International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 07 | July -2017 www.irjet.net p-ISSN: 2395-0072

Evaluating energy saving opportunities in Mumbai residences through efficient operation and maintenance of appliances

Umesh B. Phatakare[1], Dr.Santosh D. Dalvi[2]

[1]Student (M.E.), Dept. of Mechanical Engineering, Alamuri Ratnamal Institute of Engineering and Technology, Shahapur, Thane ,Maharashtra, India
[2]Associate Professor, Dept. of Mechanical Engineering, Lokmanya Tilak College of Engineering , Navi Mumbai, Maharashtra ,India

---

Abstract - *This research explore the thermal , electricity usage awareness and energy saving behavioral pattern in the residential sector in Mumbai mega city ,the commercial capita; of India. The research follows three pathways. First, determining the energy usage awareness attitude from energy profile of populace. Second, observing operational and maintenance aspects of home appliances. Third, analysing the impact of above observations on energy conservation and efficiency.*

The research shows that from the energy awareness perspective, the residential electricity consumption of India is gradually catching up the industrialized countries. There is enormous variation in operation and maintenance attributes towards home appliances. The research suggest that the sustainability retrofits like energy efficient bill, energy awareness campaign, equipment card and micro-level recording of electricity consumption changes the normal behaviour to the energy responsible behaviour of populace.

Keywords: energy awareness, electricity, home cluster, Mumbai residents, appliances

1. INTRODUCTION

The article is based on the survey questionnaire distributed to 100 houses in Mumbai metropolitan region and field interview of the respondents.

The research topic belongs to the field of energy conservation and energy management. Driven by rapid urbanization and increasing household incomes, residential energy consumption in India has been growing steadily in the past decade, posing critical energy and greenhouse gas emission challenges.

In-home energy usage awareness affects the lifecycle energy consumption of all kinds of dwellings. Although a number of research efforts have focused on energy awareness at the household or building scale worldwide, few attempts have been made to understand the variation in energy usage awareness patterns across Metro cities in India.
The work presents research on electricity usage awareness in the residential sector of Mumbai- Mega city of Asia and Economic Capital of India. Specifically, based upon four different home typologies viz. flat, chawl/slum/zopdi, bungalow and row house, identified in Mumbai, the levels of electricity usage awareness have been examined.

Ephemerally, this research,

- Focus on understanding behavioral pattern of Mumbai residential sector to use electricity or electrical energy.
- Aims at finding electricity usage awareness level of Mumbai residents.
- Concludes the critical success factors that govern energy awareness and henceforth residential electricity consumption.
- Proposes the measures to reduce residential electricity consumption using sustainable energy tools.

There exists an extensive literature on residential energy awareness and different approaches are found.

Literature shows the behavioural dimensions of energy use and depth economic way to measure home electricity consumption that enables analysis of different household appliances .It gives the energy saving information in more concrete manner. Some Paper suggest education program to overcome resistance and lack of consumer awareness relating to electricity consumption and energy efficiency labels.

This research differs from previous scholarship on energy efficiency and consumer behavior in four ways. First, a well collection of the energy strategy literature has explored the behavioral aspects of electricity use as well as detailed the barriers to energy efficiency and demand side management programs. Although studies discussed earlier (and the hundreds of others not mentioned) are useful, they have tended almost exclusively to look at behavioral patterns of energy consumption and barriers in United States, UK, Sweden, Australia, Japan, Norway, Greece, France and China. Much less work has been done on the patterns and barriers in developing countries such as India, Bangladesh and Pakistan. This study is an attempt to help fill that gap by focusing on the patterns and barriers in Mumbai Mega city-the commercial capital of India.

Second, many scholars and analysts continue to approach the issue of energy policy and India at the national scale. This study looks at the sub-national level to explore the challenges facing Indian provinces and, within this province, the predicaments and issues at the household and individual scale.

2. RESEARCH METHOD

This study follows the methodology shown as follows:

2.1 Descriptive Research Strategy

This study is based on descriptive research strategy. Cluster approach is adopted for classification of the respondents.

2.1.1 Type of home in Mumbai (Cluster Approach)

In Mumbai region four types of home constructions are authorized viz. slum, flat, row house and bungalow. In the research the home type is called as home cluster. In slum clusters chawl are included. Slums are initially built in illegal manner and after few years they get authorization from Government due to political interference. Now-a-days Government is taking the severe action against the slum as soon as it built. Flat clusters are popular in Mumbai than any other type. The government is now approving the schemes of converting slums into flat clusters of smaller built-up area. Row house is an independent house connected to other independent houses in row. These clusters have separate electricity metering system. Bungalow clusters is also an independent villa having more area than row house. The standard of leaving is very extraordinary in these clusters.

