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Household Cooling, Electricity Bills and the Energy-Efficiency Gap in Nagpur District (2019–2023)

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Abstract

In Nagpur, a hot summer isn't something households can simply wait out. Most of them own at least one cooling appliance, and many pay for it every month. This paper looks at what 560 households in Nagpur District told us about the appliances they own, how often they use them, what they pay, and what they do (or don't do) about energy and the environment. Ceiling fans were nearly universal (88.0%), and air conditioners and coolers each reached close to half of the households. About 62% said cooling pushed their electricity bill up. Awareness was high: 75.4% knew about energy-efficient appliances, and 67.3% knew cooling has an environmental cost. But only 34.6% owned an efficient appliance, and 59.3% had taken no specific step to reduce their impact. The gap between knowing and doing is the main story here. We close with practical ideas aimed at the moments when households are most open to change: just before summer and just before a purchase.

Keywords: cooling appliances; household electricity cost; energy efficiency; environmental awareness; consumer behaviour; Nagpur District.

1. INTRODUCTION

1.1 Background of the Study

In hot Indian cities such as Nagpur, cooling appliances are no longer a luxury. Ceiling fans, table fans, evaporative coolers and air conditioners are part of everyday household life, because they affect sleep, work, study and health. The World Health Organization (2021) describes extreme heat as a serious health threat, particularly for older adults, children, outdoor workers and low-income groups, and access to cooling is one-way households protect themselves.

The same appliances also draw a great deal of electricity, especially during the hottest hours of the day. The International Energy Agency (2018) identified space cooling as one of the fastest-growing sources of future electricity demand. Davis and Gertler (2015) explained part of the reason: as incomes rise in warm countries, more households adopt air conditioning, and the energy impact grows with them. At the national level, the India

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Cooling Action Plan sets out three aims: reducing cooling demand, improving appliance efficiency and managing refrigerants responsibly (Ministry of Environment, Forest and Climate Change, 2019).

1.2 Statement of the Problem

Much of the discussion on cooling takes place at the global or national level. Far less is known about how households in a specific hot district own, use and pay for cooling appliances, and whether their awareness of energy efficiency and the environment translates into action. Without district-level evidence, local policy on energy conservation, consumer education and sustainable urban development has little to build on.

1.3 Objectives of the Study

The study has the following objectives:

1. To examine the types of cooling appliances owned and used by households in Nagpur District.
2. To analyse the pattern of electricity expenditure and the increase in bills attributed to cooling appliances.
3. To assess household awareness of energy-efficient appliances and of the environmental impact of cooling.
4. To identify the factors that influence purchase decisions and future purchase intention.
5. To suggest measures that encourage energy-efficient and environmentally responsible cooling.

1.4 Research Questions and Hypotheses

The objectives are expressed as three research questions: (a) what cooling appliances do households own and use, (b) what does cooling cost them, and (c) does awareness lead to sustainable practice. The following hypotheses (stated in alternative form) were tested:

- **H1:** Summer air-conditioner use has a significant effect on the reported increase in electricity bills.
- **H2:** Air-conditioner ownership is significantly associated with reporting a higher electricity bill.
- **H3:** Environmental awareness is significantly related to sustainable cooling practices.

2. Review of Literature

2.1 Cooling Demand, Climate and Public Health

Global research links rising cooling demand to higher temperatures, urbanisation and income growth (International Energy Agency, 2018; Davis & Gertler, 2015). Urban overheating adds to the problem by increasing the energy needed to keep buildings comfortable (Santamouris, 2020). At the same time, cooling is a form of protection against heat-related illness, and Sustainable Energy for All (2023) argues for cooling that is efficient, affordable and accessible to everyone. Cooling is therefore both an adaptation measure and an energy and emissions concern.

2.2 Household Cooling Behaviour in India

Khosla et al. (2021) found that cooling energy use in Indian urban households is shaped by comfort expectations, household decision-making, affordability, electricity prices and perceptions of the available options. Appliance ownership, in other words, does not fully explain cooling behaviour. Habits, social norms and household routines matter as well.

