Evaluating Appliance Ownership and Usage Pattern in India

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ABSTRACT

The residential sector in India accounted for 24% of the total electricity consumption in 2016 and is projected to rise more than eight times by 2050. This increased energy demand would primarily be driven by appliances and equipment and attributable to several factors including better access to electricity and rising disposable income. However, at present, there is limited data and understanding of residential energy end-use. As the penetration of appliances and subsequently energy use expands in Indian households, it is becoming pertinent to establish end-use baseline for formulating informed energy policies and assessing the potential impact of these policies.

A 'first of its kind' comprehensive pan-India residential end use survey was conducted across 5,000 urban households spanning different climate zones, socio-economic strata and demographics across the country. The objective of the study was to evaluate appliance ownership and usage patterns for urban households and develop a framework for collection and analysis of data on energy end-use in the India's residential sector for conducting such surveys in future.

The data indicates that appliance ownership and usage is on the rise significantly. With households shifting towards nuclearisation, per capita energy use is also increasing. The results also provide good insights on variations in energy consumption across climatic zones and demographic parameters for the major appliances. This could potentially influence the formulation of customised energy policy interventions to reduce energy consumption. This data can also promote better understanding of future electricity demand, thereby enabling better planning and demand side management programs.

Keywords: Residential end use survey, usage patterns, appliance ownership, consumer behavior, socio economic characteristics.

Introduction

India is one of the fastest growing economies in the world and will continue to remain so over the next few years. Several programs and initiatives by the Government of India such as *Saubhagya* (Sahaj Bijli Har Ghar Yojana)[1], *smart cities mission*, electrification of the transport sector, coupled with urbanization, growing per capita income and increasing population could have a profound impact on both future economic growth and energy demand within the country. Total electricity consumption in the country grew at a CAGR (compounded annual growth rate) of more than 7% between 2001 and 2015 with residential sector as a key contributor reflecting 177% growth (TERI 2017). The residential sector's share of total electricity consumption has risen to 24% in 2016 (MOSPI 2017) and is projected to increase eightfold by 2050 (Shukla, Rawal, and Shnapp 2015).

As the residential electricity consumption increases, it is becoming more important to understand the energy usage pattern and consumption of appliances and equipment in Indian households. Currently in India, all policy formulation related to appliance use and residential energy end-use is based on assumptions and limited information. For better impact analysis of energy policies, real-time data on ownership and usage patterns in Indian households is essential. This

1 A scheme to ensure household electrification (both urban and rural) in India.

would help establish a realistic end-use baseline for assessing the potential impact of energy policies as well as enable better future electricity demand projection (Chunekar, Varshney, and Dixit, 2016). Therefore, we conducted a 'first of its kind' comprehensive pan India survey to understand residential energy end use patterns in Indian homes.

The study aims to provide a better understanding on the energy use characteristics such as appliance ownership and usage patterns for urban households in India. The major objectives of the study included:

- Gather information on individuals' demographic characteristics
- Ownership and usage pattern of key appliances
- Variation in energy consumption across various climate zones and socio-economic strata
- Appliance purchase, technological and behavioral patterns
- Data on the appliance inventory and its age

Approach and Methodology

A preliminary research of census data was conducted which led to a national representative sample of 8,448 households including urban and rural households. The scope of the study was limited to urban areas as it accounts for approximately two-third of the consumer durables market (IBEF 2018). Accordingly, representative sample has been adjusted to 5,242 households pan India across 21 cities. The sample distribution ensured the representation of various climatic zones, urban agglomeration and socio economic classification. The sample had equal representation of metro and non-metro cities, while the representation of climatic zones and geographical regions was based on the population size as shown in Figure 1 below-

