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Let's Boost Energy Saving on Hon'ble Prime Minister Shri Narendra Modi's Way: An Empirical Study

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ABSTRACT

Hon'ble Prime minster Shri Narendra Modi's first energy campaign with the gift of LED bulbs to Delhi leads to think that every citizen of India should start energy conservation from their home itself. In line with the thought, an empirical study has been conducted from the houses of urban localities of Ahmedabad jurisdiction to analyze the lighting load and to motivate them for energy saving through reduction in lighting load without hampering any individual needs. Primary data through questionnaire were collected to analyze the exact lighting load and awareness towards energy saving. Study reveals that most of houses are not equipped with energy efficient lighting in-spite being concern over saving of energy just by flipping on-off of lighting as per their personal requirements. Motivation with technical inputs is the need of the day to involve everyone towards the goal.

Keywords: *Energy conservation, Energy Saving, Energy Efficiency, Energy saving Techniques, LED Lighting*

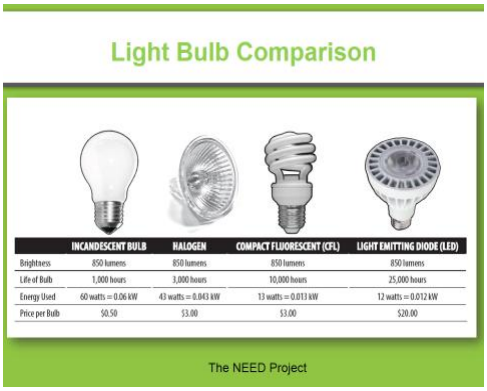
INTRODUCTION

National Energy Revolution is one of the prime agenda of our Hon'ble Prime Minister Shri Narendra Modi which had promised if elected in parliamentary elections. This has come in light in recent article "Get 2 LED bulbs for Rs.130.00 each, save electricity"[1] as a first energy campaign with the gift of LED bulbs to each registered power consumers with two LED bulbs of 7 watt each at a price of Rs.130.00 against the MRP of about Rs. 600.00 as it was observed by PM that it was much more economical to conserve power than to produce it.

Earlier "Bachat Lamp Yojana" programme were implemented through Bureau of Energy Efficiency (BEE) and now installing LED bulbs for domestic and street – lighting in a hundred cities is targeted for completion by March 2016(TOI, Jan06, 2015, page 8)

Research shows that 25% of the Electricity load are coming from lighting itself , if every citizen of India start to have energy conservation from their home , it would boost not only energy saving but also result to cover more area to supply to the needy that too without considering enhancement of the production of energy.

There are number of ways to save with Lighting and one of them is to change five lights that are most frequently used such as Kitchen ceiling, living Room, Bathroom and outdoor post lamp with CFL/LED bulbs. CFL last up to 10 times than incandescent bulbs[2] and LED bulbs are 50% more energy efficient than CFL.



(Source: The NEED Project, Energy Information Administration, U.S. Department of Energy. www.eia.gov)

Definition of terms as revealed during the "Energy Efficiency Fundamentals Workshop Pat Higby".[3] "**Energy Conservation**: is any behavior that results in the use of less energy. Turning the lights off when you leave the room and recycling aluminum cans are both ways of conserving energy [and] **Energy Efficiency**: is the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy

[1] Time of India , Ahmedabad edition dated 06Jan2015, page 1 and 8

[2] http://www.njcleanenergy.com/residential/programs/energy-star-products/information/ten-ways-save-lighting, accessed on 22Jan2015

[3] www.uni.edu/ceee/sites/default/.../energy_efficiency_fundamentals_.pptx Accessed on 02Feb2015

than an incandescent bulb to produce the same amount of light is an example of energy efficiency. However, the decision to replace an incandescent light bulb with a compact fluorescent is an act of energy conservation".

Detailed emphasis revealed in "Energy Efficient Lighting" an article of eartheasy solution of sustainable living[4] that an "Electric lighting burns up to 25% of the average home energy budget. The electricity used over the lifetime of a single incandescent bulb costs 5 to 10 times the original purchase price of the bulb itself. Light emitting diode (LED) and compact fluorescent lights (CFL) bulbs have revolutionized energy-efficient lighting.