2.1.2 Survey

The survey was finally conducted in the 2015-16.Total 120 households were interviewed, out of which 100 households questionnaire forms found valid. The form consists of 24 questions concentrating on leaving profile. The form also consists of response about operating and maintenance aspects of home appliances.

2.2 Sampling Analysis

Sampling is one of the important components of research design, which provides the information about the characteristics of a population. The target population in this research is substantially large along with lower budget favored us to use the sampling.
Sampling in this research composed of the following steps-

1. Definition of Target Population
2. Sampling Frame Design
3. Sampling Technique
4. Sample Size Calculation

1. Definition of Target Population
   The target population for the Mumbai Energy Project has been defined as follows.
   Element- Household
   Sampling Units- Household Type
   Time- 2015

2. Sampling Frame Determination
   A Sampling frame is a representation of the elements of the target population. It consists of list or set of the directions for identifying the target population. In this research type of house is used as sampling frame i.e. Slum area, Flat/Block, Row House, Bungalow etc.

3. Sampling Technique
   Simple random sampling technique is used as traditional sampling approach.

4. Sample Size Calculation
   Sample size refers to the number of elements to be included in the study.
   The most general equation is used in the research to calculate the sample size is as follows.

Sample Size Calculation

$$n = \frac{\frac{p(1-p)}{\frac{A^2}{z^2} + \frac{p(1-p)}{N}}}{R}$$

n= Sample Size required
p = estimated variance in population, as a decimal:(0.5 for 50-50, 0.3 for 70-30)
R = Estimated Response rate, as a decimal
Z = based on confidence level: 1.96 for 95% confidence, 1.6449 for 90% and 2.5758 for 99%
A = Precision desired, expressed as a decimal (i.e., 0.03, 0.05, 0.1 for 3%, 5%, 10%)
N=Size of Population
The description for the various terms of sample size formula is given in the following lines.

(A)=Desired Precision of Results

The level of precision is the closeness with which the sample predicts where the true values in the population lie. The difference between the sample and the real population is called the sampling error.

If the sampling error is ±3%, this means that 3 percentage points are added or subtracted from the value in the survey to find out the actual value in the population. This range is also commonly referred to as the margin of error.
The level of precision depends on balancing accuracy and resources. High levels of precision require larger sample sizes and higher costs to achieve those samples, but high

margins of error can leave results that aren't a whole lot more meaningful than human estimation.

(z)=Confidence Level
The confidence level involves the risk, that analyst is willing to accept that the sample is within the average or "bell curve" of the population. A confidence level of 90% means that, were the population sampled 100 times in the same manner, 90 of these samples would have the true population value within the range of precision specified earlier, and 10 would be unrepresentative samples. Higher confidence levels require larger sample sizes.

(p)=Degree of Variability
Variability is the degree to which the attributes or concepts being measured in the questions are distributed throughout the population. A heterogeneous population, divided more or less 50%-50% on an attribute or a concept, will be harder to measure precisely than a homogeneous population, divided say 80%-20%. Therefore, the higher the degree of variability is expected, the distribution of a concept to be in target audience, larger the sample size must be to obtain the same level of precision.
If variability is too difficult to estimate, it is best to use the conservative figure of 50%.

(R)=Response Rate
Assuming,
For Schedules, Interviews the response rate is almost 100%, i.e. R=1
For web based surveys the response rate is lower than that for schedules, i.e. 0.7

For this study,
p=0.5
R=0.8
Z=1.96
A=0.05
N=2000000

Population of Mumbai is around 10000000. Assuming that on an average five members per house, the number of houses will be 2000000.

$$n = \frac{\frac{0.5(1-0.5)}{\frac{0.05^2}{1.96^2} + \frac{0.5(1-0.5)}{2000000}}}{0.8}$$

n = 480.10≃500 (selected 100)
Thus final target schedules& interviews, n=500 (Selected 100)

Also, there are minimum five observations for each independent variable. Although the minimum ratio is 5:1 and desired level is between 15 to 20 observations per variable.

2.3 Measurement and Scaling

Measurement is the assignment of numbers or other symbols to characteristics of objects according to set rules. Likert scale is used in this research that belongs to Non-comparative and continuous rating category in which each object is scaled independently of the others in the stimulus set. Likert scale is a widely used rating scale that requires the respondents' to indicate the degree of agreement and disagreement with each of a series of statements about the stimulus object. This scale has following advantages:

1. It is easy to construct and administer.
2. Respondents readily understand how to use the scale, making it suitable for mail, telephone, personal or electronic interviews.

Five point Likert scale description used in this research is as follows

1- Most Positive response
2- More Positive response
3- Positive response
4- Negative response
5- Most negative response

The respondents are expected to rate the object by placing a mark at an appropriate position on a line that runs from one extreme of the criterion variable to the other.