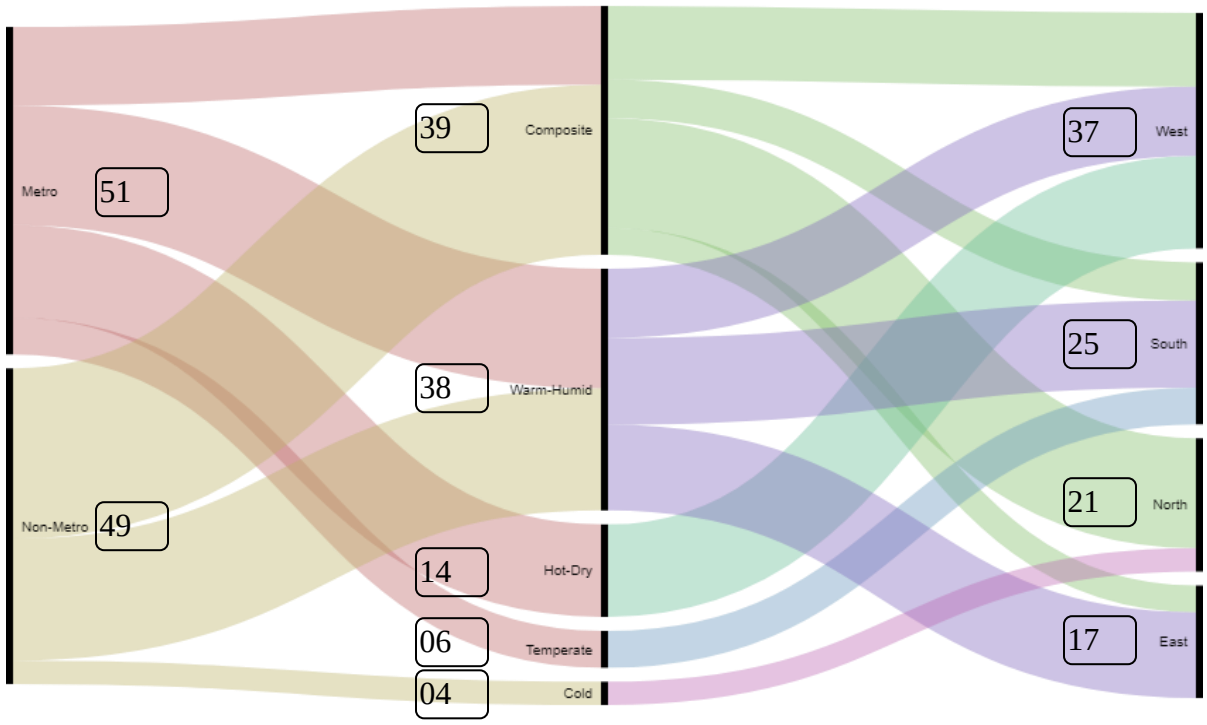

Figure 1. Percent weightage of samples on basis of the city type, climatic zones and geographies