LED (Light emitting diode) lighting:

LEDs are small, very efficient solid bulbs. New LED bulbs are grouped in clusters with diffuser lenses which broadened the applications for LED use in the home. LED technology is advancing rapidly, with many new bulbs styles available. Initially more expensive than CFLs, LEDs bring more value since they last longer. Also, the price of LED bulbs is going down each year as the manufacturing technology continues to improve.

LEDs are solid light bulbs which are extremely energy efficient. When first developed, LEDs were limited to single- bulb use in applications such as instrument panels, electronics, pen lights and, more recently, string of indoor and outdoor Christmas lights. Manufactures have explained the applications of LEDs by 'clustering' the small bulbs. The first clustered bulbs were used for battery powered items such as flashlights and headlamps. Today, LED bulbs are made using as many as 180 bulbs per cluster, and encased in diffuser lenses which spread the light in wider beams. Now available with standard bases which fit common household light fixtures, LEDs are next generation in home lighting.

Benefits of LED light bulbs:

- ***Long-lasting*** – LED bulbs last up to 10 times as long as compact fluorescents, and far longer than typical incandescent.
- ***Durable***- since LEDs do not have a filament, they are not damaged under circumstances when a regular incandescent bulb would be broken. Because they are solid, LED bulbs hold up well to jarring and bumping.
- ***Cool***- these bulbs do not cause heat build-up; LEDs produce 3.4 Btu's/hour, compared to 85 for incandescent bulbs. Common incandescent bulbs get hot and contribute to heat build-up in a room. LEDs prevent this heat build-up, thereby helping to reduce air conditioning costs in the home.
- ***Mercury-free***- no mercury is used in the manufacturing of LEDs
- ***More efficient***- LED light bulbs use only 2-17 Watt of electricity (1/3rd to 1/30th of incandescent or CFL). LED bulbs used in fixtures inside the home save electricity, remain cool and save money on replacement costs since LED bulbs last so long. Small LED flashlight bulbs will extend battery life 10 to 15 times longer than with incandescent bulbs.
- ***Cost-effective***- although LEDs are initially expensive, the cost is recouped over time and in battery saving, LED bulb use was first adopted commercially, where maintenance and replacement costs are expensive. But the cost of new LED bulbs has gone down considerably in the last few years. And are continuing to go down. Today, there are many new LED light bulbs for use in the home, and the cost is becoming less of an issue.
- ***Light for remote areas and portable generators***- because of the low power requirement for LEDs, using solar panels becomes more practical and less expensive than running an electric line or using a generator for lighting in remote or off-grid areas. LED light bulbs are also ideal for use with small portable generators which homeowners use for backup power in emergencies.

CFL (Compact Fluorescent Light) lighting:

CFLs are simply miniature versions of full sized fluorescents. They screw into standard lamp sockets, and give off the light looks similar to the common incandescent bulbs- not like the fluorescent lighting we associate with factories and schools.

CFL lighting benefits

- ***Efficient***: CFLs are four times more efficient and last up to 10 times longer than incandescent. A 22 Watt CFL has about the same light output as a 100 Watt incandescent. CFLs use 50-80% less energy than incandescent.
- ***Less expensive***: although initially more expensive, you save money in the long run because CFLs use 1/3 the electricity and last up to 10 times as long as incandescent. A single 18 Watt CFL used in place of a 75 Watt incandescent will save about 570 kWh over its lifetime. At 8% per KWh, that equates to a $45 saving.
- ***Reduces air and water pollution***: replacing a single incandescent bulb with a CFL will keep a half-ton of CO2 out of the atmosphere over the life of the bulb. If everyone in the U.S used energy –efficient lighting, we could retire 90 average size power plants. Saving electricity reduces CO2 emissions, sulphur oxide and high-level nuclear waste
- ***High quality light***: newer CFLs give a warm, inviting light instead of the "cool white" light of older fluorescents. They use rare earth phosphors for excellent colour and warmth. New electronically ballasted CFLs don't flicker or hum.
- ***Versatile:*** CFLs can be applied nearly anywhere that incandescent lights are used energy-efficient CFLs can be used in recessed fixtures, table lamps, track lighting, ceiling fixtures and torchlights. 3 way CFLs are also now available for lamps with 3-way setting .dimmable CFLs are also available for lights using a dimmer switch.