2.4 Questionnaire Design

A questionnaire is a formalized set of questions for obtaining information from the respondents. A good questionnaire translates the information needed into a set of specific questions that the respondents can and will answer. However, schedule form of questionnaire has been used in the study to collect the primary data from respondents.

2.5 Quantitative Descriptive Data Collection

The data collection package of this study include

a) Fieldwork procedures
b) Reward system for respondents
c) Communication aid

It is the crucial step in research design that involves primary or secondary data collection. For analysis of electricity consumption the required secondary data was obtained after collecting the electricity bills. The primary data obtained through filling the questionnaire is used for analyzing the energy awareness of Mumbai residents.

2.5.1 Field Selection

In total, 100 questionnaires were delivered to the following home clusters.

Table 1: Location Statistics

Location Statistics				
	Freq.	Percent	Valid Percent	Cumulative Percent
1	40	39.6	39.6	39.6
2	11	10.9	10.9	50.5
3	12	11.9	11.9	62.4
4	1	1	1	63.4
5	32	31.7	31.7	95
6	2	2	2	97
7	1	1	1	98
8	1	1	1	99
Total	100	100	100	

The pie chart of field selection is shown.

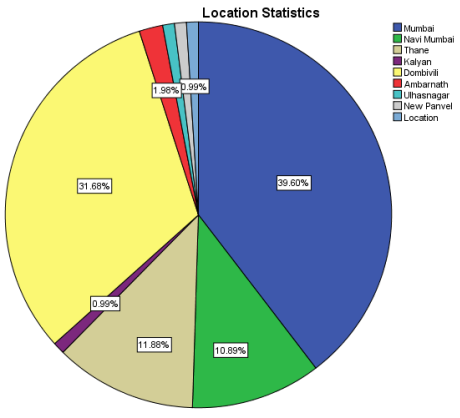

Figure 1: Location Statistics

General profile of the respondents is shown in the analysis part. In Mumbai region, most of the respondents are residing in buildings comprising flat or room or block type home clusters. The education level of the respondents in Mumbai is quite good.

3.DATA ANALYSIS

This section shows the result from the field research ,interview and survey. There are four distribution licensees supplying electricity in the city of Mumbai namely Brihan-Mumbai Electric Supply and Transport Undertaking (BEST), Maharashtra State Electricity Distribution Company Ltd.(MSEDCL), Reliance Infrastructure Ltd. Distribution(RInfra-D), and Tata Power Company Limited – Distribution (TPC-D).

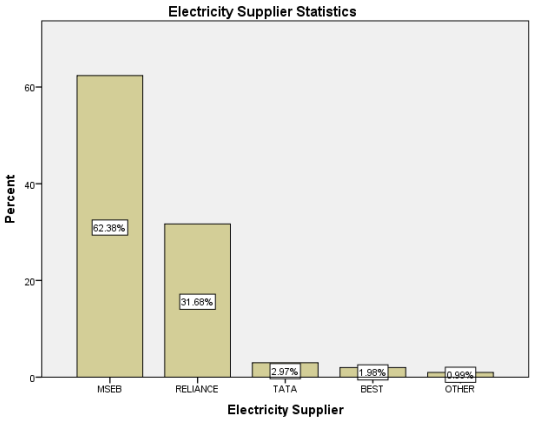

Figure 2: Electricity Supplier

But actually Mumbai and its metropolitan region are lightened by three major electricity distribution houses viz. BEST Undertaking (Municipal Corporation of Greater Mumbai owned), M/s Reliance Infrastructure Limited (Private Sector) and MAHADISCOM (State Government of Maharashtra owned). BEST distribute electricity to Greater Mumbai (Urban area), Reliance powers suburban Mumbai and MAHADISCOM lightens remaining part of Mumbai region. Thus the electricity suppliers' policy may differ according to the locality.

The distribution of questionnaire according to the electricity supplier is shown in Figure 2. As MAHADISCOM (Maharashtra State Electricity Distribution Corporation) distributes electricity to Maharashtra state excluding Mumbai urban only, hence about 77 percent i.e. 387 forms were distributed among MAHADISCOM consumers. The response rate (92.18 percent) is unusually high due to use of most successful survey research instrument i.e. field interviews.

The research not only includes the questionnaire survey for determining energy awareness and behavior but also suggests the tools for motivating Mumbai residences to improve the energy awareness levels. In India, at present there are around eight private and fifty six Government distributors of electricity. Almost all the distributors excluding few are captivating the efforts for improving energy efficiency through awareness programs.

3.1 Cross Tabulation Analysis(CTA)

Cross tabulation analysis also called as contingency analysis, display the relationship between two or more categorical (nominal or ordinal) variables. The size of the table is determined by the number of distinct values for each

variable, with each cell in the table representing a unique combination values

3.1.1 CTA between House Type and Appliances Ownership

Since 2010 in India, the sale of energy efficient home appliances is in revolutionary phase. Cross tabulation analysis is performed for ownership of energy efficient appliances by different home clusters.

