CAG
Citizen consumer and civic Action Group

CAG's ENERGY AUDITING INITIATIVE FOR HOUSEHOLDS IN TAMIL NADU(Phase I)

AN ANALYSIS OF THE ENERGY AUDIT REPORTS OF 100 HOUSEHOLDS

ENERGY AUDIT FOR TN HOUSEHOLDS PHASE I

In the first phase of CAG's energy auditing initiative, engineers from CAG performed walk-through audits for 100 households (HH) in and around Arakkonam town in Vellore district, Tamil Nadu. This report captures key findings from the audits and highlights the need to promote energy audit for HHs as the first step towards effective energy management.

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INTRODUCTION

In case of energy, less is more. With the ever increasing demand for energy[1] and soaring energy costs,[2] consumers everywhere are seeking to conserve energy and move to energy efficient solutions. As a result, energy audit has been garnering increased interest as a way of improving energy conservation and efficiency across different consumer categories.[3]

Energy audit[4] is the process of determining the types and costs of energy use in a building, evaluating where a building uses energy, and identifying opportunities to reduce consumption. It is an analysis of a facility, which indicates how and where the said facility can reduce energy consumption and save energy costs. Insights from an energy audit can provide concrete measures to (i) promote energy conservation by reducing the number of hours that appliances are used for, and (ii) improve energy efficiency with usage of energy-efficient appliances.

Energy audits can be performed at several levels[5] and for different kinds of consumers. While it is widely adopted and seen as a mandate[6] among most commercial and industrial entities, it is still a new concept for households, especially in India. Through its energy auditing initiative for households in Tamil Nadu (TN), Citizen consumer and civic Action Group (CAG) aims to familiarise the concept of energy audit and thereby promote energy conservation and energy efficiency among household consumers of TN.

BACKGROUND

Household (HH) consumers in Tamil Nadu make up 70% of the electricity connections and 30% of the electricity consumption in the state.[7] A study[8] reveals that Tamil Nadu is among the top three states in the country, that rank high in terms of total residential electricity consumption (REC) and that the state's REC has been growing at a Compound Annual Growth Rate (CAGR) of 7% between 2004 and 2015.

With the increasing residential/HH electricity consumption trends, the State also reflects a growing appetite for electricity. At present, the average power demand of Tamil Nadu is about 14,500 MW to 15,500 MW.[9] In April 2019, power demand in the state had crossed 16,000MW for the first time and TANGEDCO sources highlighted that the increased demand was mainly from HH electricity consumers. The sources further revealed that the demand is expected to rise continuously in the coming years.[10] Under such circumstances, energy conservation and use of energy efficient appliances at a HH level will play a major role in managing the State's ever increasing demand for electricity. And, energy audits which enable consumers to develop a better understanding of the consumption patterns can be seen as a first step in the right direction.

CAG's ENERGY AUDITING INITIATIVE

In the first phase of the initiative, energy audits for 100 HHs[(i)] in and around Arakkonam town in Vellore district, TN, were completed in the month of November 2019. And, based on the findings from the energy audits, customised recommendations to enable energy and cost savings were provided to all 100 HHs.

Vellore District Profile:

Vellore, 135 km west of Chennai is a district in Tamil Nadu which lies in the Eastern Ghats region and Pallar river basin. Broadly classified as hilly terrains and plain regions, the district has a tropical climate with an average annual temperature of 27.9 °C. Vellore experiences dry heat year round; and, April, May and June are considered the hottest months in the district. [11]

(i) Among the 100 HHs audited:
Number of HHs with 1 Bedroom, Hall, Kitchen (1BHK) = 40
Number of 2 Bedroom, Hall, Kitchen (1BHK) = 30
Number of 3 Bedroom, Hall, Kitchen (1BHK) = 30

APPROACH

Engineers from CAG performed walk through audits which involve a tour of the house to visually inspect its operations and energy using systems. The audit further involved analysing patterns of energy usage to generate reports based on the consumers' input and responses. The audit reports thus generated were subsequently shared with the respective HH consumers.

METHODOLOGY

Both qualitative and quantitative methods have been used for this analysis. A user-friendly excel calculator was developed in-house to aid the HH energy audit process w.r.t data collection, analysis and reporting. CAG's energy audit excel calculator comprises six sections under which consumer information around their household energy consumption can be filled in:

- **Introduction**

  Provides basic details of the energy audit tool and the instructions for its use.