2.3 Energy Labels and Consumer Purchase Behaviour

The Bureau of Energy Efficiency (2026) operates a standards and labelling programme that rates

appliances by star level. Si-dai et al. (2021) reported that energy-efficiency labels can influence the purchase of energy-saving household appliances, but their effect depends on whether consumers understand and trust the label. Efficiency in the appliance itself is also important: Shah et al. (2015) showed that highly efficient room air conditioners combined with low-global-warming-potential refrigerants can considerably reduce the climate impact of cooling.

2.4 Green Purchase Behaviour and the Attitude–Behaviour Gap

Jaiswal and Kant (2018) found that environmental concern and a favourable attitude towards green products encourage green purchasing among Indian consumers, although price, availability and trust can act as barriers. Peattie (2010) similarly argues that sustainable consumption depends on norms, values and practical constraints. This disconnect between holding a favourable attitude and acting on it is commonly called the attitude–behaviour gap.

2.5 Theoretical Framework

The study draws on the Theory of Planned Behavior, which explains intention and behaviour through attitude, subjective norms and perceived behavioural control (Ajzen, 1991). In the context of cooling appliances, attitude refers to how consumers judge efficient and eco-friendly products, subjective norms to the influence of family, neighbours and retailers, and perceived behavioural control to affordability, availability and the ability to understand labels.

2.6 Research Gap

The literature gives strong national and international evidence on cooling demand, labelling and green consumption. However, few studies combine household ownership, usage, electricity cost, awareness and purchase intention for a single hot Indian district. This study addresses that gap for Nagpur District for the period 2019–2023.

3. Research Methodology

3.1 Research Design

The study uses a descriptive and analytical survey design. Primary data were collected from households using a structured questionnaire covering demographics, appliance ownership, usage frequency, electricity expenditure, awareness, satisfaction and purchase intention.

3.2 Study Area

Nagpur District, in central India, was selected because of its hot summers, urban growth, diverse consumer market and smart-city development.

3.3 Sampling Method and Sample Size

Stratified random sampling was used so that different groups of consumers would be represented. In total, 620 responses were received. After screening for incomplete and invalid answers, 60 responses were removed, leaving **560 valid responses** for analysis.

3.4 Profile of Respondents

The largest age group was 26–35 years (31.8%), followed by 36–45 years (24.8%) and 18–25 years (19.8%). Nearly half of the respondents held an undergraduate degree (48.0%) and 27.1% held a postgraduate degree. Women accounted for 49.1% of respondents and men for 48.2%, and about 41% were employed full-time.

3.5 Tools for Data Analysis

Data were analysed using frequency and percentage analysis (Creswell & Creswell, 2018), followed by chi-square tests, analysis of variance (ANOVA), correlation and regression to test the hypotheses. Composite indices for energy-**efficiency** awareness, environmental awareness and sustainable practices were prepared from categorical questionnaire items.

