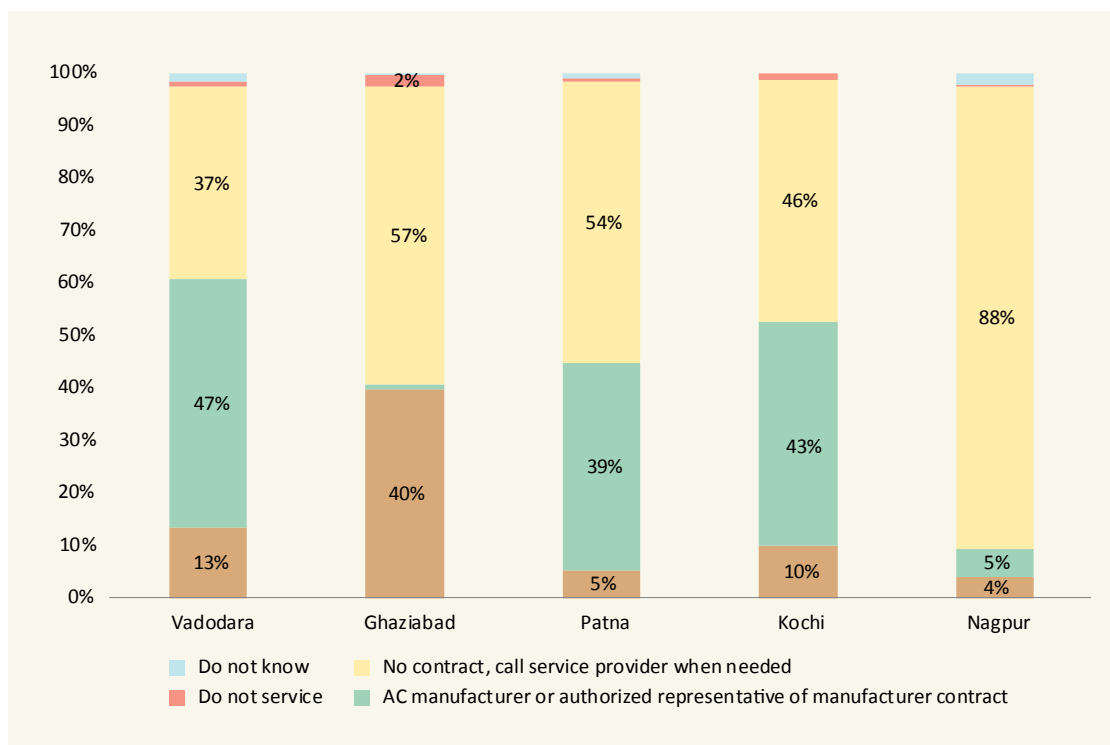
About 71% of all the households rely on local companies either through a contract or a needs-basis arrangement whereas 27% get the servicing done from the manufacturing company. The reliance on the local companies is particularly high in Ghaziabad (97%) and Nagpur (92%) (see Figure 18). A recent study (CEEW, 2017) found that only 30% of the technicians in the local companies are formally trained and certified for AC servicing and many learn servicing through either apprenticeship or by trial and error.

Use of good practices by servicing technicians can reduce refrigerant leakage and minimize the indirect emissions of air conditioning equipment related to power generation by maintaining the rated energy efficiency of in-use equipment. The India Cooling Action Plan (ICAP) (MoEF&CC, 2019) mentions a MoU between the Ministry of Environment, Forest and Climate Change (MoEF&CC) and Ministry of Skill development & Entrepreneurship to skill and certify 1,00,000 AC service technicians under the Pradhan Mantri Kaushal Vikas Yojana – Skills India Mission. This is a step in the right direction and should be continued in long term.

4. Conclusion

Several insights emerge from the survey that can inform policies/programmes developed to manage India's burgeoning air-conditioning demand. These insights may be particular to the five cities surveyed but they can also be indicative of the generic behavior related to air-conditioning exhibited across India.

The average MPCE of the sample households owning one AC in each city is lesser than the average MPCE of the top 5th quintile of all the urban households in that state. Although the decision to buy an AC maybe driven by a number of factors other than income, this indicates a possibility of more middle-income urban households buying ACs in future. Furthermore, about 70% of the sampled households consider AC as a necessity rather than luxury. However, the average use of AC still remains restrained. Quite a few households report controlling their AC usage to reduce their electricity bills. Although this contributes to lowering the overall energy consumption from ACs, the lower usage hours also increase the payback period on the incremental price paid for energy efficient variant of an AC. High payback periods may deter households from buying energy efficient ACs. This needs to be factored while developing standard payback period examples for consumer awareness or deciding the price points of any incentive programme.