- **Basic information**

  In this section, user(s) can fill-in consumer details such as name, address, type of house (1BHK, 2BHK, or 3BHK), built up area, contact number, number of peak i.e., summer months which record higher energy consumption and other off peak months.

- **Data**

  consists of a list of appliances and their corresponding wattage in a dropdown format. User(s) can choose the appliances that are relevant for their HHs and add information such as number of appliances in use and their usage hours.

- **Energy Audit Questionnaire**

  Inquires about consumers' behaviour w.r.t purchase, handling and maintenance of their HH electrical appliances.

- **Summary**

  Presents the annual consumption patterns of the household; provides an appliance level break-up of the energy consumed in units; and further highlights the appliances that consume most energy in units in the audited household.

- **Energy Audit Report**

  Provides the following: (i) a detailed representation on consumption patterns, (ii) Energy Performance Index (EPI) value which provides an insight into consumers' household energy efficiency levels, (iii) a set of customised recommendations based on the responses, provided in the energy audit questionnaire. This report is produced for every audited HH.

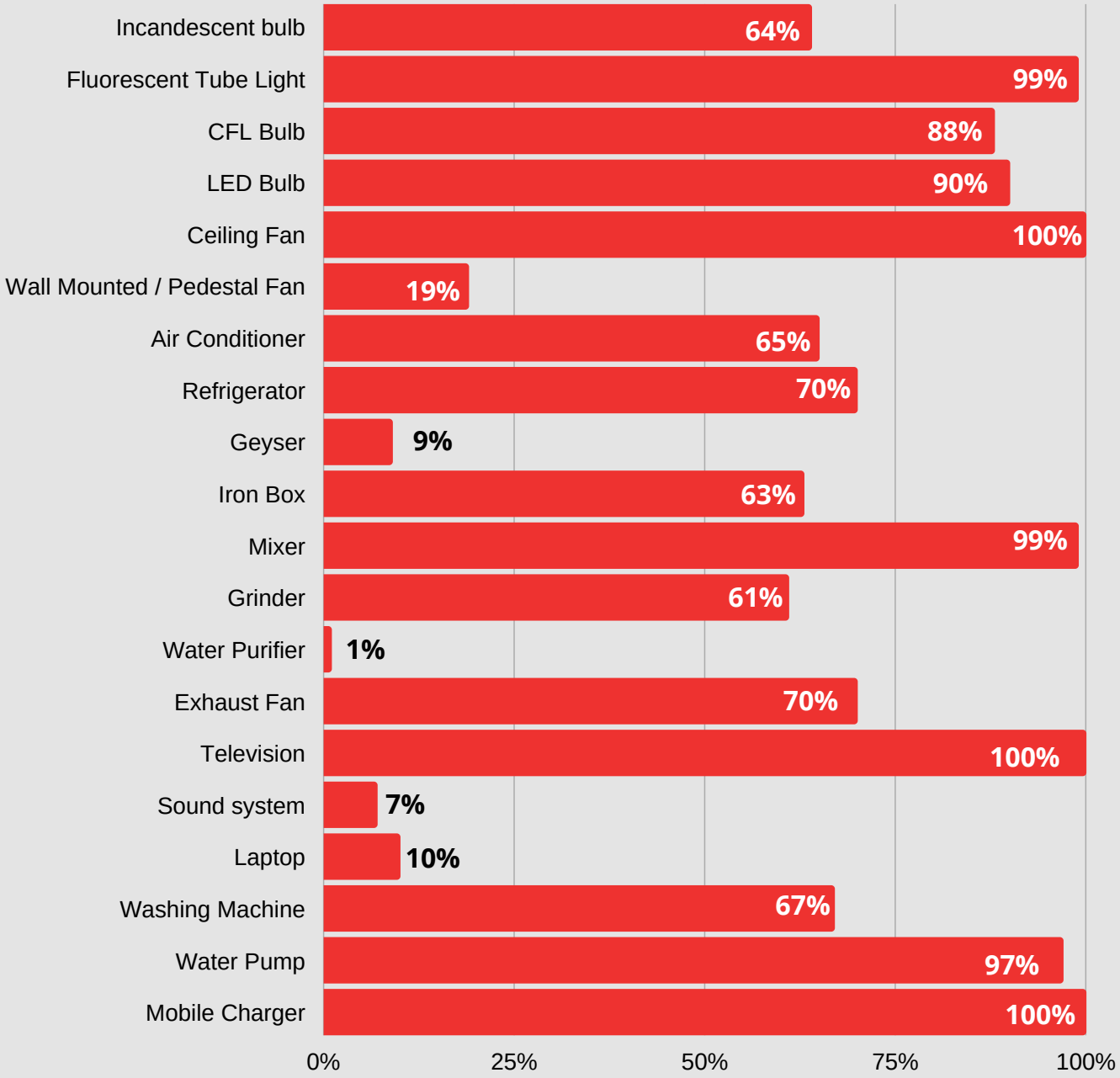
KEY OBSERVATIONS

100 energy audit reports were reviewed and analysed to (1) identify the various electrical appliances utilised in HHs, (2) understand energy consumption patterns of the audited HHs, (3) determine their energy performance, and (4) study their energy usage behaviour.

1.OWNERSHIP OF ELECTRICAL APPLIANCES:

It was observed that about 20 different appliances were being used across the 100 HHs audited. Figure 2 represents the various appliances owned and utilised in audited HHs.

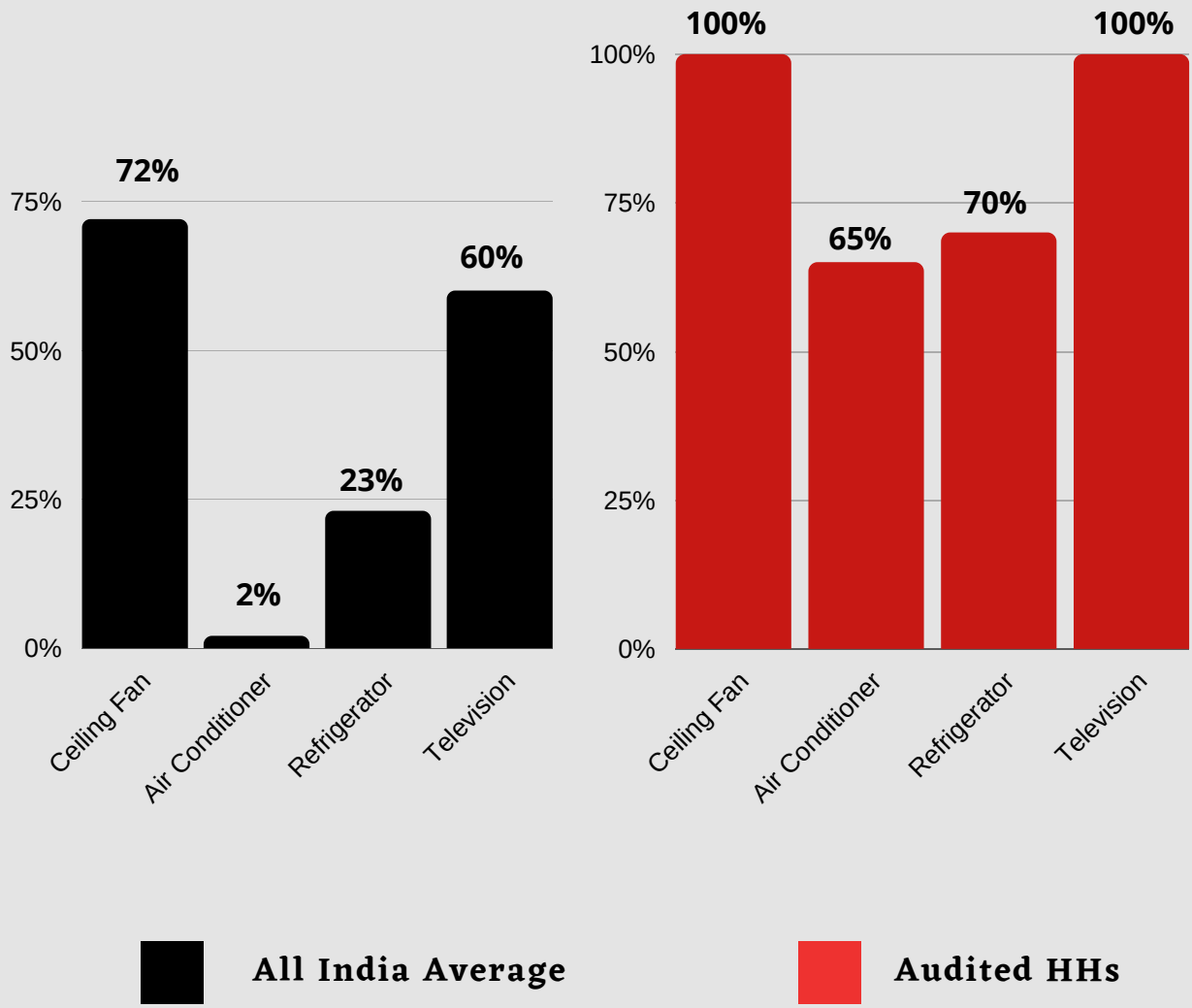
Figure 1: Ownership of electrical appliances in Audited HHs