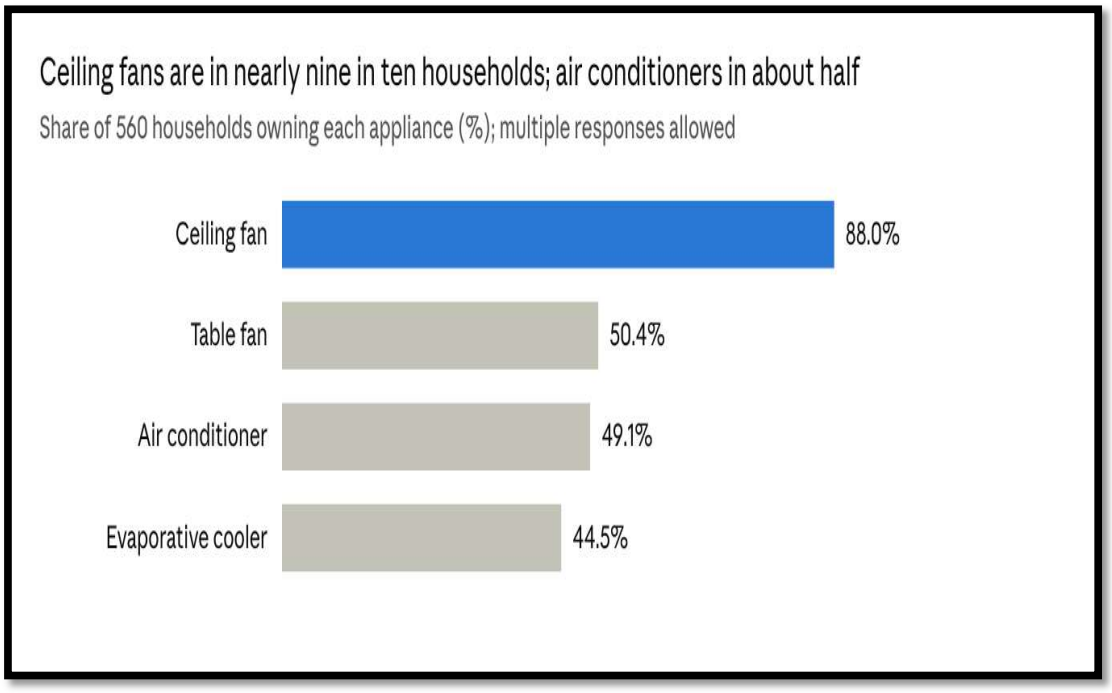
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4. Data Analysis and Interpretation

4.1 Ownership Pattern of Cooling Appliances

Ceiling fans were the most common appliance, owned by 493 of 560 households (88.0%). Table fans followed at 50.4%, air conditioners at 49.1% and evaporative coolers at 44.5%. Respondents could select more than one appliance, so the percentages exceed 100. Most households therefore use a mix of appliances, with fans in regular use and coolers or air conditioners added during peak heat.

Figure 1. Ownership of cooling appliances



Primary household survey, Nagpur District, n = 560 valid responses

4.2 Usage Pattern during Summer

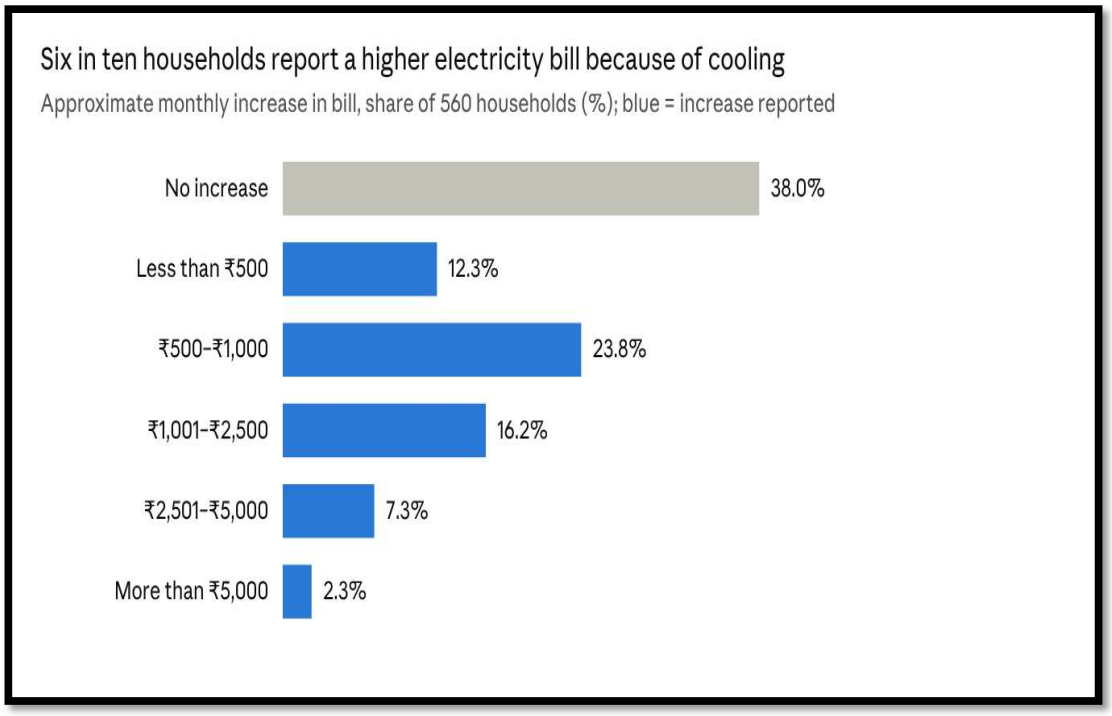
Ownership and actual use differ. During summer, 50.9% of respondents reported that they never used an air conditioner and 55.5% that they never used a cooler. At the other end, 36.7% used an air conditioner often or always (24.6% often and 12.1% always), and 27.9% used a cooler often or always (20.2% often and 7.7% always). Frequent air-conditioner users are a smaller group, but they are the group most likely to drive up electricity cost.