Figure 3 shows the lighting possession statistics by the respondents staying in different types of home clusters. 40% of the flat owners are using 100% energy efficient lights. Slum respondents are least in this survey but observation says that they are not using energy efficient lights due to low living standards.

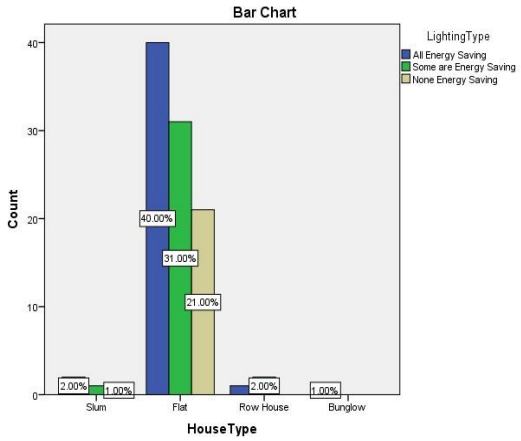

Figure 3: House wise Lighting Type Ownership

Figure 4 shows that about 73% flat respondents own 3 STAR rated refrigerators.

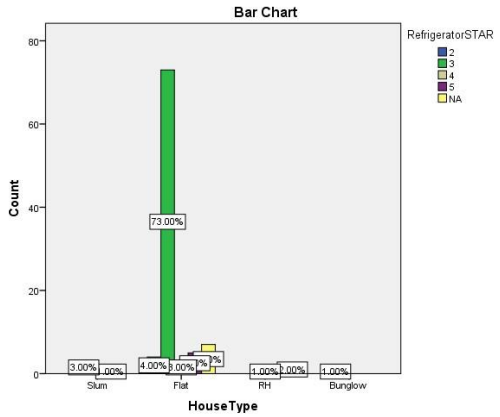

Figure 4: House wise Refrigerator Ownership

Figure 5 shows the television ownership statistics by various home clusters.

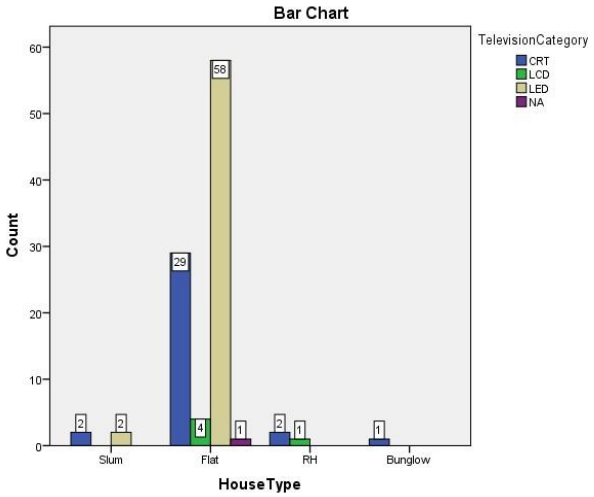

Figure 5: House wise Television Ownership

3.1.2 CTA between Electricity Distributor and Appliances Ownership

The responsibility of electricity distributor can't be overlooked in order to carry out Energy Awareness Survey in Mumbai region. Figure 29 shows that 30% respondents served by MSEB and 14% respondents served by Reliance owns 100% energy saving lights in their houses.

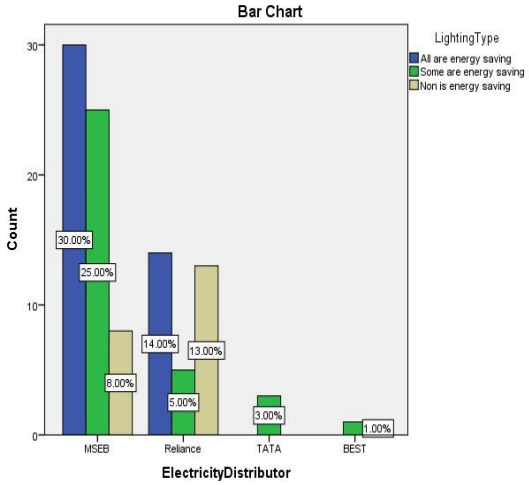

Figure 6: Distributor wise Lighting Ownership

Figure 7 shows the ownership statistics of STAR refrigerator by the respondents served by electricity distributors. MSEB consumers significantly own the STAR rated refrigerators.