We developed a detailed survey questionnaire to gather following information-

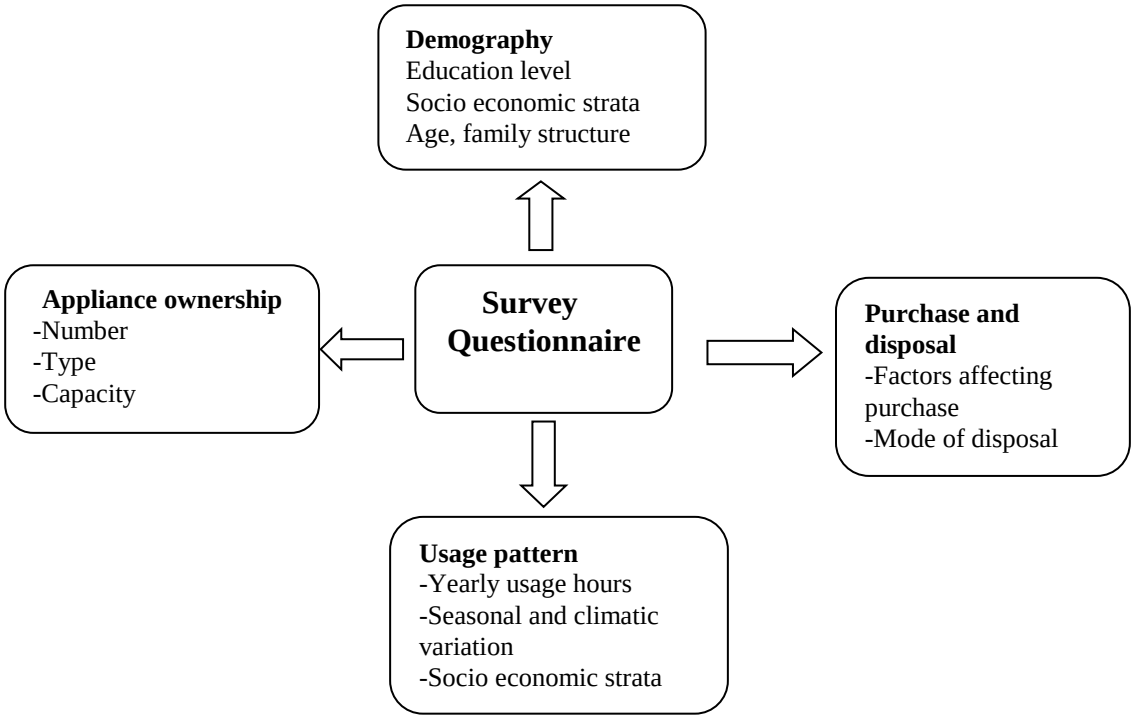

Figure 2. Survey questionnaire framework

The survey was conducted using Computer Assisted Personal Interview (CAPI) technique. The potential respondents were provided a brief background of the study before initiating the survey. On an average, each session lasted for 40-45 minutes. An electronic device facilitated data recording while also minimizing discrepancies. The compiled responses were then analyzed to identify key patterns on the ownership and usage pattern of appliances.

Key Patterns

Demographic Characteristics

Demographic characteristics based on gender, age group, socio economic strata, education level etc. of the respondents covered in the survey are shown in Figure 3.