[4] http://eartheasy.com/live_energyeff_lighting.htm accessed on 15Feb2015

Table1: Equivalent wattages and light output of Incandescent, CFL and LED bulbs

Light Output	LEDs	CFLs	Incandescent
Lumens	Watts	Watts	Watts
450	4 - 5	8 - 12	40
750 - 900	6 - 8	13 - 18	60
1100 - 1300	9 - 13	18 - 22	75 - 100
1600 - 1800	16 - 20	23 - 30	100
2600 - 2800	25 - 28	30 - 55	150

(Source: http://eartheasy.com/live_led_bulbs_comparison.html)

Table2: Comparing the features of Incandescent, CFL and LED bulbs

	LEDs	CFLs	Incandescent
Frequent On/Off Cycling	no effect	shortens lifespan	some effect
Turns on instantly	yes	slight delay	yes
Durability	durable	fragile	fragile
Heat Emitted	low (3 btu's/hr)	medium (30 btu's/hr)	high (85 btu's/hr)
Sensitivity to high temperature	some	yes	no
Sensitivity to low temperature	no	yes	no
Sensitivity to humidity	no	yes	some
Hazardous Materials	none	5 mg mercury/bulb	none
Replacement frequency (over 50k hours)	1	5	40+

(Source: http://eartheasy.com/live_led_bulbs_comparison.html)

LITERATURE REVIEW

We use light energy every day[5]. However in homes, up to six percent of our energy use is for lighting[6] and this is one of the areas where we may cut down the energy consumption that too by installing energy efficient lighting. An article Energy Efficiency and Renewable Energy: Harnessing the Power of the Consumer published in Bloomberg Business Review Research Services for ABB[7] reveals that "It is estimated that the world will need to produce far more energy in 2030 than it does today according to the international energy agency (IEA), world energy demand may expand by 36% between 2008 and 2030- an average rate of 1.2% per year". However, "In the New Policies Scenario the combination of rising population and economic growth in India leads to electricity demand rising almost four-fold from 2008 to 2035, making it the third-largest consumer of electricity at the end of the Outlook period, behind China and the United States" (IEA, world energy outlook 2010, chapter 7, page233)[8].

Patterson Murray G. (1996) emphasis that "Energy efficiency is now a central focus of many national energy policies and at the forefront of the debate on energy sustainability issues; but surprisingly little serious attention has been given to defining and measuring the concept. If energy efficiency policy objectives are going to be properly set in place and progress towards them monitored, theoretically sound operational definitions of energy efficiency need to be developed".

Rao Radhakrishna (2001) reveals that "Currently, 60,000 villages remain outside the central power grid, while more than one million electrified villages have to make do with 'erratic and unreliable' power supplies". However, as revealed by Damian Pitt, John Randolph, David St. Jean & Mark Chang(2012) " While single family homes represent approximately ¾ of housing units nation-wide, and have greater energy-demand per-unit than multi-family units, achieving energy saving in existing multi-family buildings also will be necessary to reduce total residential energy use to acceptable levels over the coming years." However, the basic behavioral conservation measure for the residential sector were used in BC Hydro's analysis (2007) as reflected by Mithra Moezzi (2009) for lightening emphasis on:

- Light only what is needed for tasks
- Use lowest-wattage lights possible
- Reduce outdoor lighting
- Turn off lights when leaving the room

[5] http://www.need.org/Files/curriculum/infobook/LightP.pdf Accessed on 30Jan2015
[6] http://www.need.org/Files/curriculum/infobook/LightI.pdf Accessed on 29Jan2015
[7] http://www02.abb.com/global/seitp/seitp326.nsf/0/902b67472cb7e3d9c125783000357dfc/$file/bbwrs_energyeff_wp_20110203.pdf Accessed on 28Feb2015
[8] http://www.worldenergyoutlook.org/media/weo2010.pdf. Chapter7,page 233. Accessed on 28Feb2015