This indicates that ownership of energy guzzling appliances such as air conditioners (65%), refrigerators (70%), televisions (100%), and washing machines (67%) is very high among audited HHs. Further, on inquiry into the efficiency of these appliances it was observed that among these HHs 62% do not check their appliances for star-rating. And, although 90% of the audited HHs own LED bulbs, usage of its inefficient counterparts such as incandescent bulbs and CFL bulbs still continues, suggesting lack of awareness around energy efficient alternatives.

Based on data from nationwide HH census and surveys,[ii] it has been identified that appliance ownership in Indian HHs is still low, but fast growing.[12] Figure 2. presents a comparison of percentage ownership of the electrical appliances between the audited HHs and the all India average.

Figure 2: Ownership of electrical appliances (Audited HHs Vs All India Average)[iii]



[ii] Data sources referred to include the 15th Indian Census conducted in 2010, nationwide surveys like the 68th round of survey conducted by the National Sample Survey Office (NSSO) in 2012 and the second round of India Human Development Survey (IHDS) conducted in 2012.

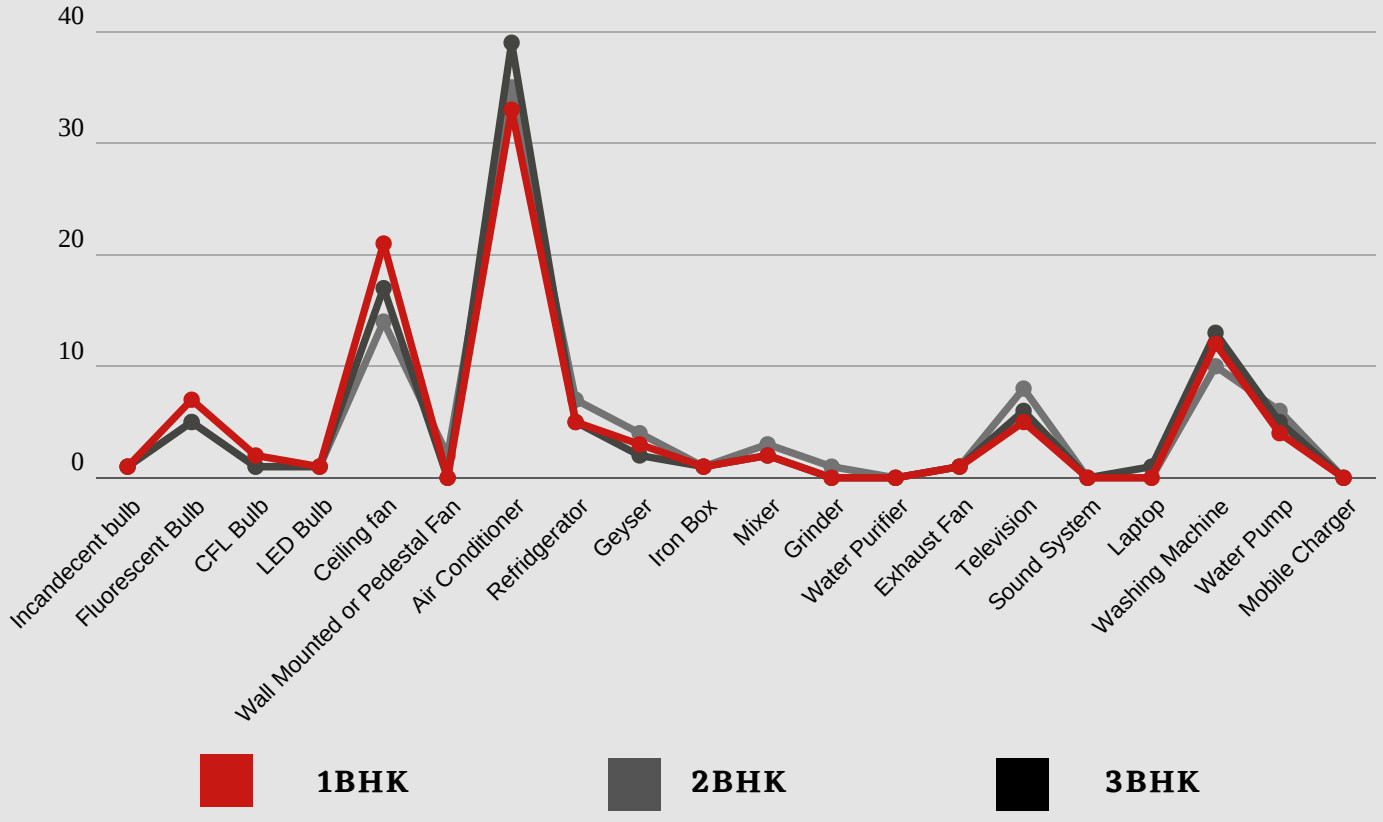
[iii] The All India Average (%) ownership of electrical appliances has been sourced from the above cited study on residential electricity consumption in India.