Three-star rated models have the highest share in the all the ACs owned by the sample households. This indicates that although periodic tightening of energy efficiency standards of ACs under BEE's Standards and Labeling programme is necessary, it is not sufficient. People may resort to buying lower rated models. Additional interventions are required to get households to buy higher rated efficient models. This would require carefully designed awareness and incentive programmes to promote uptake of higher rated models. The survey reveals that multiple factors play a role in a household's decision to buy ACs and their relative importance varies across the cities. A localized awareness campaign for such efficiency programmes focusing on locally relevant factors can be effective along with a general national level campaign. Some common findings across the cities like households' reluctance of purchasing AC online or the prevalence of the bandwagon effect can be considered to improve the impact of programmes. The awareness about BEE's mobile app to help consumers buy star-rated ACs and EESL's programme of super-efficient AC is also found to be low and efforts can be focused on increasing the same.

The survey findings also reinforce the need for some recent government initiatives. The average AC temperature setting of a household in the sample is found to be 21 degrees Celsius. BEE's mandate of setting default AC setting at 24 degrees Celsius and increasing the awareness around it can result in households increasing the temperature setting and consequently reducing electricity consumption. Similarly, the plan to certify and train 1,00,000 AC service technicians can increase the adoption of good servicing practices in the local service sector which is utilized by about 71% of the households in the sample.

India's energy requirement from air-conditioning is bound to grow in future. Policies/programmes developed to manage this burgeoning demand should be people centric to improve their effectiveness. Insights on human behaviour related to air-conditioning, as gathered from surveys like the one in this report, should inform the design of these policies/programmes as well as their periodic assessments to identify mid-course corrections if needed. This will be crucial for India to meet its increasing cooling demand in a sustainable manner and achieve the goals stated under India Cooling action plan.

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6. Appendices

Appendix A – Regression Analysis

We ran a linear regression analysis in order to analyse the relationship between annual usage hours of the most used AC and other variables such as: location (city), floor level of the house, whether a house is aware of the environmental impacts of using an AC or not, the material with which the house been built i.e. brick, siporex, concrete (with brick as the reference variable), star rating of the most used AC, monthly per capita expenditure, and AC sizing (with correctly sized as the reference variable). The results from the same, can be found in Table 8.

Table 8: Coefficients from regression on annual usage hours and related variables[3]

Annual usage hours and related variables – Regression coefficients	
(Intercept)	1164.23 ***
Ghaziabad	-680.83 ***
Patna	-174.44 ***
Kochi	-953.96 ***
Nagpur	-420.17 ***
Floor level	-8.53
AC usage impacts environment	141.17 ***
Autoclaved concrete (Siporex)	-119.83 .
Concrete block	182.57 **
Most used AC: 2 star rated	90.32
Most used AC: 3 star rated	402.27 .
Most used AC: 4 star rated	456.91 .
Most used AC: 5 star rated	408.55.
Monthly per capita expenditure	-0.011 *
Undersized	54.71 .
Oversized	0.83

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3. *** representing significant at 99.99% level, ** representing significant at 99.9% level, *representing significant at 95% level, representing significant at 90% level

Appendix B – Questionnaire

Question	Possible Answer

(3)   Respondent ID- {0}

(5)   Interview date-{0}

(7)   Interview start time-{0}

(8)   Introduction:

Hello, I am_____from _____.
I am conducting a survey on behalf of Prayas (Energy Group), a Pune based not-for-profit organization working for public interest in India's energy sector. The objective of the survey is to understand how people buy and use air conditioners (ACs) in India. This information can help inform and design policy interventions which will help address the demand from ACs in the future. In this regard, I would like to conduct this survey which will take 20-25 minutes. Information gathered from this survey will be used only for research purposes. Personal data collected will not be shared with anyone. A representative from Prayas (Energy Group) may call you for verification purposes.

(9)   Respondent should be more than 18 years. Respondent should have adequate information to answer questions related to purchase and use of the ACs in home. ACs being used in the home should have been purchased by the respondent's family. Households using gifted ACs, rented ACs or ACs pre-installed by the builder or previous tenants should not be considered. Households that have rented part of their premises should answer the questions only for the part they use.

