Energy Conservation in Domestic Sector for Better Utilization of Power – Indian Context

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Abstract: There is a wide gap in the supply and demand of power in India and bridging the gap by installing new power stations is not going to take place in near future. The other alternative is to conserve every watt of energy. Energy conservation in domestic sector is a good point to start as about 20% of the total energy generated is utilized for domestic purpose, which is a considerable share. In this paper Indian electrical market and domestic power utilization are critically analyzed with respect to cost, efficiency and need and various methods to conserve the energy are suggested without much investment and sacrifice of comfort.

Keywords: *Energy Conservation, Domestic Energy, Power Utilization, Energy Efficiency*

1. INTRODUCTION

Electrical Energy is undisputedly the most vital element for industrial growth of any country. India is one of the many developing countries, which is suffering from acute power shortages. Almost all the states of India are not able to manage the demand from the three main sectors, viz. domestic, agriculture and industrial sectors. The recent industrial growth due to economic reforms further worsened the situation. This results in exhaustion of fossil fuels and causes ecological imbalance. Various factors including political pressures resulted in irrational distribution of the power among the various sectors, giving higher priority to domestic sector at the cost of the other two sectors.

Domestic power consumption in India takes about $1/5^{th}$ of the total power consumption, which is substantially high. Previously the power was subsidized in all the states of India and people (mis)used power liberally without worrying about efficiency of the appliances. Because of the economic reforms, the subsidy is being withdrawn in power sector in a phased manner throughout India and the power tariff is steadily increasing and the people began to realize the need for energy conservation. Even the Government of India made an act for energy conservation in 2001, which shows the seriousness of the power situation. Since domestic sector use the power in variety of applications, this is a potential area to be considered for energy optimization. By reducing the domestic energy consumption, the other sectors will get more power thereby helping the country to prosper further. As a side effect, it improves the ecological balance (Narasimham, S.V.L, Dr , and Ramalinga Raju, M, 2001.)also. In this connection an analysis is made on the consumers' choice and various measures are suggested in this paper to improve energy efficiency. Andhra Pradesh – a state of India, which has a population of about 70 millions, is considered for statistics, which represent the general conditions of any other state in India.

2. DOMESTIC POWER CONSUMPTION IN ANDHRA PRADESH

Andhra pradesh per capita consumption statewide is 480KWH per annum. Tables1 and 2 show the growth of domestic consumers and their connected load in the last 5 years (International Copper Promotion Council (India), Hand Book, 2001) and consumption pattern of the power in domestic sector (Chaudhary S.R., 2002.).

Year	*No. of Consumers (Connections)*	*Connected Load (Mw)*	*% Growth in connected load*
1996-97	6,803,038	3756	
1997-98	7,300,553	4028	7.34
1998-99	7,694,653	4246	5.4
1999-00	8,124,786	5039	18.67
2000-01	10,258,475	6327	25.56

Table 1: Growth of domestic consumers & connected load in Andhra Pradesh

Application	*%of consumption*
Lighting	40
Fanning	22
Refrigeration	12
Heating/Air conditioning	14
Audio/Video	07
Others	05

Table 2: The consumption pattern of the power in domestic sector

2. INDIAN MARKET

Cost is the most crucial factor in consumer choice. Many times cost supersede quality even though the equipment is inferior in quality, inefficient and hazardous. In recent times, quality awareness is slowly increasing thanks to the multi national companies for their better quality products at relatively lower prices. In this regard various domestic electrical equipment commonly used in Indian houses are critically analyzed and alternatives are suggested wherever possible

3.1 Lamps

Indian domestic illumination is totally dominated by the incandescent lamps of varying wattage (40W/60W/80W/100W). Despite their inefficiency, they are still preferred in lower income groups just because of their very low initial cost. Fluorescent lamps are also popular and are used mainly in the utility areas like reading rooms, bedrooms and living rooms, though they are costlier by more than 10 to 15 times than incandescent lamps. Even in the fluorescent lamps, aluminium chokes are predominant, which cost much less compared to copper choke.

In India, about 80 percent of the domestic lighting is through incandescent lamps. Hence it is one area that should be concentrated most for conservation of energy. Nowadays use of CFLs (Compact Fluorescent Lamp) is steadily increasing because of their very low power consumption, long life and better illumination over incandescent lamps. However CFLs may not be a replacement when illumination is required for precision work. Table 4 shows the comparison of the various popular types of lamps (Kushare,B..E and Bapat R.B., Energy Conservation-Demand side perspective, 2002.)From table 3, one can observe that the incandescent lamp is a source for energy wastage because of its low luminous efficiency. Following calculation shows how economic to replace incandescent with

Type of lamp	P.F.	Power consumption (watts)	Output lumens	Efficiency Lumens/watt
Incandescent 100W	1.0	100	1200	12.0
Fluorescent tube lamp 40W	0.6	52.48	2460	46.87
Fluorescent tube lamp 40W with electronic choke	0.98	33.17W	2890	68.0
CFL 15W	0.90	19.6W	900	45.91

Table 3: Comparison of various types of lamps

Fluorescent Tube Light (FTL) and with CFL. For calculations it is assumed that the operation hours are 5 Hours per day and the cost of Energy as Rupees 3/- per Kwh though it is much higher if the consumption is more.