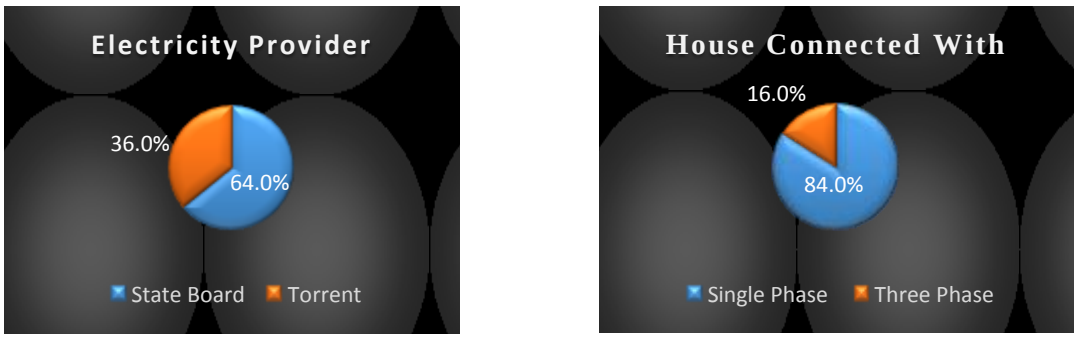
METHODOLOGY

Empirical study was administered through questionnaire with an open interview with the respondents of urban area of Ahmedabad. 110 houses were approached out of which 75 respondents participated to reveal the information. Both the area was selected where different electricity supplier exits.

ANALYSIS

Data collected through questionnaire were analyzed through MS-Excel by plotting graphs covering different aspects to find out energy awareness and it's saving especially on lighting. Following facts revealed:

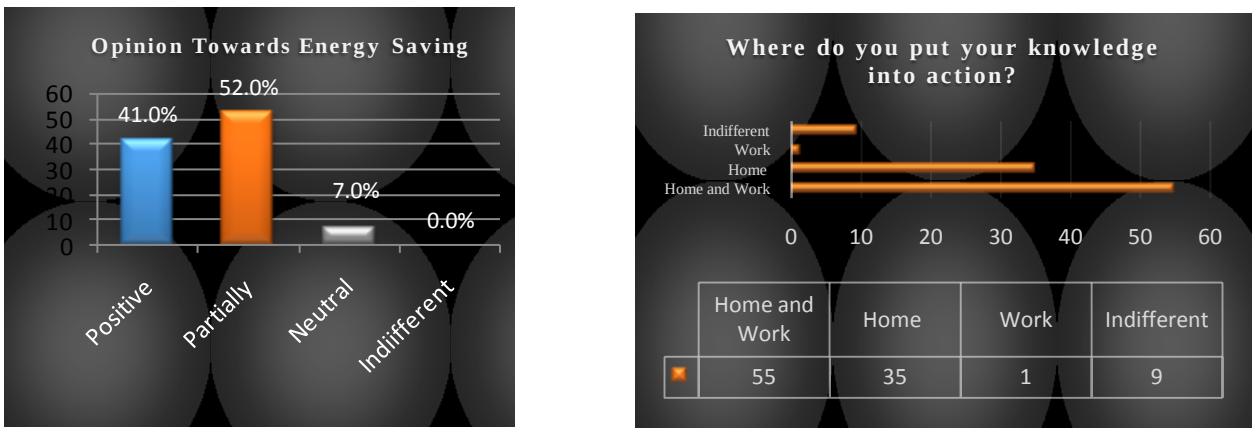
Figure1: Electricity supplier



(Source: Primary data through questionnaire)

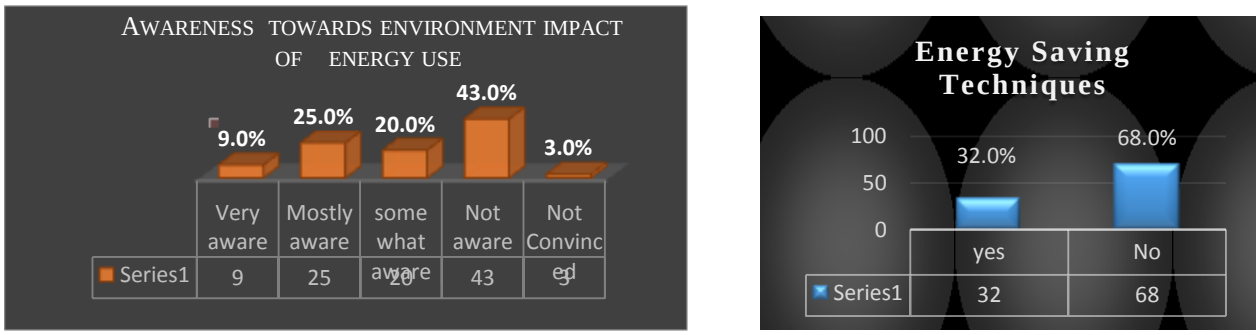
Analyzed to consider 3/4th respondent which are connected with state electricity board being having less electricity tariff comparatively to Torrent Power with having connection of single phase and three phase with an ratio of 5:1 respectively.