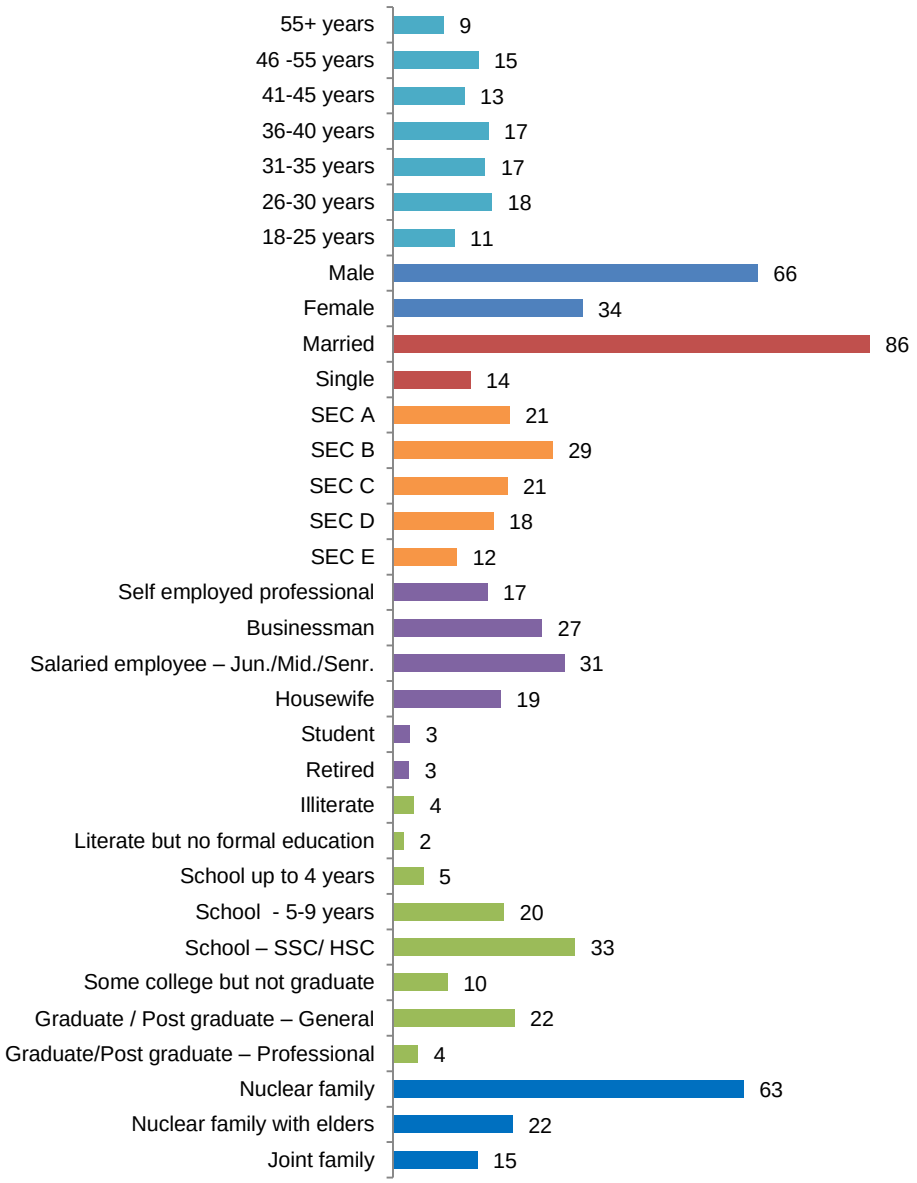

Figure 3. Demographic characteristics of the respondents

Purchase Age

The surveyed households had more than 50% major appliances purchased over the past five years providing an overall age of the inventory of appliances covered by the study (see Figure 4).

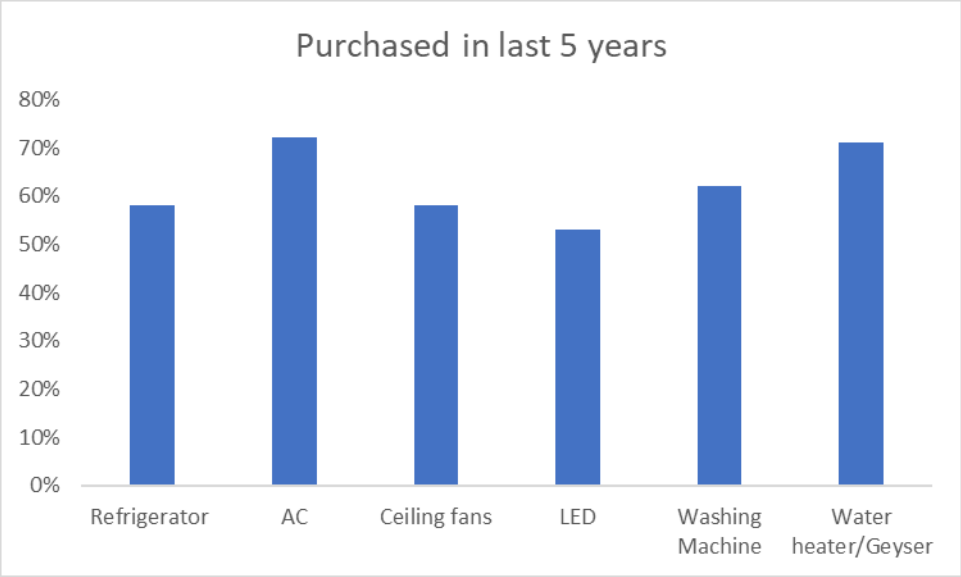

Figure 4. Appliances purchased in last five years

Ownership and Usage Pattern

The survey also provided broad patterns of the ownership (in percent) and average annual usage (in hours) for each of the appliances amongst the total population covered, as shown in Figure 5.