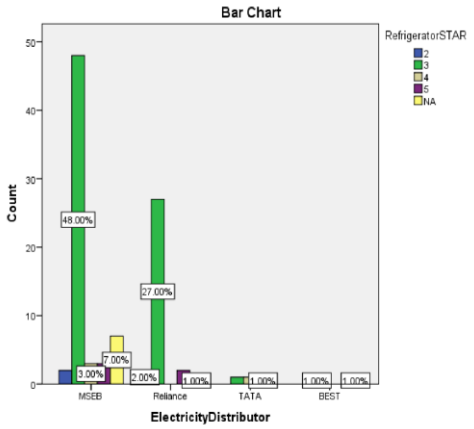

Figure 7: Distributor wise Refrigerator Ownership

Figure 8 shows the statistics of television ownership by the respondents served by various electricity distributors. MSEB consumers own LED televisions to 42%.

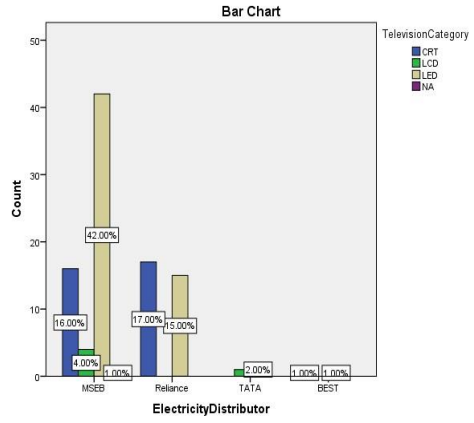

Figure 8: Distributor wise Television Ownership

3.1.3 CTA between locality and Appliances Ownership

This section discusses the variation of appliances ownership according to the locality of respondents. In Mumbai region the living status varies according to the locality. As shown in figure 9 Dombivali regions (20%) maximum numbers of respondents own energy efficient lighting in their houses. It could be due to highest level of education in Dombivali. There is scope to save energy by replacing all other lights by LED but due to sacrifice in comfort level and high cost of LED the female respondents are not agree with this statement.

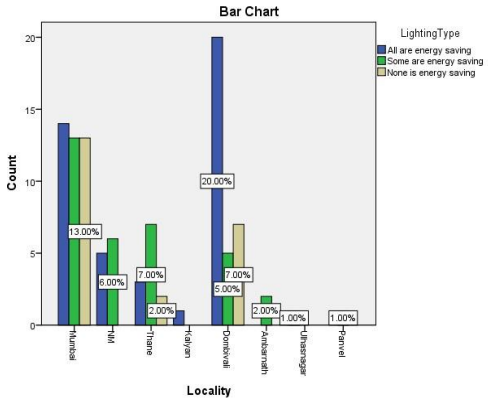

Figure 9: Location wise Lighting Ownership

Figure no. 10 shows that 31% respondents in Mumbai and Dombivali region owns 3 STAR refrigerators. There is wide scope to own STAR refrigerators by Thane, Kalyan, Ambarnath and Panvel respondents.

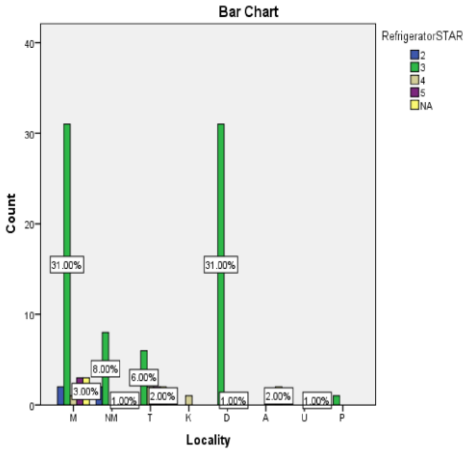

Figure 10: Location wise Refrigerator Ownership

4.HOUSEHOLD APPLIANCES OPERATION & MAINTENANCE ANALYSIS

The patterns of residential power consumption across the globe differ due to socio economical, environmental and technological factors.

4.1 Descriptive analysis for energy consumption of home clusters

Descriptive analysis of monthly electricity consumption for year 2016-17 is carried out. It was possible due to collection of electricity bills at the time of interview from respective home cluster. As shown in Table 2,22% flat type clusters consumes 201 to 300 kWh per month. And for 55% flat clusters, the monthly consumption is below 200 kWh.

Table 2: Electricity Consumption Details Of Mumbai Homes

Electricity Consumption	
Unit	House hold
<100kWh	9
101-200kWh	55
201-300kWh	22
301-400kWh	2
>400kWh	6
Don‟t Know	6
Total	100

Table 3: LPG Consumption Details Of Mumbai Homes

LPG Consumption (kg per month)	
Unit	House hold
15.5 kgpm	59
31kgpm	7
7.75kgpm	7
10.3kgpm	14
Don‟t Answer	3
Don‟t Know	10
Total	100

Table 4: PNG Consumption Details Of Mumbai Homes

PNG Consumption (SCM)	
Unit	House hold
<25SCM	3
26-40SCM	1
>40SCM	2
No PNG	94
Total	100

4.2 Analysis of Operating hours of Major Home Appliances

The variable that contributes for higher energy consumption is confidently the operating hours of the home appliances. It flatteringly depends on number of family members in home and various characteristics associated with them like age, income level, habits, occupancy in house, work nature, education level etc. It also depends on home characteristics viz. type of home, nature of ownership.