(10)	Q0_1.Do you agree to participate in the survey?	Yes
		No
(11)	Q0_2. Did your family buy the AC?	Yes
		No
(12)	Q0_3. Does your family use AC for at least 2 months in a year?	
(13)	Basic Information	Yes
		No
(14)	Q1_1. Name of city	Vadodara
		Ghaziabad
		Patna Kochi
		Nagpur
(15)	Q1_2. Zone	North
		East
		West
		South
(16)	Q1_3. Structure of the house	Apartment Independent Bungalow
(17)	Q1_4. Total number of floors in the apartment building/house	
(18)	Q1_5. Floor level of the house	Ground floor
		Basement
(19)	Personal/Household Details	
(20)	Q2_1. Surname of the Respondent	
(21)	Q2_2. Name of the Respondent	
(22)	Q2_3. Can you give us your phone number?	

Please mention that the number will not be shared and is only collected for verification purposes. If the respondent still does not want to give phone number move to next question"

(23)	Q2_4. Can you give us your email id ?	Yes
		No
(24)	Email ID	
(25)	Q2_5. Can you give us the postal address of this house?	

(26)   Q2_6. What is your age?

(27)   Q2_7. Gender of Respondent   Male

                        Female

                        Other

Surveyor selects. Do not ask

(28)   Q2_8. Who was involved in the decision
making for purchasing an AC?   Self
Spouse
Child
Parent
Other
All of the above

(29)   Q2_9. What is your level of education?   No formal Schooling

Up to 12th Class

Graduate

Post-Graduate

(30)   Q2_10. How many people usually
live in this house?

(31)   Q2_11. How many people in the following
age groups usually live in this house?

    (1) *Age group 0-15*

    (2) *Age group 16-30*

    (3) *Age group 31-45*

    (4) *Age group 46-60*

    (5) *Age group more than 60*

(32)   Q2_12. Is this house owned or rented?   Owned

                        Rented

(33)   Q2.12.1 Is any part of this house rented ?   Yes

                        No

(34)   Q2_13. How old is this building?

In years (YY) . Best guess is OK

(35)   Q2_14. What is the carpet area of the house?

In sq. ft. Please exclude the area of rented rooms. Best guess is OK

(36)   Q2_15. How many rooms are there in the house?

Please exclude rented rooms, bathrooms, and toilets

(37)   Q2_16. What is the material of the walls

of the house?

Burnt clay bricks

Autoclaved aerated concrete (Siporex)

Concrete

Block

Other Don't know

(38)   Q2_17. What is the material of the
roof of the house?

Cement

Clay roofing tile

Other

Don't know

(39)   Q2_18. What is the type of the windows?

Non-glazed

Single Glazed

Double-Glazed

Don't know

(40)   AC characteristics

(41)   Q3_1. How many ACs do you have?

(42)   Q3_2. How many ACs do you use regularly?

(43)   (43)

Chapter 6

(45)   I will now ask questions regarding details on
each AC starting with the most used AC

AC1

(46)   Q3_2_1. What room is this AC placed in? - AC 1

Living room

Bedroom 1

Bedroom 2

Bedroom 3

Other

(47)   Q3_2_2. What is the age of this AC? - AC 1
Mark under 1 year as 1 year

(48)   Q3_2_3. What is the type of this AC? - AC 1

Window

Split

(49)   Q3_2_4. What is the type of this split AC? - Inverter

AC 1

Non-inverter

Don't know

(50)	Q3_2_5. What is the tonnage of this AC? - AC 1	0.5
		0.75
		1
		1.5
		1.8
		2 or More than 2
		Don't know
(51)	Q3_2_6. What is the star rating of this AC? - AC 1	1
		2
		3
		4
		5
		None
		Don't know
(52)	Q3_2_7. Is this the most recently bought AC? - AC 1 AC2	Yes
		No
(54)	Q3_2_1. What room is this AC placed in? - AC 2	Living room
		Bedroom 1
		Bedroom 2
		Bedroom 3
		Other
(55)	Q3_2_2. What is the age of this AC? - AC 2 Mark under 1 year as 1 year	
(56)	Q3_2_3. What is the type of this AC? - AC 2	Window
		Split
(57)	Q3_2_4. What is the type of this split AC? - Inverter AC 2	Non-inverter
		Don't know
(58)	Q3_2_5. What is the tonnage of this AC? - AC 2	0.5
		0.75
		1
		1.5

1.8

2 or More than 2

Don't know

(59)   Q3_2_6. What is the star rating of this AC?