Figure 2: General opinion towards energy saving



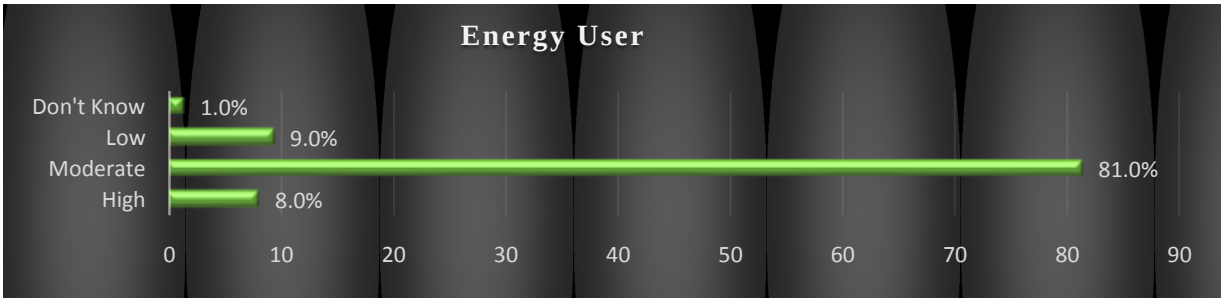
41% of respondents are positive towards energy saving. However, there is a need to have more awareness to boost everyone towards energy saving as only 35% can put their energy saving knowledge into action.

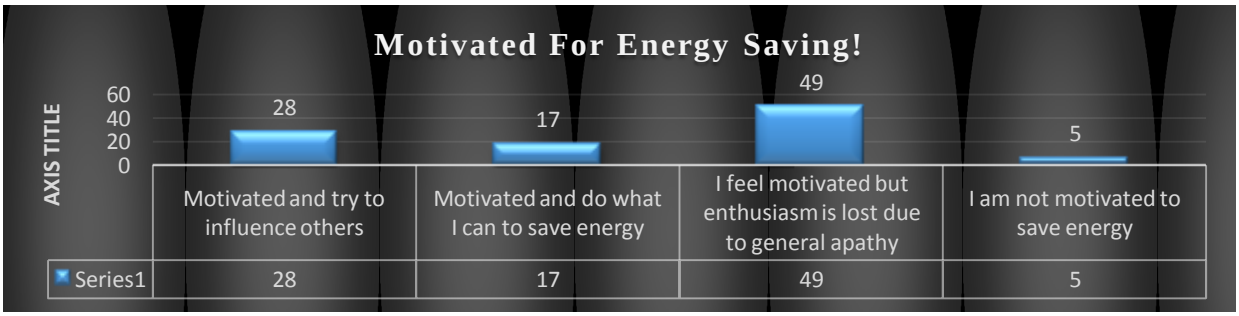
Figure 3: Awareness towards Environment Impact of Energy Use



54 % respondents are aware towards the environment impact of energy use. However, 68% don't know about the techniques to be used to save energy.

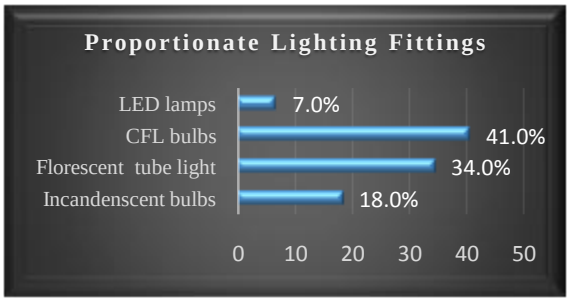
Figure 4: Quantifying Urban Energy Users