Simple frequency analysis between types of home appliances and daily operating hours is conducted which is represented. The response of do not knowing and possessing the particular home appliances is also included.

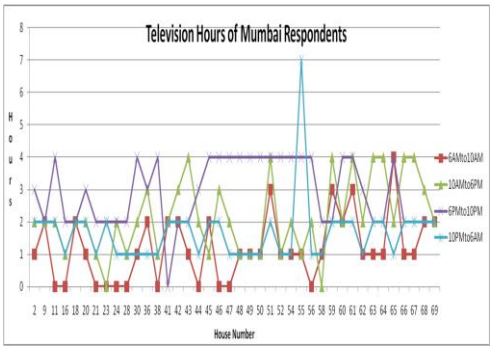

Figure 11: Television Working Hours

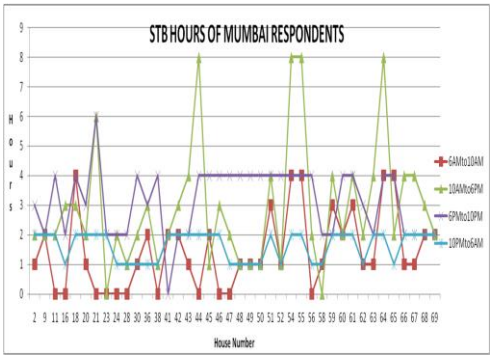

Figure 12: STB Working Hours

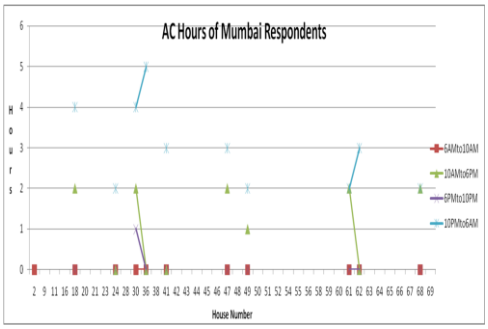

Figure 13: AC Working Hours

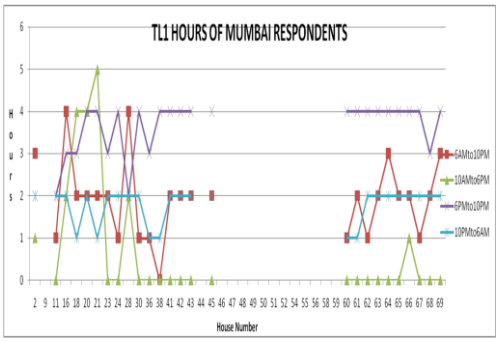

Figure 14: Tube Light 1 Working Hours

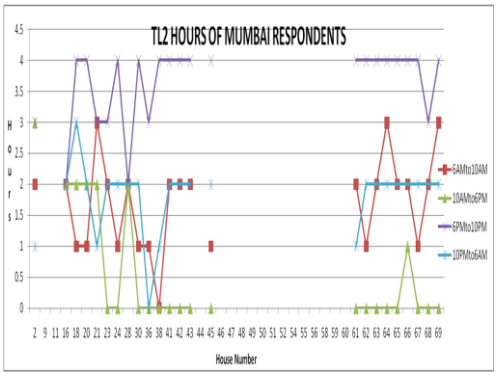

Figure 15: Tube Light 2 Working Hours

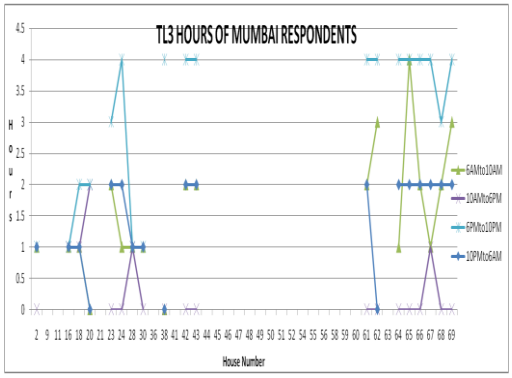

Figure 16: Tube Light 3 Working Hours

Above figures shows the working hour of the television, lights, AC and STB.

4.3 Analysis of operating procedure of critical appliances

The large energy savings can be achieved through the standardization of operating procedure of home appliances. The table 5 shows the procedures adopted by various houses to operate critical appliances like television, air conditioner, electric water heater and computer.