    - AC 2

1

2

3

4

5

None

Don't know

(60)   Q3_2_7. Is this the most recently bought AC? - AC 2

Yes

No

(61)   Q3_2_8. What can you say about the use of this AC as compared to the most used AC in summer months? - AC 2

Similar
Slightly lesser (25% lesser)
Half as much (50% lesser)
Significantly lesser (75% lesser) This AC is hardly used

    AC3

(62)   Q3_2_1. What room is this AC placed in? -

    AC 3

Living room

Bedroom 1

Bedroom 2

Bedroom 3

Other

(63)   Q3_2_2. What is the age of this AC? - AC 3 Mark under 1 year as 1 year

(64)   Q3_2_3. What is the type of this AC? - AC 3

Window

Split

(65)   Q3_2_4. What is the type of this split AC? - Inverter

    AC 3

Non-inverter

Don't know

(66)   Q3_2_5. What is the tonnage of this AC? -

    AC 3

0.5

0.75

1

1.5

1.8

2 or More than 2

Don't know

(67)	Q3_2_6. What is the star rating of this AC? - AC 3	1
		2
		3
		4
		5
		None
		Don't know
(68)	Q3_2_7. Is this the most recently bought AC? - AC 3	Yes
		No
(69)	Q3_2_8. What can you say about the use of this AC as compared to the most used AC in summer months? - AC 2	Similar
		Slightly lesser (25% lesser)
		Half as much (50% lesser)
		Significantly lesser (75% lesser)
		This AC is hardly used

AC4

(70)	Q3_2_1. What room is this AC placed in? - AC 4	Living room
		Bedroom 1
		Bedroom 2
		Bedroom 3
		Other
(71)	Q3_2_2. What is the age of this AC? - AC 4 Mark under 1 year as 1 year	
(72)	Q3_2_3. What is the type of this AC? - AC 4	Window
		Split
(73)	Q3_2_4. What is the type of this split AC? – Inverter AC 4	Non-inverter
		Don't know
(74)	Q3_2_5. What is the tonnage of this AC? - AC 4	0.5
		0.75
		1
		1.5
		1.8
		2 or More than 2
		Don't know
(75)	Q3_2_6. What is the star rating of this AC? - AC 4	1
		2
		3
		4
		5

		None
		Don't know
(76)	Q3_2_7. Is this the most recently bought AC? - AC 4	Yes
		No
(77)	Q3_2_8. What can you say about the use of this AC as compared to the most used AC in summer months? - AC 4	Similar
		Slightly lesser (25% lesser)
		Half as much (50% lesser)
		Significantly lesser (75% lesser) This AC is
	AC5	hardly used
(78)	Q3_2_1. What room is this AC placed in? - AC 5	Living room
		Bedroom 1
		Bedroom 2
		Bedroom 3
		Other
(79)	Q3_2_2. What is the age of this AC? - AC 5 Mark under 1 year as 1 year	
(80)	Q3_2_3. What is the type of this AC? - AC 5	Window
		Split
(81)	Q3_2_4. What is the type of this split AC? - Inverter AC 5	Non-inverter
		Don't know
(82)	Q3_2_5. What is the tonnage of this AC? - AC 5	0.5
		0.75
		1
		1.5
		1.8
		2 or More than 2
		Don't know
(83)	Q3_2_6. What is the star rating of this AC? - AC 5	1
		2
		3
		4
		5
		None
		Don't know
(84)	Q3_2_7. Is this the most recently bought AC? - AC 5	Yes
		No

(85)	Q3_2_8. What can you say about the use of this AC as compared to the most used AC in summer months? - AC 5	Similar Slightly lesser (25% lesser) Half as much (50% lesser) Significantly lesser (75% lesser) This AC is hardly used
(86)	AC buying behaviour	
(87)	I will now ask some questions related to the most recently bought AC	
(88)	Q4_1. Where did you purchase this AC?	Online Store
(89)	Q4_1_1. Will you consider buying an AC online?	Yes No May be
(90)	Q4_1_2. Why would you not consider purchasing an AC online?	Do not make any online purchases Trust store purchase compared to online buying since I get to see AC and its features in person Value salesperson recommendations Others
(91)	Q4_2. Is this AC new or second-hand?	New Second-hand
(92)	Q4_3. Please select which of the following factors influenced on your decision of buying this AC Read all the options	Advertising: Newspaper/ Magazines/ TV ads/ Social media ads Insufficient cooling from existing cooling appliance AC available on EMI AC available at discounted price Most friends/family own an AC Increase in purchasing power
(93)	Q4_3_1. Which cooling appliance did you most depend on before buying this AC	AC Air-cooler Ceiling Fan Table Fan
(94)	Q4_4. Rank the following factors in order of their importance for your choice of AC Read out all the options and then ask the respondent to rank. Possibly help respondent by asking them what was most important,	