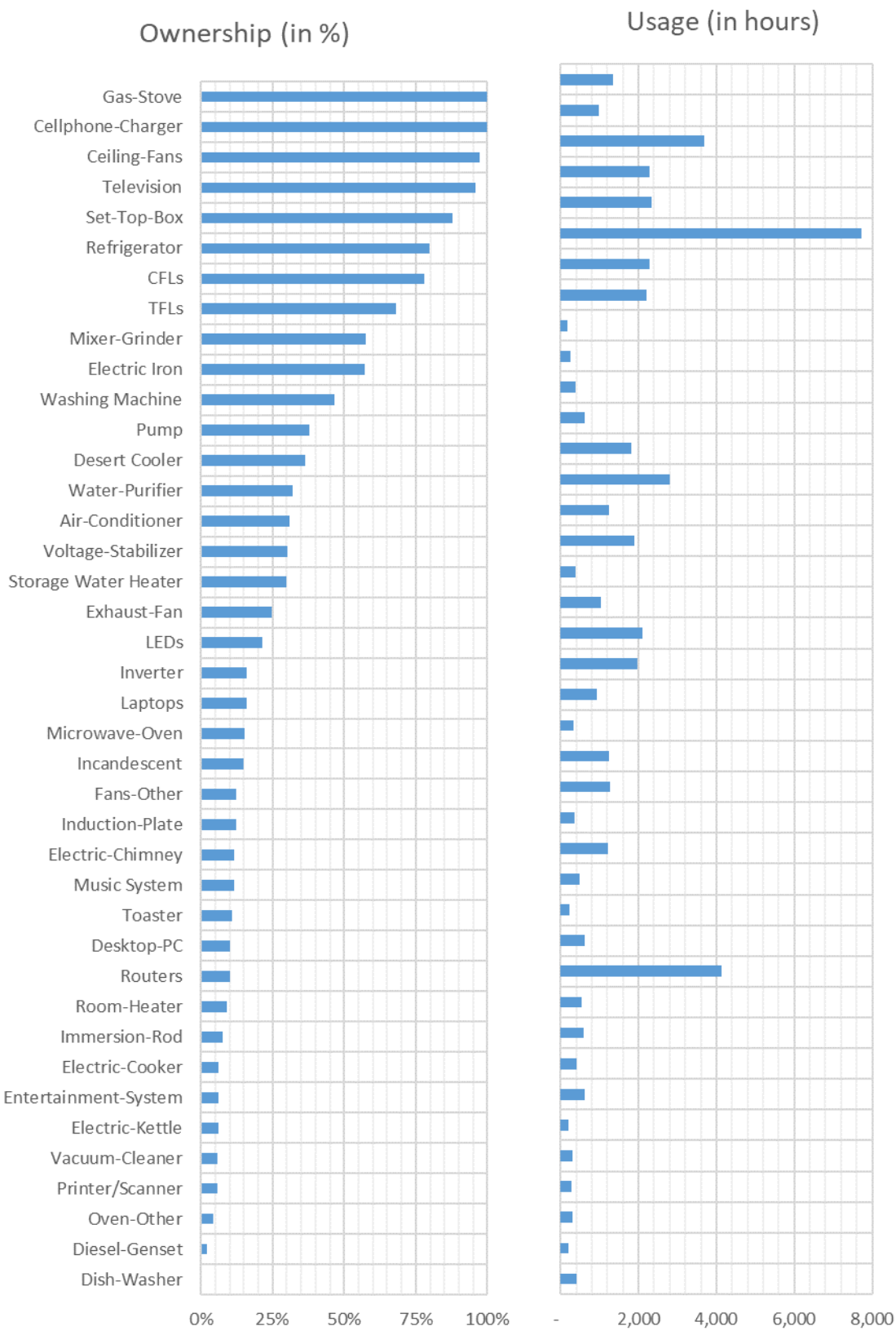

Figure 5: Ownership and usage hours of appliances

The survey reflected that appliances such as gas stove, ceiling fan, refrigerator, television, and set top box had high ownership while refrigerator and ceiling fans were used for highest number of hours.

Therefore, appliances with high ownership and usage hours as well as those with higher energy consumption were further selected to analyze the ownership and usage pattern and any variations with climatic zones and socio economic

characteristics (see Table 1).

Table 1. Ownership and usage pattern of the selected appliances and any variation with climatic zone and socio economic characteristics

Appliance	Parameter	% and annual hours	Climatic zone	Socio economic characteristics
Refrigerator	Ownership	80%	No impact	No impact
	Usage	7719	Temperate zone shows highest usage, followed by composite	No impact
AC	Ownership	31%	Similar across all climatic zones except cold climate, which reflect negligible ownership.	Increases with increase in income. Higher ownership observed with higher socio economic strata.
	Usage	1200	Similar across all climatic zones except cold climate, where ACs are not used.	No difference
Ceiling fan	Ownership	97%	100% ownership across climatic zones except cold climate where it is approx. 30%	No impact
	Usage	3694	More than 3500 average annual usage hours across all climatic zones except cold climate where it was approx. 300 hours.	No impact
LEDs	Ownership	22%	Cold climatic zone reflected lower ownership (14%) as compared to other zones while Hot-dry reflected highest ownership	Increases with increase in income.
	Usage	2113	Lesser annual usage hours observed in cold and hot-dry climatic zone.	No impact
Washing Machine	Ownership	47%	No impact	Ownership is dependent on socio economic strata. Lower income groups show significantly less ownership (27%) as compared to middle and higher income groups (72%).
	Usage	379	Surprisingly, cold climatic zone reflected maximum usage (580 hours).	Increases with increase in income. Higher income groups reflect maximum usage.
Water heater/ Geyser	Ownership	30%	Cold climatic zone reflected highest ownership (73%).	Ownership is dependent on socio economic strata. Lower income groups show significantly less ownership (16%) as compared to middle (35%) and high-income groups (47%).
	Usage	395	Cold climatic zone reflected highest usage (780 hours) while and Hot-Dry climate reflected lowest usage (320 hours).	No significant impact