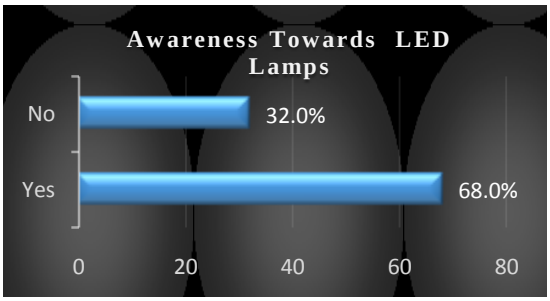




81% Respondents are using moderate energy whereas only 8% are higher energy users. Energy efficient lighting techniques are required to be demonstrated among the moderate energy users as 68% are not aware of any energy saving techniques (Reference Figure 3) and even only 41% respondents are aware about peak hours. However, there are only 28% respondents are motivated and try to influence others.

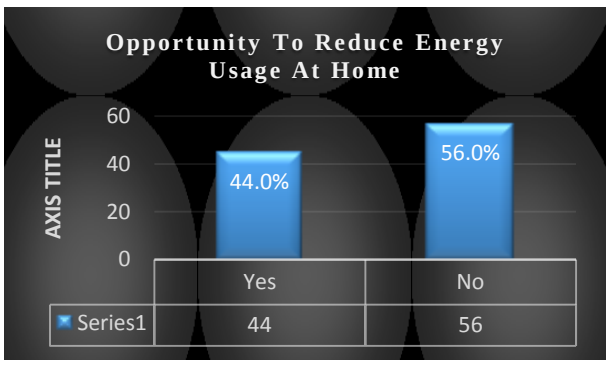
Figure 5: Proportionate Lighting Fittings and Awareness towards LED Lamps

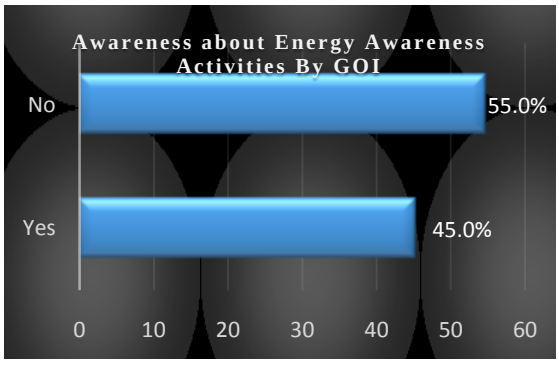




41% respondents have CFL lighting arrangements with the concept to keep energy saving techniques at home whereas 32% respondents are not aware of LED Lamps. Moreover, 34% respondents are still using florescent tube lights with a view that it is working why we should replace to. In-spite of awareness towards energy saving lighting some respondents equipped their home with Incandescent bulbs having an opinion that being outside fittings of the home and it would have no loss if there be any theft compared to CFL or LED being of its initial cost.

Figure 6: Opportunity to reduce Energy Usages at Home





During the survey it was noticed that 56% of respondents are not having any opportunity to reduce Energy usages at home whereas only 45% respondents are aware about the energy awareness activities of Govt. of India.

Empirical Analysis

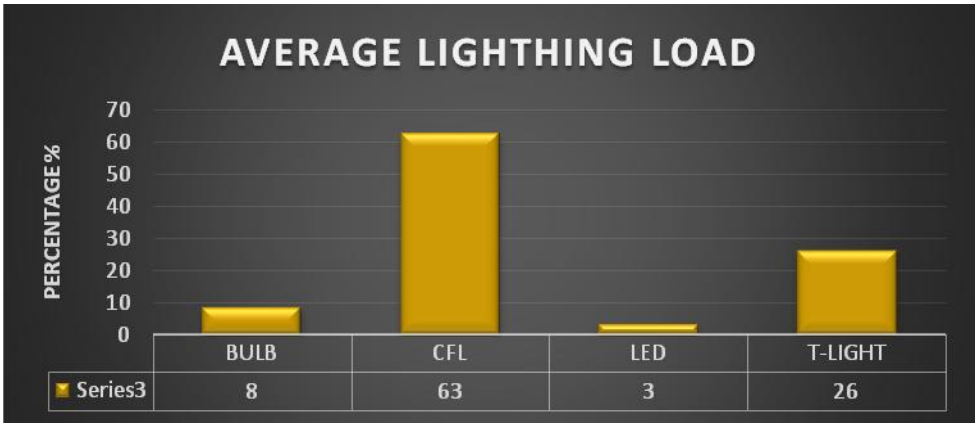
Table 3: Average Distribution of lighting arrangements in a house surveyed