what was next in order of importance,
like a process of elimination

(1) Brand

(2) Service

(3) Energy Efficiency (Star rating)

(4) Price

(5) Salesperson recommendation

(95)   Q4_5. How did you decide on the size of this AC ?

On-site visit by technician
Recommendation by salesperson
Own calculation

(96)   Q4_6.How much did you pay for the AC?   Randomly guessed on my own
                                                       Don't know

In Rs. Best guess is OK.

(97)   Q4_7.Did you avail of an EMI option for   Yes
        purchasing the AC?   No

(98)   Q4_8.What are the minimum number of years   Don't know
        that you expected this AC to last for at the
        time of purchase?

In years. Best guess is OK.

(99)   AC usage behaviour

(100)   I will now ask you questions related to the
        usage of your most used AC

(101)   Q5_1. How many months in a year
        do you use this AC?

Take maximum number if respondent gives
a range of months

(102)   Q5_2. In the last summer, how many hours
        did you typically use the AC between 6 am
        and 6 pm i.e. daylight hours on a weekday

Round off to nearest hour

(103)   Q5_3. In the last summer, how many hours
        did you typically use the AC between 6 am
        and 6 pm i.e. daylight hours on a weekend
Round off to nearest hour

(104)   Q5_4. In the last summer, how many hours
        did you typically use the AC between 6 pm
        and 6 am i.e. night time hours

Round off to nearest hour

(105)   Q5_5. What temperature do you usually
         set your AC?

In degree Celsius

(106)   Q5_6. Do you use ceiling fan while using AC ?   Always
                                                              Mostly
                                                              Sometime
                                                              Never

(107)   Q5_7. What is the carpet area of the room
         in which this AC is placed?   Don't know

In sq. ft Best guess is ok. Surveyor can prompt by
helping the respondent guess the size of the
room x ft by y ft

(108)   Q5_8. How many windows does this room have?

In case of confusion, Count the number of
window frames

(109)   Q5_9. How do you get your AC serviced?   Have a contract with the local
                                                              company
                                                              Have a contract with the AC
                                                              manufacturer or authorized
                                                              representative of manufacturer
                                                              Do not have a contract, but call a
                                                              service provider when need be
                                                              Do not service
                                                              Don't know

(110)   Q5_10. How frequently do you service your AC?   Multiple times in a year Once a year

If the AC is recently purchased, ask about their   Once in two years Once
plan on servicing   in three years

(111)   Q5_11. Has your use of AC increased over time?   Once in more than 3 years
                                                              Don't know

Mark not applicable if AC is under a year old   Significantly
                                                              Slightly
                                                              No change

(112)   Q5_12. During a powercut,   Decreased Not
         does your AC run on back-up ?   applicable
                                                              Yes it runs on an inverter
                                                              Yes it runs on a diesel genset

(113)	Q5_13. How satisfied are you with the cooling provided by this AC ?	No it does not run on any power backup Very satisfied Somewhat satisfied Not satisfied
(114)	Perception related questions	
(115)	I will now ask questions related to your perception of ACs	
(116)	Q6_1. Do you control your AC usage to prevent increase in electricity bill?	Always Sometimes Never
(117)	Q6_2. To your knowledge does the use of an AC impact the environment?	Yes No Not sure Don't know
(118)	Q6_2_1. Ho do you think the use of an AC impacts the environment?	It increases the total electricity demand It increases the chances of refrigerant leakage It increases the local temperature outside home
Read all the options		Other
(119)	Q6_2_2. Do you control your AC usage to reduce its impact on the environment?	Always Sometimes Never
(120)	Q6_3. Do you think of AC as a luxury or necessity?	Luxury Necessity Can't Say
(121)	Q6_4. EESL, a public sector company, has launched a programme to sell super-efficient AC online at Rs 41,000. Are you aware of such a programme?	Yes No
(122)	Q6_5. BEE, a government agency responsible for star rating, provides a mobile app to help consumers search and compare star rated products. Are you aware of such an app?	Yes No
(123)	Q6_6. Suppose the local electricity company launches a programme where they can remotely control the temperature setting of your AC during certain times of day and offer a compensation. Will you participate in such a programme?	Yes No Maybe

Explain to the respondent that Utility {0}
will pay you for letting it control the temperature
of your air-conditioner. {0} may want to do it
to bring down the demand for electricity at certain
times of the day to avoid load shedding. You can
always manually override the control

(124) Q6_6_1. Why would you not be willing to
take part in such a program?