On an average, 2% of Indian HHs own air-conditioners and 23% own refrigerators, whereas, amongst the audited HHs the ownership of these energy guzzlers was substantially higher, implying an above-average electricity consumption, greater dependency on electrical appliances and a strong need to adopt measures to conserve electricity.

2. ELECTRICITY CONSUMPTION PATTERNS:

Appliance-wise electricity consumption was studied across the three types of HHs audited - 1BHK, 2BHK and 3BHK. Figure 3. proves that the annual electricity consumption of air-conditioners and ceiling fans are the highest across all three types of HHs.

Figure 3: Annual electricity consumption across three types of HHs audited



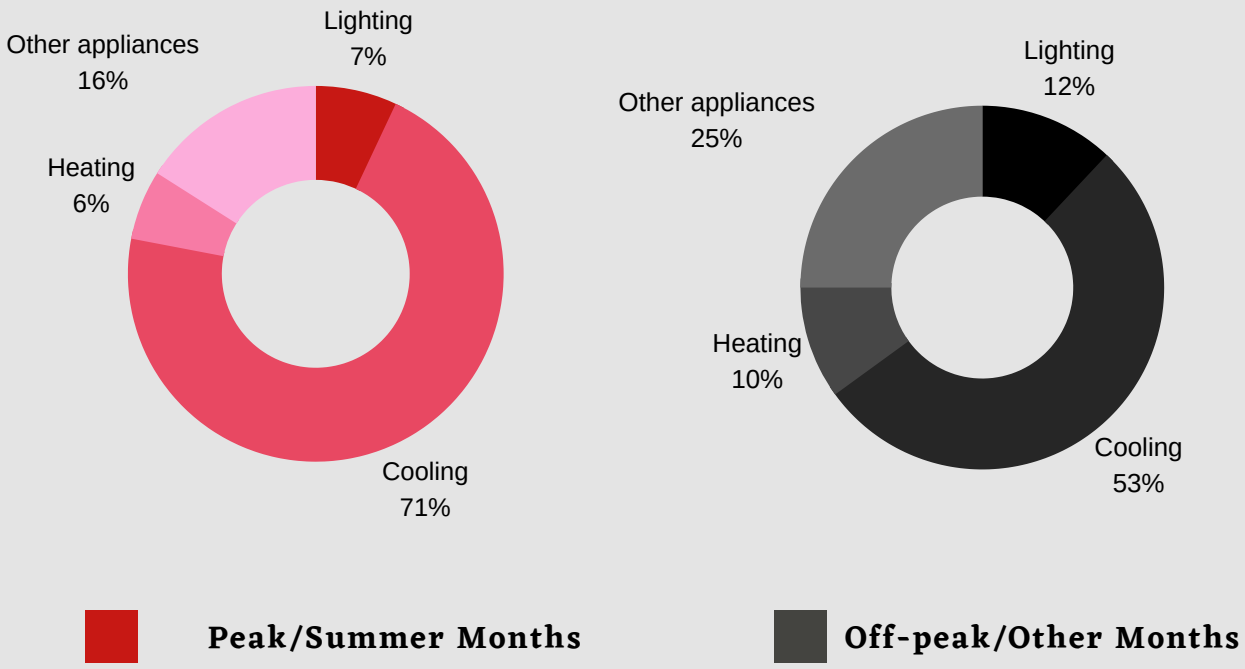
Appliance-wise electricity consumption was studied across the three types of HHs audited - 1BHK, 2BHK and 3BHK. Figure 3. proves that the annual electricity consumption of air-conditioners and ceiling fans are the highest across all three types of HHs.