Key technological and behavior patterns for the major appliances from the survey

Refrigerators- Indian refrigerator market is dominated by two types- direct cool refrigerators frost-free refrigerators. The market for both the types is almost similar (see Figure 6); however, the frost-free refrigerator market of India is gaining popularity and momentum over traditional direct cool refrigerator.
The survey revealed that refrigerators upto 200 litre constitute approximately 70% of the stock, but the demand for higher capacities is also increasing due to changing food habits, increasing participation of women in the workforce and increasing disposable income.

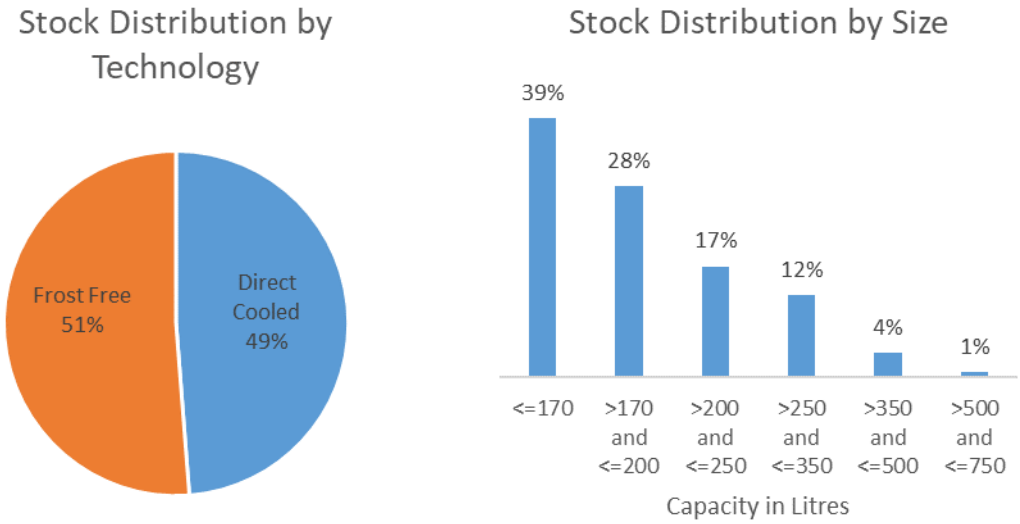

Figure 6. Refrigerator market and technology

Television- Survey findings indicate that Light Emitting Diode (LED) and Liquid Crystal Display (LCD) televisions have replaced conventional Cathode Ray Tube (CRT) type and constitute approximately 60% of the stock (see Figure 7). While many CRTs exist in current stock, the market is transforming towards more advanced technologies.

Approximately 85% of TV stock is 32 inches and below and 21 to 32 inches is the most popular category in the existing stock. However, the market for 44 inches and above is expected to grow rapidly, owing to higher aspirational level, increasing affordability, availability of high-quality content, and a bouquet of offers from various national and international brands. In addition, several new brands are entering the market, which are providing large screen sized televisions at a cheaper price.