Surveyor will not read out options but choose
one based on the response given by
the respondent.

Concerned about my privacy
Concerned that such a program will
damage my AC
Concerned about inconvenience
that it will cause
I have not understood how this
program will work
Others

(125) Q6_7. Which of the following do you
think will help you reduce your AC usage?

Better building design and
construction material

Read all the options

White painted roofs and external
walls Double-glazed windows
Opening doors and windows
Using ceiling fans with
air-conditioners
Using water within the house for
cooling such as air coolers,
spraying water on walls,
khus curtains
None of the above

(126) Additional Background questions

(127) Q7_1. To your knowledge do any of the
following people own an AC?

Your immediate neighbours
Your close relatives
Your close friends
All of the above
None of the above

(128) Q7_2 - Do you have a home solar power system?

Yes
No

(129) Q7_3. How much did your household
spend on electricity last month? (in Rs.)

(130) Q7_4. How much did your household spend on
electricity in the hottest summer month? (In Rs.)

Approximate the electricity bill for the area in which the household lives by subtracting what the tenant pays

(131)   Q7_5. In a typical month, how much does your household spend on food, fuel, electricity and other miscellaneous goods and services such as rent, school fees for children?

(132)   We would like to express our sincere thanks for giving your time for this survey.   Would not like to disclose

(134)   Interview end time

Related publications of Prayas (Energy Group)

1. Understanding the Electricity, Water and Agriculture Linkages (2018)
   http://www.prayaspune.org/peg/publications/item/395

2. Towards an understanding residential electricity consumption in India (2018)
   https://www.prayaspune.org/peg/publications/item/383

3. PEG Comments and Suggestions NTP July 2018 (2018)
   http://www.prayaspune.org/peg/publications/item/382

4. Clean Cooking Mission: A way to transition to completely smoke-free kitchens Roundtable
   discussion organized by Prayas and the Collaborative Clean Air Policy Centre (CCAPC) (2018)
   http://www.prayaspune.org/peg/past-events/145-roundtable-clean-cooking-mission-a-way-
   to-transition-to-completely-smoke-free-kitchens.html

5. THE OBSTINATE BULB - Moving beyond price-focused interventions to tackle India's persistent
   incandescent bulbs problem (2018)
   http://www.prayaspune.org/peg/publications/item/380

6. Comments and Suggestions for the Draft Amendment in the provisions relating to Captive
   Generating Plant in Electricity Rules, 2005 (2018)
   http://www.prayaspune.org/peg/publications/item/379

7. The journey towards energy savings begins from home (2018)
   http://www.prayaspune.org/peg/publications/item/378

8. Electricity Distribution Companies in India: Preparing for an uncertain future (2018)
   http://www.prayaspune.org/peg/publications/item/377

9. Fuelling the Transition: Costs and Benefits of using Modern Cooking Fuels as a Health Intervention
   in India (2018)
   http://www.prayaspune.org/peg/publications/item/376

10. Pradhan Mantri Ujjwala Yojana: What we need to know (2018)
    http://www.prayaspune.org/peg/publications/item/375

11. Evaluating energy efficiency programmes in India (2018)
    http://www.prayaspune.org/peg/publications/item/374

Rising demand for space-cooling and particularly the use of ACs has the potential of putting enormous strain on India's power system by not only pushing up the overall electricity demand but also requiring to build generation and distribution capacity to meet the demand at peak times. India already has a few policies/programmes to address this increasing demand from ACs. A systematic understanding of consumer behaviour is crucial to design these interventions effectively and to periodically assess their outcomes. In this report, PEG presents insights on questions related to the purchase and usage behaviour of room air-conditioners which are based on a survey of 1500 households in five Tier-2 cities across India. This study adds to the limited literature examining the household behaviour related to the purchase and use of AC in India.

प्रयास

Prayas (Energy Group)