Table 5: Standard Procedure

Appliances	Total Homes	Procedure	
		Standard	Other
TV	100	80	20
AC	35	14	21
Electric Water Heater	25	14	11
Computer	59	57	2

5.CONCLUSION

In this study, the behavioral pattern of Mumbai residents is studied in respect to electricity use as well as the factors influencing the home energy awareness and saving are examined.

The major findings includes-

1. Factors influencing energy awareness

- The household energy awareness and hence electricity consumption is varied according to the critical factors like a) usage aspects of home appliances b) energy saving interest c) consumption recording d) basic energy knowledge.
- Household socio-economics and demographics, attitudes and home physical attributes influence household's choice of energy source, appliance ownership and the energy consumption pattern. The influencing factors include use of energy critical appliances, number of occupants, education levels, home ownership, home construction area and interest towards energy saving.

2. Energy Awareness and home type

- Bungalow clusters are superior among all home clusters in purchasing and maintaining energy critical appliances. It is due to highest standard of living and land ownership where the bungalow is built up.
- The mean score of saving elasticity is in the favour of slum clusters and it is quite obvious as low income levels and less number of appliances in home. The flat clusters subjugated other home clusters for the sub-dimension basic energy knowledge which is because of higher education levels.

3. Role of Electricity distributor

- Due to regular practice of conducting energy audits by Reliance Infrastructure Limited, the private distributor, the electricity saving behavior is considerable than other electricity distributors.
- Private distributors of electricity have broad scope to improve non-commercial relations with consumers whereas Government distributors have to reduce the communication gap between themselves and the residential consumers.

4. Education levels and energy awareness

- Energy saving and energy awareness of homes varied according to education levels. The difference among the education levels in energy saving awareness dimension was in favor of graduate homes. Graduate homes had more awareness for energy saving than lower education level homes.

5. Electricity Consumption

- In Mumbai there is lack of relationship between home cluster and electricity consumption, in respect to the query, how household use energy. It is due to horizontal space limitations, vertical growth, Redevelopments and reforms in residential sector of Mumbai.
- Enormous variation levels in electricity consumption among same types of homes call for Energy Benchmarking.

6. Home appliances and Mumbai residents Attitude

- Mumbai residents does not operate and maintain energy critical appliances effectively, thereby leading Mumbai province towards continuous increase in electricity consumption. E.g. switching off the appliances from plug point, utilization of thermostat of refrigerator, cleaning of condenser coils of refrigerator, cleaning of ceiling fan blades and filters of air-conditioner etc.
- The proportion of replacing traditional home appliances with energy efficient appliances in Mumbai is not appreciable.

7. Switchover to Non-conventional Energy sources

- Noteworthy is the fact that, Mumbai residents are not inclined towards the use of nonconventional energy for day-to-day use due to space limitations and frenetic work culture of Mumbai Mega City.

REFERENCES

[1] Zhaohua Wang, Bin Zhang, Jianhua Yin, Yixiang Zhang, "Determinants and policy implications for household electricity-saving behavior: Evidence from Beijing, China," Energy Policy 39, 3550–3557, May 2011.

[2] Ajzen I, "The theory of planned behaviour", Organizational Behavior and human Decision Processes Vol-50, 179–211, Feb 1991.

[3] Kristina Ek, PatrikSoderholm, "The devil is in the details: Household electricity saving behavior and the role of information," Energy Policy 38, 1578–1587, Oct 2010.

[4] Brandon G, Lewis A, "Reducing household consumption: a qualitative and quantitative field study," Journal of Environmental Psychology 19, 75–85, Feb 1999.

[5] Sardianou E, "Estimating energy conservation patterns of Greek households," Energy Policy 25, 3778–3791, Oct 2007.

[6] FengDianshu, Benjamin K. Sovacool, Khuong Minh Vu, "The barriers to energy efficiency in China: Assessing household electricity savings and consumer behavior in Liaoning Province," Energy Policy 38, 1202–1209, Apr 2010.

[7] Yoshihiro Yamamoto, Akihiko Suzuki, Yasuhiro Fuwa, "Decision-making in electrical appliance use in the home," Energy Policy 36, 1679–1686, Sept 2008.

[8] Reza Kowsari, HishamZerriffi, "Three dimensional energy profile: A conceptual framework for assessing household energy use," Energy Policy, Jan 2011.

[9] Jenny Palm, "The public–private divide in household behavior: How far into home can energy guidance reach?," Energy Policy 38, 2858–2864, Apr 2010.

[10] Wilson, Charlie, Dowlatabadi, Hadi, "Models of decision making and residential energy use," Annual Review of Environment and Resources 32, 169–203, 2007.

[11] Keirstead, James, "Evaluating the applicability of integrated domestic energy consumption frameworks in the UK," Energy Policy 34 (17), 3065–3077, Feb 2006.

[12] Lutzenhiser, Loren, "Social and behavioural aspects of energy use," presented at Annual Review of Energy and the Environment 18, 1993, 247–289.