4.3 Electricity Expenditure and Increase in Bills

Most households fell into low-to-moderate expenditure groups: 36.4% paid ₹1,000–₹2,500 per month and 29.6% paid ₹2,501–₹5,000. At the extremes, 18.6% paid less than ₹1,000 and 4.3% paid more than ₹7,500.

When asked about the effect of cooling appliances, 347 households (62.0%) reported an increase in their monthly bill, while 213 (38.0%) reported no increase. The most frequent increase was ₹500–₹1,000 per month (23.8%), and roughly one household in ten reported an increase above ₹2,500.

Figure 2. Increase in monthly electricity bill due to cooling appliances

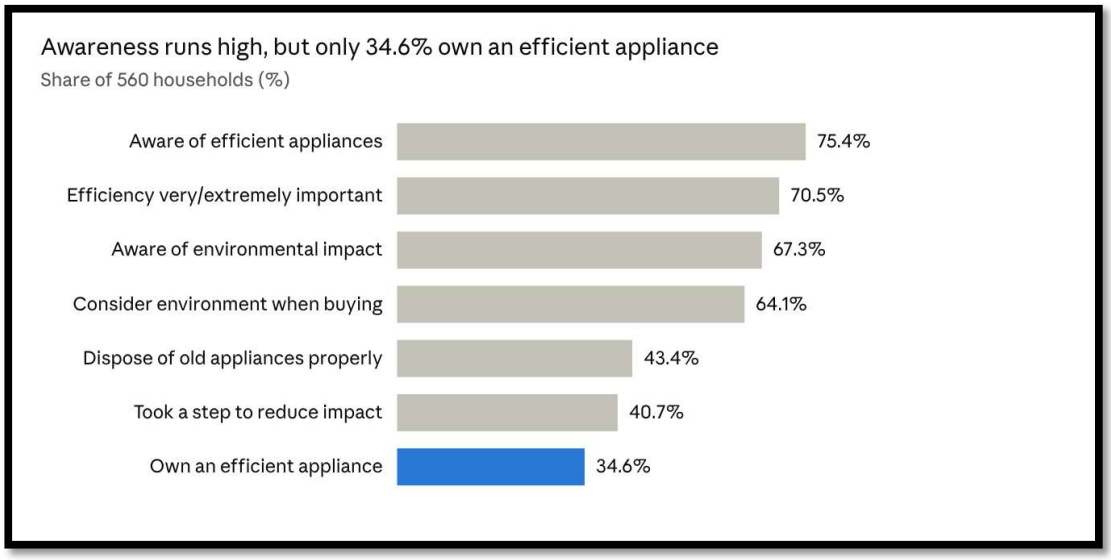


Primary household survey, Nagpur District, n = 560 valid responses

4.4 Awareness versus Adoption

Figure 3 compares what households know and intend with what they actually do.