HH electrical appliances can be classified into 4 broad categories:

- **Lighting:** Incandescent bulb, CFL bulb, fluorescent tube light, LED bulbs
- **Cooling:** Ceiling fan, wall mounted / pedestal fan, air-conditioner, refrigerator
- **Heating:** Geyser, iron box, mixer, grinder, water purifier, exhaust fan
- **Other Appliances:** Television, sound system, laptop, washing machine, water pump, mobile charger

Figure 4 shows the percentage of units consumed by the 4 categories of appliances during peak and off-peak months - i.e. summer months and other months.

Figure 4. Electricity consumption during peak and off-peak months



Consumption patterns reflect that the electricity consumption of cooling appliances rank highest during both peak and off-peak months. During the peak-months i.e. summer, cooling appliances consume a relatively higher percentage of electricity and on the other hand, lighting appliances consume significantly lower percentage of electricity.

The HHs' extensive usage of cooling appliances can be attributed to the dry heat experienced in the district, year round. Furthermore, the consumption patterns should be seen in line with the projections of India's energy requirement for space-cooling which is expected to increase significantly.

The International Energy Agency (IEA) projects a 15-fold increase in India's cooling related electricity consumption from 2016 to 2050. The rising demand for space cooling has potential to cause substantial strain to overall electricity demand and increase the need to expand generation and distribution capacity.[13] Given the context, it is crucial to ensure that consumers develop a better understanding of their consumption behavior, especially w.r.t. cooling appliances.

3. ENERGY PERFORMANCE:

EPI or Energy Performance Index is a widely used metric to compare energy performance of similar buildings. It is the ratio of energy or electricity used per square meter of the building, per annum (kWh/m2/year).

EPI is a key metric used by the Bureau of Energy Efficiency (BEE) for benchmarking energy usage in commercial buildings.[14] In an attempt to apply the Index to HHs, a baseline study[(iv)] was conducted and an energy performance benchmark has been arrived at for the three different types of HHs.

This benchmark draws from the average EPI of similar HHs and indicates the energy efficiency level of a HH compared to others with spatial similarity. Therefore, HHs with EPI value equal to (or) below the benchmark would be considered more energy efficient in comparison with the rest of the audited HHs.

(iv) Nearly 800 households were surveyed in Chennai and Arakkonam to measure and benchmark energy performance for three different kinds of HHs

Table 1. Energy Performance Benchmark

Type of HH	1BHK	2BHK	3BHK
EPI Benchmark (kWh/Sq m/year)	21.5	23.6	25.4

Among the audited HHs:

- 45% of the 1BHKs had EPI values above the highlighted benchmark of 21.5 kWh/Sq m/year.
- 63% of the 2BHKs had EPI values above the highlighted benchmark of 23.6 kWh/Sq m/year.
- 64% of the 3BHKs had EPI values above the highlighted benchmark of 25.4 kWh/Sq m/year.

This suggests that a majority of audited 1BHKs (55%) are energy efficient HHs. On the other hand, a majority of audited 2BHKs (63%) and 3BHKs (64%) consume energy inefficiently, thus indicating a strong need to adopt a targeted approach to enhance energy performance.