[13] Tsuyoshi Ueno, Fuminori Sano, Osamu Saeki, Kiichiro Tsuji, "Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data," Applied Energy 83, 166–183, Apr 2006.

[14] Mansouri I, Newborough M, "Dynamics of energy use in UK households: enduse monitoring ofelectric cookers," ECEEE Summer Stud: 3–8, 1999.

[15] Wood G, Newborough M, "Design and functionality of prospective energyconsumption displays," in: Proc 3rd international conference on energy efficiency in domestic appliances and lighting, 2003 pp. 757–770.

[16] Brandon G, Lewis A, 1999. Reducing household energy-consumption: a qualitative and quantitative field study. J Exp Psychol; 19:58–74.

[17] Egan C, "Graphical displays and comparative energy information: what do people understand andprefer?," ECEEE Summer Stud: 2–13, 1999. [22] NEXT21. Second-phase report. Osaka Gas 2002 [in Japanese].

[18] Tsuyoshi Ueno, Fuminori Sano, Osamu Saeki, Kiichiro Tsuji, "Effectiveness of an energy-consumption information system on energy savings in residential houses based on monitored data," Applied Energy 83, 166–183, Apr 2006.

[19] Nikolaos Zografakis, Angeliki N. Menegaki, Konstantinos P. Tsagarakis, "Effective education for energy efficiency," Energy Policy 36, 3226– 3232, May 2008.

[20] Stubbs, M., "Energy education in the curriculum," Educational Studies 11.2, 133–150, Feb 1985.

[21] Cathy Mullaly, "Home energy use behavior: a necessary component of successful local government home energy conservation (LGHEC) programs," Energy Policy. Vol. 26, No. 14, pp. 1041-1052, Dec 1998.

[22] EleniSardianou, 2007. Estimating energy conservation patterns of Greek households, Energy Policy 35, 3778–3791.

[23] Wood G, Newborough M, "Dynamic energy-consumption for domestic appliances: environment, behaviour and design," Energy and Buildings (5), 821–41, Nov 2003.

[24] IanaVassileva, Fredrik Wallin, Erik Dahlquist, "Analytical comparison between electricity consumption and behavioural characteristics of Swedish households in rented apartments," Applied Energy, May 2011.

[25] Rubens A. Diasa, Cristiano R. Mattosb, Jose A. P. Balestieri, "Energy education: breaking up the rational energy use barriers," Energy Policy 32, 1339– 1347, Apr 2004.

[26] Paritosh Nandi, SujayBasu, "A review of energy conservation initiatives by the Government of India," Renewable and Sustainable Energy Reviews (12) 518-530, Nov 2008.

[27] B. Sudhakara Reddy, "Overcoming the energy efficiency gap in India‟s household sector," Energy Policy 31, 1117–1127, Feb 2003.

[28] Firth S, Lomas K, Wright A, Wall R, 2008. Identifying trends in the use of domestic appliances from household electricity consumption measurements. Energy Build; 40:926–36

[29] Ouyang J, Hokao K, 2009. Energy-saving potential by improving occupants‟ behaviour in urban residential sector in Hangzhou City, China. Energy Build; 41:711–720.

[30] Dyer, R.F. and T.J. Maronick, 1989. An evaluation of consumer awareness and use of energy labels in the purchase of major appliances: A longitudinal analysis, Journal of Public Policy and Marketing, 83-97.

[31] McNeill, D.L. and W.L. Wilkie, 1979. Public policy and consumer information: Impact of the new energy labels. Journal of Consumer Research 6, I-II.

[32] Iana V, Fredrik W and Erik D. "Analytical comparison between electricity consumption and behavioural characteristics of Swedish households in rented apartments." Applied Energy (2011).

[33] Pachauri S. "An analysis of cross-sectional variations in total household energy requirements in India using micro survey data." Energy Policy 32, (2000): 1723–1735.

[34] Pachauri S and M. Filippini. "Elasticities of electricity demand in urban Indian households." Energy Policy 32, (2004): 429-436.

[35] Tiwari P. "Architectural, demographic, and economic causes of electricity consumption in Bombay." Journal of Policy Modelling 22, no. 1 (2000): 81-98.

[36] Mohamed G. Hassan, R. Hirst, C. Siemieniuch and A.F. Zobaa. "The impact of energy awareness on energy efficiency." International Journal of Sustainable Engineering 2, no. 4 (2009): 284-297.

[37] Vision Mumbai, transforming Mumbai into a world class city- A summary of recommendations‟, A Bombay First- Mckinsey Report, Sept 2003.

[38] Energy Statsistics, 2012, Issue 19, central statistics office, Ministry of statistics and programme implementation government of India New Delhi. (6-15)

[39] H S Kamath, R V Nesari, "Role of Education in Energy Conservation", 1-4, Personal report.