Distribution of lighting arrangement in a house		
Lighting Elements	NO	%
BULB	1	8
CFL	8	63
LED	0.4	3
T-LIGHT	3	26
Total	**13**	**100**

(Source: Primary data from Questionnaire survey)

Table3 reveals that Out of 75 respondents 63% have lighting arrangements with CFL whereas only 3% were having LED lighting in their houses. Graphical presentation shows exiting highest arrangements of lighting are CFL.

Figure 7: Graphical Presentation of lighting load arrangements



(Source: Primary data through questionnaire)

To get an empirical analysis on energy conservation through Lighting, average lightings were taken into account. Table 4 shows average arrangements of lighting in urban area of Ahmedabad. However, comparing with conventional lighting arrangements with LED lighting were analyzed and found that by replacing existing conventional lighting with LED; one can save upto (306-93)W= 213 W(considering an average hour of operating of 5 hours in a day). There would be a saving of Rs. 1866.00 in a year by just replacing it with LED.

Table 4: Analysis of energy saving by replacing with LED

TOTAL LIGHTING ANALYSIS			Watts	Replace With	LED(W)
BULB	1	25W	25		5
CFL	8	[23+(8x4)+15+18+28]W	116		(5x8) = 40
LED	0.4*	0	0		---
T-LIGHT	3	(40 +15**)x3W	165		(16x3)=48
		Total	**306**		**93**

*quantity may not be considered being less than 0.5
**considering 15 Watt for choke

Table 5: Cost effectiveness in case of replacement with LED

Cost Effectiveness			Average Energy Saving in terms of Rs. per year per house
Description	Existing consumption	Consumption when to Replace with LED	
Total Wattage	306	93	**2681-815 = 1866**
cost per unit	4.8[#]	4.8	
operating hours	5	5	
Total cost of energy per year	**2681**	**815**	

(**#** Source: http://www.ugvcl.com/petition/Tariff_Schedule.pdf Point No.1.2, page 93)

Table 6: Cost Analysis (Existing Lighting arrangements Vs LED)

Sr. No.	Product	Existing Quantity Per House	Cost Per Product * (in Rs.)	Basic Installation Cost	Cost Per Element	Total Cost Per House	When Replaced with LED	LED Product	Quantity	Cost Per Product	Basic Installation cost	Total Cost per House (In Rs.)
1	25W incandescent bulb	1	15	0	15	15		**5W**	1	275	__	275
2	40W tube-light	3	40	330	370	1110		**16W**	3	880	Inclusive	2640
3	28W CFL (spiral)	1	280	0	280	280		**10W**	1	375		375
4	23W CFL(3U)	1	200	0	200	200		**10W**	1	375		375
5	18W CFL (3U)	1	170	0	170	170		**7W**	1	295		295
6	15WCFL(2U)	1	140	0	140	140		**5W**	1	275		275
7	8W CFL (2U)	4	110	0	110	440		**5W**	4	275		1100
Total Cost (in Rs.) per House						**2355**		**Total Cost (in Rs.) per House (with LED)**				**5335**

Payback period = 5335/ 1866 = 2.85 years = 25000 hrs.
(If considering one by one replacement in a year with an energy saving of Rs. 1866/- per year per house)

Table 7: An average LIFE SPAN of different Lighting Products : An Illustration with Cost