4. ENERGY USAGE BEHAVIOUR

In addition to studying the HHs' energy consumption patterns and their energy performance, consumers in the audited HHs were questioned about their behaviour w.r.t energy usage. A range of questions around purchase, handling, and maintenance of electrical appliances were asked in addition to inquiries around consumer awareness of energy conservation.

Based on consumer feedback, a targeted approach was adopted where customised recommendations were made to improve a HH's energy performance. It was observed that in a majority of the audited HHs this could be achieved through simple behavioural changes.

Most responses indicated consumer interest in conserving energy; but, reflected a lack of awareness around energy conservation measures and practices. Further, it was found that consumers were largely reluctant in choosing energy efficient appliances, owing to the initial investments involved.

RECOMMENDATIONS

In every HH's energy audit report, the HH's energy consumption patterns were captured along with information around the HH's energy efficiency level i.e. EPI value of the HH and the variance in relation with the relevant benchmark. This was supplemented with customised recommendations in the form of behavioural changes to enhance their energy performance. The most common recommendations made during the energy audits were as follows:

1. RECOMMENDATIONS FOR HHS

- Reduce the amount of standby power consumption[(v)] by ensuring that appliances are turned off, when not in use. - Standby losses contribute to 7-10 % of HH electricity consumption and there is immense saving potential in the act of unplugging a device/appliance, when it is not in use.[15]

- Make informed purchases - i.e. check appliances for BEE star-rating[(vi)] and purchase energy efficient appliances suitable for your HH.

(v) Stand-by loss is defined as the electricity consumption of an appliance when it is actually not in use.

(vi) To promote energy efficiency and conservation, Bureau of Energy Efficiency (BEE) introduced star rating system (varying from 1-5) for various electrical appliances such as air conditioners (fixed & variable speeds), ceiling fans, colour televisions, direct cool refrigerators, frost-free refrigerators, LED lamps, water heaters, washing machines, etc., based on their power consumption. The star rating system is a labelling system, under which the manufacturer is required to place a label indicating how much electricity the appliance is likely to consume under pre-set conditions. More the number of stars on

For, In addition to the initial investment, it is important to account for the life cycle cost of appliances and the benefits in the long run.

- Clean and maintain electrical appliances regularly - eg. Make sure that the blades of the fan, filters of the air-conditioners, the lampshades etc. are cleaned regularly to avoid accumulation of dust which could affect the performance of the appliances.

- Replace existing appliances with their energy-efficient alternatives such as LED bulbs and brushless DC fans to increase energy and cost savings.

- Practice Do-It-Yourself (DIY) audits[16] and follow appliance-specific best practices to meet energy needs at optimal levels of consumption.

2. POLICY RECOMMENDATIONS

Findings from the energy audits, suggest that HH consumers are increasingly dependent on electrical appliances and lack adequate awareness of energy conservation measures and energy efficient alternatives.

Above all, there is immense potential to maximise energy and cost savings by altering energy consumption patterns with behavioural changes. Therefore it is crucial to adopt policy measures to:

- Develop campaigns that can help improve consumer understanding around the environmental impacts of their energy-use patterns, especially w.r.t. energy guzzlers such as air-conditioners.

- Increase awareness among consumers about BEE's Standards and Labeling programme and other Government schemes promoting energy efficiency.

- Adopt a multi-stakeholder approach to ensure increased consumer awareness around energy conservation, energy efficiency and renewable energy.

- Promote energy audits at the HH level to encourage consumers to conserve energy and adopt energy efficient alternatives.

CONCLUSION

CAG's energy auditing initiative was launched to ensure that HH electricity consumers understand their consumption patterns and behaviour. An understanding of consumption is the first step towards empowering consumers to take concrete measures to promote energy conservation and improve energy efficiency.
In its first phase with a user-friendly energy audit calculator, CAG was able to help 100 HHs in their journey towards enhancing their energy performance. Above all, with its targeted approach to increasing consumer awareness, the initiative has been able to provide consumers with customised energy solutions.

In conclusion, energy audit being the first step towards efficient energy management should be widely adopted at the HH level. Systematically studying HH energy consumption and prescribing behavioural changes through energy audit can be an impactful way to promote energy conservation. Such targeted efforts to conserve electricity would imply a reduction of expense on electricity in HHs and lower levels of fossil fuels burnt at regional and national levels. This translates to economic benefits in the households, increased energy efficiency in the country and a healthier environment for all.

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