Figure 3. Awareness, intention and action among households



Primary household survey, Nagpur District, n = 560 valid responses

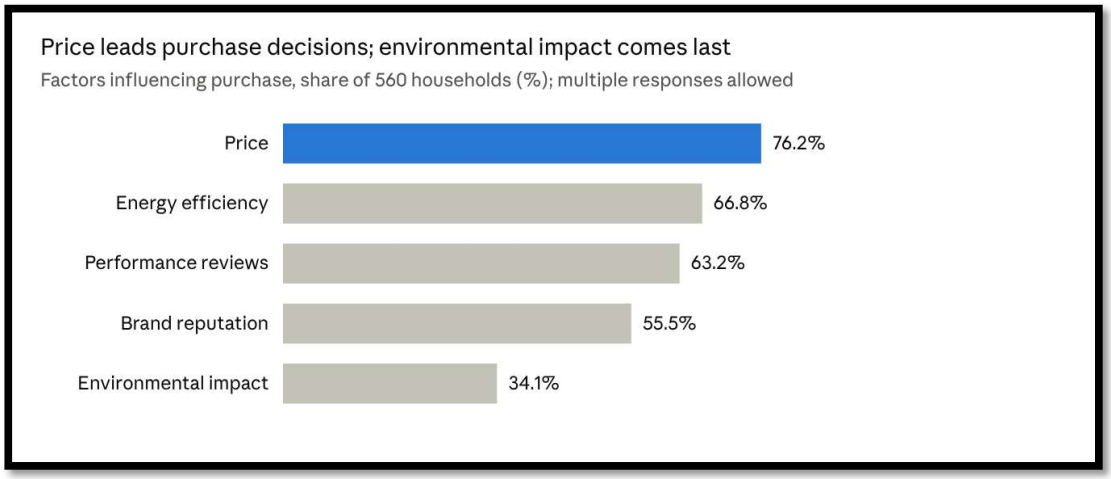
In addition, 58.8% of households believed that cooling appliances contribute to climate change and 26.1% were unsure. Responsible disposal (43.4%) is reported against all respondents; about a quarter (25.4%) had no old appliance to dispose of, while 31.2% did not dispose of old appliances responsibly.

Among the specific measures reported, using energy-efficient appliances (25.2%), regular maintenance (21.8%) and reduced usage (19.8%) were the most common, followed by alternative cooling methods (10.7%). A majority, 332 households (59.3%), reported no specific measure at all.

4.5 Factors Influencing Purchase and Future Purchase Intention

Price was the most frequently cited purchase factor (76.2%), followed by energy efficiency (66.8%), performance reviews (63.2%) and brand reputation (55.5%). Environmental impact was cited by 34.1%. Warranty and after-sales service were rated very or extremely important by 63.7%.

Figure 4. Factors influencing the purchase of cooling appliances



Primary household survey, Nagpur District, n = 560 valid responses

Looking ahead, 36.8% planned to buy a new cooling appliance within a year, 35.2% did not, and 28.0% were unsure. Among planned buyers, 59.2% were considering an air conditioner. The main reasons were replacing an old appliance (35.9%), upgrading to a more efficient model (30.6%) and increasing cooling capacity (21.8%).

4.6 Satisfaction with Cooling Appliances

Among respondents able to rate their appliances, satisfaction was generally positive. Mean scores on a five-point scale ranged from about 3.6 to 3.8 for air-conditioner performance, cooler performance, maintenance, noise level and cooling efficiency.

4.7 Hypothesis Testing

Hypothesis	Test used	Result	Decision
H1: Summer AC use affects the increase in bills	ANOVA	$F = 18.96$, $p < .001$	Accepted
H2: AC ownership is associated with higher bills	Chi-square	$\chi^2 = 61.66$, $p < .001$	Accepted
H3: Environmental awareness relates to sustainable practices	Correlation	$r = 0.185$, $p < .01$	Accepted

A regression of the sustainable cooling behaviour index on energy-efficiency awareness, environmental awareness, purchase intention and income was statistically significant, but only environmental awareness contributed meaningfully ($\beta = 0.185$, $p < .001$). The model explained 3.4% of the variation in sustainable behaviour ($R^2 = 0.034$), which indicates that other factors not captured in the survey also shape behaviour.