3.1.1 Replacement with FTL

Cost of FTL with copper choke:	Rs. 275/-
Cost of Incandescent lamp:	Rs. 15/-
Difference in cost:	Rs. 260/-
Power consumed by Incandescent lamp:	100W
Power consumed by FTL:	52.48W
Saving in power:	47.52W
Payback period:	1 year

3.1.2 Replacement with CFL:

Cost of CFL:	Rs. 40/-
Cost of Incandescent lamp:	Rs. 15/-
Difference in cost:	Rs. 25/-
Power consumed by Incandescent lamp:	100W

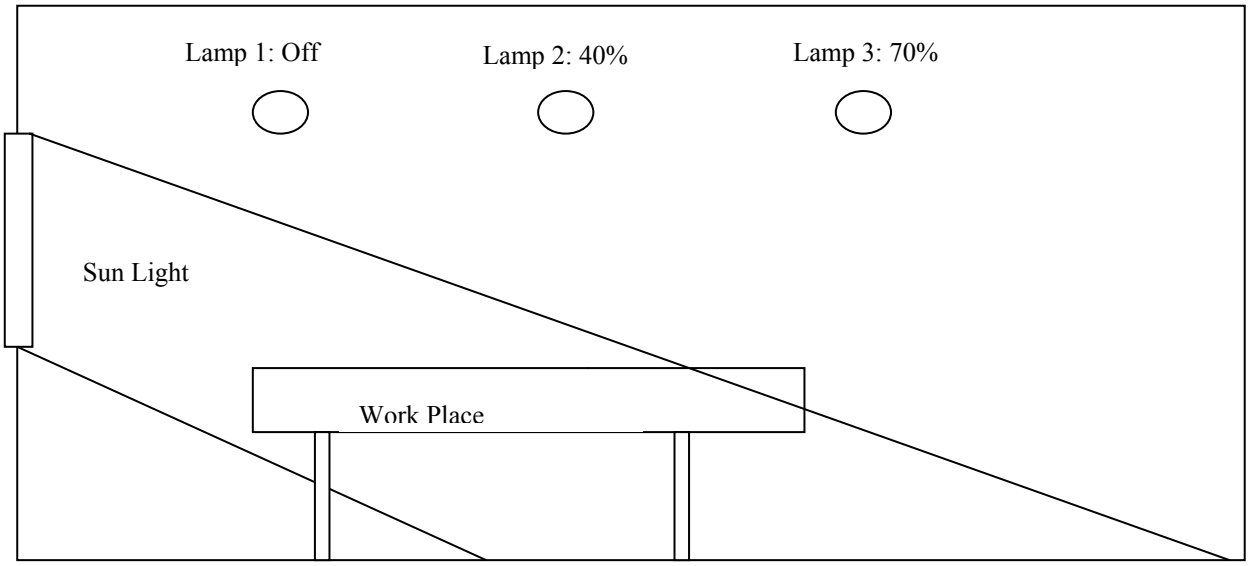

Figure 1. Typical room layout with sun light

Power consumed by CFL:	19.6W
Saving in power:	80.4W
Payback period:	21 days

In both the cases, it can be observed that the savings are very impressive and hence replacement of incandescent lamps is highly recommended. The payback period is inversely proportional to the period of usage.

3.1.2 Replacement with CFL

Cost of CFL:	Rs. 40/-
Cost of Incandescent lamp:	Rs. 15/-
Difference in cost:	Rs. 25/-
Power consumed by Incandescent lamp:	100W
Power consumed by CFL:	19.6W
Saving in power:	80.4W
Payback period:	21 days

In both the cases, it can be observed that the savings are very impressive and hence replacement of incandescent lamps is highly recommended. The payback period is inversely proportional to the period of usage. Another method to conserve energy in this area is to use the natural light effectively so that the period of usage of lamps may be minimized. Following figure shows how the daylight can be used to augment the electrical lighting.