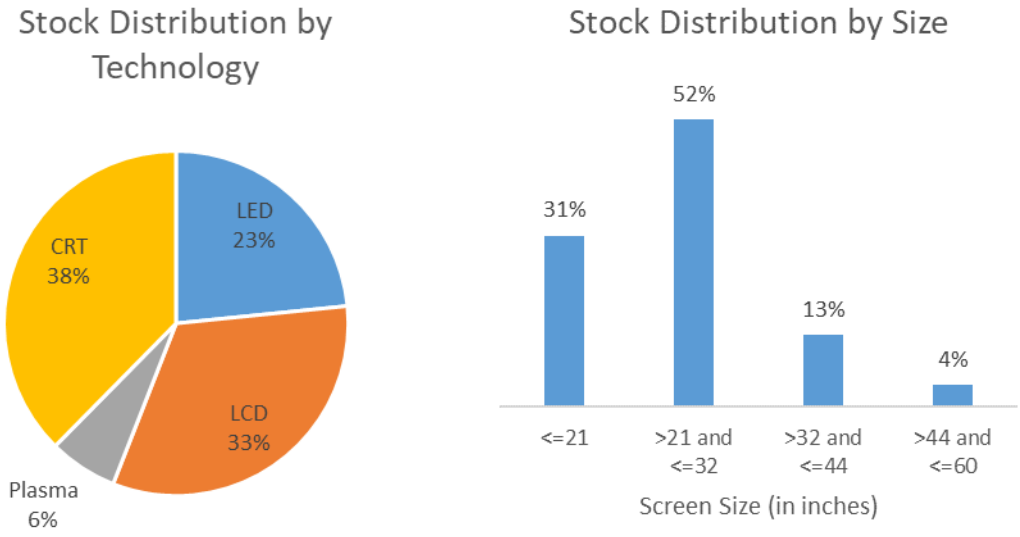

Figure 7. Television market and technology

Air Conditioners- Survey data indicates that split systems are becoming more popular than the window systems. Amongst the split units, the market is moving towards inverter or variable speed technology, which already account for more than a fifth of installed stock owing to higher energy efficiency and lower operating cost as compared to fixed speed units. Survey also reveals that 1 Ton and 1.5 Ton are the most prevalent capacities and account for 80% of installed stock as shown in Figure 8.

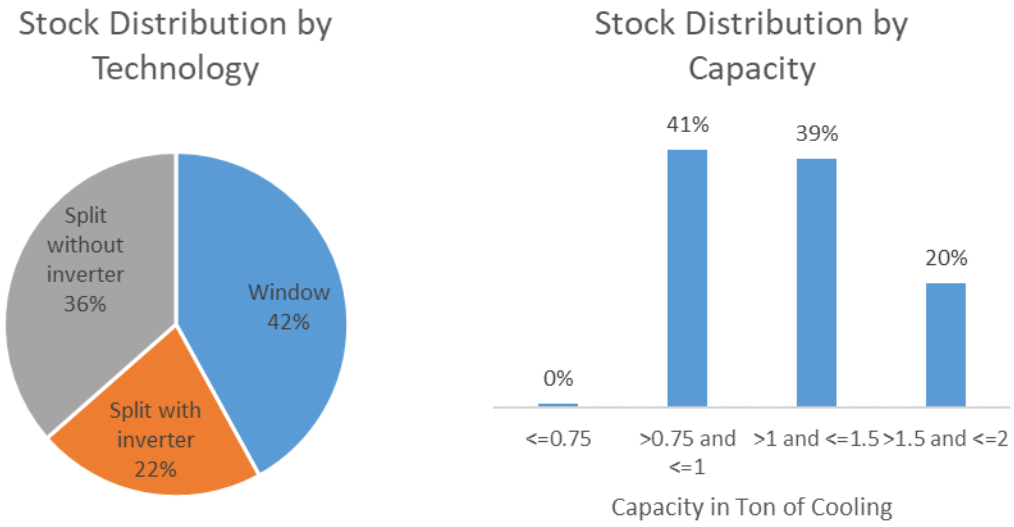

Figure 8. Air Conditioner market and technology

Room AC penetration in India is still low due to price sensitivity, however it is expected to grow rapidly primarily due to increase in number of cooling degree days, rising incomes and increasing urban nuclear families (MoEFCC 2019).

Water heater- The survey results reveal that there are two technologies available in the market for water heaters- gas based and electric. The electric water heaters is the dominant market and comprises of 84% (see Figure 9) as it comes with low ownership cost and lower maintenance, is forecasted to dominate the market in the near future (Research and Markets 2015).

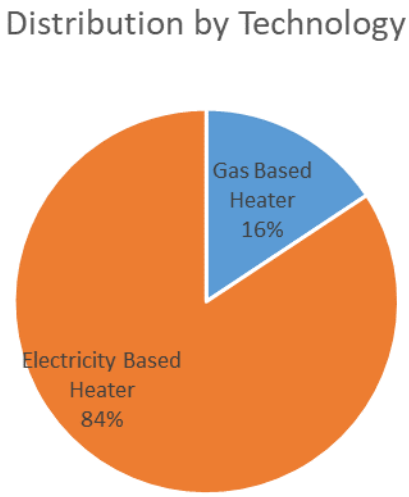

Figure 9. Water heater market and technology

Lighting- The survey reveals that ownership of incandescent bulbs is very low at 15% while compact fluorescent lamps showed more than 70% ownership in the surveyed households. Ownership of LED lighting market has growing rapidly

due to Government initiatives such as UJALA[2] scheme, the world's largest bulk procurement program for LEDs, which resulted in huge reduction in price of the bulbs. In addition, growing awareness amongst consumers is expected to play a vital role in shaping the country's LED market over the next five years.