5. Discussion

The main result is that awareness is no longer the main obstacle. About three in four households know about energy-efficient appliances and seven in ten consider efficiency important when buying, yet only 34.6% own an efficient appliance.

The Theory of Planned Behavior offers a useful reading of this result (Ajzen, 1991). Attitudes appear favourable, but perceived behavioural control looks weaker: efficient models must be affordable, available and understandable. The finding that price is the leading purchase factor (76.2%) while environmental impact is cited far less (34.1%) is consistent with Si-dai et al. (2021), who found that labels work only when consumers understand and trust them, and with Jaiswal and Kant (2018), who found that price and availability can block green intentions.

The purchase-intention results show an opportunity. Nearly two-thirds of planned buyers were replacing an old appliance or upgrading to a more efficient one, and these are moments when buyers are already comparing models. The choice of appliance also matters for the climate: with air conditioners the leading choice among planned buyers, today's purchase decisions will shape summer electricity demand for years (International Energy Agency, 2018), and efficient air conditioners with low-warming refrigerants offer a clear benefit (Shah et al., 2015).

Finally, the large "never use" shares for air conditioners and coolers, together with high fan ownership,

show that cooling in Nagpur is a layered system and not a single device. This is in line with Khosla et al. (2021), and it implies that policy focused only on air conditioners will miss much of how households actually keep cool.

6. Major Findings

1. Ceiling fans are almost universal (88.0%); air conditioners (49.1%) and coolers (44.5%) are each owned by nearly half of households.
2. About half of respondents never used an air conditioner or cooler in summer, while 36.7% used an air conditioner often or always.
3. Cooling appliances increased monthly electricity bills for 62.0% of households.
4. Awareness is high (75.4% for energy-efficient appliances, 67.3% for environmental impact), but ownership of efficient appliances is 34.6% and 59.3% report no specific measure to reduce impact.
5. Price (76.2%) and energy efficiency (66.8%) are the leading purchase factors.
6. All three hypotheses were accepted; environmental awareness showed a modest positive relationship with sustainable practices ($r = 0.185$)..

7. Recommendations

The recommendations follow from the findings and would need pilot testing.

- **Time the message.** An annual pre-summer awareness campaign between February and April would reach households before bills rise. It should explain thermostat settings, combined use of fans with air conditioners, cooler maintenance and star ratings in rupee terms.
- **Explain life-cycle cost.** Because price dominates, efficiency should be presented as lifetime running cost and not only as a rating. Households reporting high summer bills are a natural first audience.
- **Support upgrades.** Exchange offers, seasonal rebates or low-interest financing could help low- and middle-income households replace old appliances.
- **Strengthen disposal systems.** Clear, authorised take-back and e-waste collection points would help households that wish to dispose of appliances responsibly.

  Promote passive measures. Shading, curtains, ventilation and cool roofs reduce the load on any appliance (Santamouris, 2020).

8. Limitations of the Study and Scope for Future Research

All data are self-reported, so bill increases and habits reflect respondents' recollection and not metered consumption. The cross-sectional design shows association and not causation. The study covers one district, and respondents were relatively young and well educated, so households with lower education or income may be under-represented. Some indices were built from categorical items and the regression explained little variation. The original research design also proposed structural equation modelling and machine-learning prediction; those results are not part of this paper. Future research should combine surveys with actual electricity bills or smart-meter data and extend the study to other cities.

9. Conclusion

Households in Nagpur District depend on cooling and feel its cost, with 62.0% reporting higher electricity bills. They also show considerable awareness of energy efficiency and the environment, but few have acted on it: only 34.6% own an efficient appliance and 59.3% report no specific step to reduce impact.

Information alone is unlikely to close this gap. Efficient choices need to be affordable, easy to understand and available at the moments when households buy, replace or prepare for summer.

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