3.2 Fans and Regulators

Fans, once a luxury, became essential now for Indian climatic conditions where temperatures rise to as high as 45^0C in summer. In India, fans available at varying cost ranging from as low as Rs. 400/- to Rs. 1500/-. Cheap fans normally use substandard core laminations and aluminium windings. Standard fans are made with quality material but cost two to three times. The power consumption varies from 60Watts to 90Watts depending on the quality of the fan. Though electronic regulators are available in the market at costs ranging from Rs. 50/- to Rs. 250/- (low cost electronic regulators don't contain proper shielding to prevent RF interference), the conventional regulators are predominant chiefly because they come along with the fan. The user has no choice for opting for an electronic regulator. At medium speeds, a saving of about 14Watts was observed with the use of electronic regulator.

Replacement of low efficient fan with series regulator with high efficient fan with electronic regulator is highly recommended. Following is a comparison of economics of a high cost fan (HCF) and low cost fan (LCF), at a nominal 8 hours a day.

Cost of HCF with electronic regulator:	Rs. 1650/-
Cost of LCF:	Rs. 450/-
Difference in Cost:	Rs. 1200/-
Power consumption of HCF	
At medium speed:	50W

Power Consumption of LCF	
At medium speed:	90W
Power savings:	40W
Payback period:	2.3 years

3.3 Refrigerators

Refrigerator is another common appliance in middle and upper classes in India. Single door refrigerators take a share of more than 80 percent and almost all are right hinged (operated with right hand). These are available in variety of capacities and models, but the most popular among them is the single door 165 liters capacity. Almost all the refrigerators have right hinged doors (operated with right hand). Operation of the refrigerator with right hand takes longer time since door opening and handing the contents is to be done by right hand only. This is particularly true with cooking items since they are normally touched with right hand only in India. This leads to loss of cooling and can be saved to some extent if a left hinged door is provided.

Refrigerators in India are mostly used for preservation of food items and for cold water. If two separate compartments are provided, there can be good energy savings since the loss of cooling due to door opening is confined to that compartment only. In fact, a tap may be provided for cold water, which minimizes the openings of the door by about 60%. Normally, defrosting is done only when the deep freezer is completely choked with ice, which hampers the effectiveness thus making a refrigerator inefficient. Another common flaw is insufficient space behind the refrigerator, which deteriorates the heat transfer. The vendors should educate the consumers to ensure periodical defrosting and not to place the refrigerators close to the walls. Now a days "No Frost" models are available, which are very efficient and consume less power than the normal models.

3.4 Water heaters and solar heaters

Immersion heaters, storage geysers and running water heaters (instant water heaters) are available in India. Immersion water heaters are the cheapest and are widely used despite the fatal risk involved just because of its cost. Solar water heaters are not available in many places because of their prohibitively high initial investment. These are used only in luxury hotels, guesthouses and cottages, as the Government made it a principle to install them in these places to conserve energy. Augmenting the geyser with solar water heater greatly reduces the power consumption (as much as 80%) as solar energy is available for more than 10months a year, which raises the temperature to an adequate level. Following example shows the cost savings by the use of a solar water heater. Cost of solar heater (100 Liters): Rs. 8500/-

Heat required to raise temperature from 20^0C to 45^0C (Ambient to required temperature) for

100 liters :	2500 Kcal
Energy required: 2500/860:	2.906 KWH
Energy Required per Annum	
(300 days):	872.1 KWH
Savings @ 80% of the	
Energy Consumption:	697.7KWH
Savings in Rupees:	Rs. 2093/-
Payback period:	4 years

Apart from the energy savings, the hot water can be used for other purposes like washing and cooking during the summer when hot water is not necessary for bath.

3.5 Water Pumps

Many houses are fitted with a 350W (1/2 HP) or 750W (1 HP) motor depending on the overhead tank capacity. Most of the motors are controlled manually and average usage is about two hours a day. Overflow of tank is a common phenomenon in India since the use of automatic water level controllers is not yet popular.and on average there will be a loss of at least 10 minutes per day per motor in the form of overflow. An automatic water level controller is available for about Rs. 500/- to 800/-. The following calculation shows the savings if an automatic water controller is installed. Cost of water level controller: 500/-

Motor rating::	750 W
Energy waste per day	
@ 10 minutes of overflow :	125WH
Payback period:	3.6 years

The savings will increase with the increase of the rating of the motor and the time of overflow. This also increases the comfort level and conserves the water resources.

4. CONCLUSIONS

Energy conservation is inevitable and should become a habit to every citizen. Disciplined usage of electrical energy saves a considerable amount to individuals, and considerable power to the

nation, which can be used for industrial growth, which is currently worst hit sector by the acute power cuts. Various methods are suggested for conservation of energy in the domestic sector. Though Indian context is taken as an example, it may be applied to every country, which is suffering from power shortage.

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