Washing Machine- The market for washing machines is expected to grow steadily. With changing lifestyles, increasing nuclear families, and growing incomes, it is becoming a necessity. The market is currently dominated by semi-automatic machines, however it is shifting towards fully automatic machines.

Purchase Behavior and Appliance Disposal Pattern

Brand reputation (46%) and word of mouth publicity (38%) are the most important factors influencing purchase decision. The survey captured appliance purchase and disposal behavior as well, as shown in the figure 10.

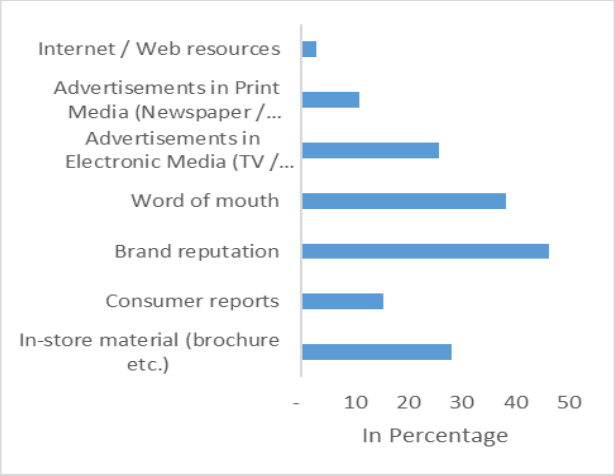

Figure 10. Consumer Purchase Behavior

Local scrap dealer is the most preferred mode for appliance disposal, followed by resale and exchange as shown in Figure 11.

Figure 11. Appliance disposal behavior

Limitation and Challenges

- The data collection questionnaire was elaborate which sometimes led to respondent fatigue.
- While the surveys were already comprehensive, there is still scope for recording additional information such as willingness to pay for energy efficient appliances, seasonal variations in operation, penetration of star labeled products etc.
- Although sample coverage was statistically determined, in interest of time and cost cold and hot-dry climate had limited representation of cities. Future surveys can explore additional cities for these two climate types.

Conclusion

2 Unnat Jeevan by Affordable LEDs and Appliances for All

Energy consumption in India, particularly residential sector is expected to grow due to several Government social welfare initiatives, urbanization and high disposable incomes. Appliances such as cell-phone chargers, TV sets, set-top boxes, cooktops/stoves (fueled by liquid/gas fuel), refrigerators and ceiling fans have penetrated 80% or more market. Washing machines, electric cooking products, lighting products, air coolers and air conditioners are expected to continue to grow and reach higher ownership levels. The market for these products is transforming towards advanced and more efficient technologies.

The survey provides deeper understanding on appliance ownership pattern and residential electricity consumption in India's urban homes. The data indicates that appliance ownership and usage is on the rise significantly. With households shifting towards nuclearisation, per capita energy use is also increasing. The results also provide good insights on variations in energy consumption across climatic zones, demographic parameters and socio economic strata for the major appliances.

The residential electricity consumption patterns and their variation with socio economic strata and climatic zone can help in formulation of product as well as region specific strategies and policy interventions to manage the rising demand efficiently. The findings will also enable estimation of more realistic energy savings based on realistic usage pattern. If the survey were conducted periodically, it would enable better understanding of usage patterns over the years thereby helping analyze the impact of energy efficiency policies more realistically. The data generated can potentially advise demand response programs, energy efficiency policies for appliances and buildings, and strategies for consumer behavior. This data can also promote better understanding of future electricity demand, thereby enabling better planning and demand side management programs. The data and the key findings are expected to be beneficial to academicians, think tanks, policymakers, utilities and consumers for research, modelling, planning and future projections.

While the survey design was quite comprehensive, there is scope for capturing additional information such as willingness to pay for energy efficient appliances, penetration of star labeled products etc. Although sample coverage was statistically determined, due to time and cost constraints, cold and hot-dry climate had limited representation of cities. Future surveys can explore additional cities for these two climatic zones.

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