Average LIFE SPAN of different Lighting Products														
TOTAL EXPENDITURE AND ENERGY COST considering replacement with LED(2.85 years payback period)														
EXISTING PRODUCT	**LIFE-SPAN**(As per respondent experience)	**LIFE-SPAN** (As per secondary data available)		Average No. of Product in a House	Replacement Required in Payback period	Replacement required considering period of 2.85 years	**COST PER PRODUCT**	**TOTAL COST**	LED Products	**COST PER PRODUCT**@	Considering existing lighting arrangement of average house	**TOTAL COST with LED**	LIFE- SPAN (As per secondary data)	
	years	Hours	years	Quantity	Quantity	Quantity	Rupees	Rupees		Rupees	Quantity	Rupees	Hours	years
BULB 25W	0.5	1000	**0.1**	1	6	6	15	90	5	275	1	275	25000	**2.85 Years**
TUBE - LIGHT 40W	1	25000	**2.85**	3	3	9	(40+330)	1710#	16	880	3	2640	25000	
28W CFL (SPIRAL)	1.5	10000	**1.14**	1	2	2	280	560	10	375	1	375	25000	
23W CFL (3U)	1.5	10000		1	2	2	200	400	10	375	1	375	25000	
18W CFL (3U)	1.5	10000		1	2	2	170	340	7	295	1	295	25000	
8W CFL (2U)	1.5	10000		4	2	8	110	880	5	275	4	1100	25000	
Replacement Cost (in Rs.) in 2.85 years								**3980**	**Replacement cost in 2.85 Years (in Rs.)**			**5060**		
#considering only tube light with no replacement of choke etc. during the period, @ As per local Market														

Actual Payback period considering energy saving through replacement with LED for a House:

(Cost of Replacement with LED – Replacement with existing lighting arrangements)/energy saving in a year = (5060.00- 3980.00)/ 1866.00 = 0.58 years

Thus cost incurred for replacement of existing lighting with LED would be recovered in a period of 0.58 years. However, recurring saving of energy would cut-down the cost of monthly energy bill for the coming years.

CONCLUSION

Availability of Energy saving techniques , adoptability concepts , promotion towards energy saving are few terms which were earlier limited to the industrial setups and now gradually being adopted by general public to have a conceptual acceptability towards energy saving. GOI promotes various schemes towards energy saving and recently 02 LED Lamps to each house at Delhi a common words for every house. However, lots of exercise is still required to reach every common person to promote energy saving not only for the Nation but to cut down their own expenses which are unknowingly been eroding their pockets.

This study results an acceptable energy saving by just switching the conventional lighting system with LED lighting at Home without hampering their existing setup.

An average of 213 Watts of energy per house may be saved (reference Table 8) which if considered an average population of Houses 18.04 Lakhs (Considering 72, 14,225 of Actual population of Ahmedabad[9] with an average 4 persons in a house). Thus 18.04 x 213 Watt-hour= 384.25 Megawatt- hour may be saved in a year or generated by saving energy.

Habit of saving energy, promotes all of us to implement new energy saving techniques at home as well as work place due to which we all have an opportunity to reduce the energy consumption. The concept of energy saving cannot be taken occasionally but it has to be well defined systematic approach to cover all households with promotional benefits such as affordable LED Lamps.

"The high cost of producing LEDs has been a roadblock to widespread use. However, researchers at Purdue University have developed a process for using inexpensive silicon wafers to replace the expensive sapphire-based technology. This promises to bring LEDs into competitive pricing with CFLs and incandescent. LEDs may soon become the standard for most lighting needs."(http://eartheasy.com/live_energyeff_lighting.htm).

[9] http://www.census2011.co.in/census/district/188-ahmedabad.html. Accessed on 26Feb2015

SUGGESTIONS

Prof. Leslie discussed during the seminar at ISLE (2013)[10] about the need to increase the acceptance of LED lighting products in India and following were the deliberations:

- More accurate information about the life of LED lighting products
- Lower costs- costs are currently 6 to 7 times higher than a traditional lighting products
- Longer product warranties- warranties are currently only one year
- Fewer premature failures of LED lighting products
- The establishment of a website for discussion and answers to question about LEDs
- Build insurance into cost of the product so that customers can receive replacements if a products fails
- Improved product-to-product colour consistency both at the beginning of product life as well as over time
- Price point for replacement lamps needs to be competitive with compact florescent lamps (CFLs)
    - Some participants commented that there was a concern about theft of LED lamps from public and commercial spaces due to the high cost

However, there is a need to engage Certified Energy Managers and Energy Auditors of Bureau of Energy Efficiency (BEE), Ministry of Power, Govt. of India to assign the responsibilities to cover their neighborhood area to promote and to lead the campaign for effective energy conservation in household lighting.

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