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DEMAND SIDE MANAGEMENT: CASE STUDY AT EDUCATIONAL INSTITUTE

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ABSTRACT: *Fossil fuels contribute more than60% of energy produced in India. The problem is that availability of fossil fuels are reducing fast. Hence the focus is to implement Demand Side Management (DSM). This paper deals with identification of efficient lighting system and calculates the saving of energy in a block of an educational institution. The work considers the current consumption and suggests the options for energy conservation. The paper considers that less efficient equipments are replaced by energy efficient equipment. The energy saving and payback period is calculated.*

Keywords: *Higher efficiency lighting system***,** *Energy conservation, Demand side management (DSM.*

I. INTRODUCTION

India is world's 2nd largest nation by population. Urbanization and industrial growth has resulted in sharp increase in energy consumption in India [1]. Nations growth is measured by its energy consumption. India is facing difficulties in meeting the demand of all sectors of people. New generation based on renewable is one of the solutions to meet the demand gap. But due to high initial cost it is not advisable to invest in renewable based new generation. Hence energy conservation at the demand side is a viable solution [2]. The energy consumed can be reduced by DSM. This causes the generation capacity to be reduced and unit cost of energy comes down. [3] [4]. This paper focuses on DSM measure at an educational institution.

II. INDIAN ENERGY SCENARIO:

The installed capacity in India is 349288MW. Table 1 summarizes the energy scenario in India.

Table 1: Energy scenario in India

Sl. No.	Particulars			
1	Source of energy	Thermal - 64%	Hydro - 13%	RES & Nuclear - 23.1%
2	Generation	Central - 24%	State - 30%	Private - 46%
3	Consumption	Domestic - 25%	Industry - 36%	Others - 39%

III. END USER ENERGY CONSERVATION

DSM is the solution for the energy crisis existing today. DSM has a potential of saving 15000MW of energy per annum [5]. Lighting, Fans form most of the energy consumption in educational institute. Use of energy efficient lamps can save energy[6]. Energy requirement is seen to reduce with proper implementation of DSM. It also improves utilization of energy and increases the load factor.

IV. LIGHTING SOURCES AND THEIR EFFICIENCY

The various electrical lighting sources have different luminous efficacy. Sources with high efficiency require lower rating and in turn reduces energy consumption.. Table 2 shows the luminous efficiency of various light sources [6].

Table 2: luminous efficiency of different light sources

Source	Incandescent lamp	Fluorescent lamps	Compact Fluorescent lamps	LED lamps
Luminous efficiency in lumen/watt	10-30	60-70	50-80	80-100

V. HARMONICS AND THD:

Harmonics is the distortion of the voltage or current wave form due to the superimposition of waveforms having frequency which is an integer multiple of the fundamental frequency. They are typically generated by non linear loads like motors, televisions, refrigerators, printers, computers (and other devices that employ SMPS- Switching Mode Power Supply) and fluorescent lighting. Harmonics tend to a decrease in the power factor of the system, thus increasing the cost of transmission and reducing the efficiency. They can cause damage to protection devices like fuses, and may result in strange behavior of a system and may cause errors in the measuring instruments. In order to minimize harmonics, one could install shunt filters of external active filters, while making sure that the cabling and earthing of the system is proper. THD is the measure of total harmonic distortion in the signal. IEEE 519 has suggested a voltage THD limit of 5% and current THD limit of 10%.

VI. EXPERIMENT SETUP AND DATA GATHERING:

An experimental setup was made to study the various lighting sources with respect to their lumen output, current drawn, power factor, THD. Lux meter mobile application was used to study the lumen output and the measurement was made at a distance of 1 feet normal to the light source. The harmonics, voltage, power, power factor, were measured using HIOKI 3198 Power quality analyzer. The energy efficient lighting sources are shown in fig 1

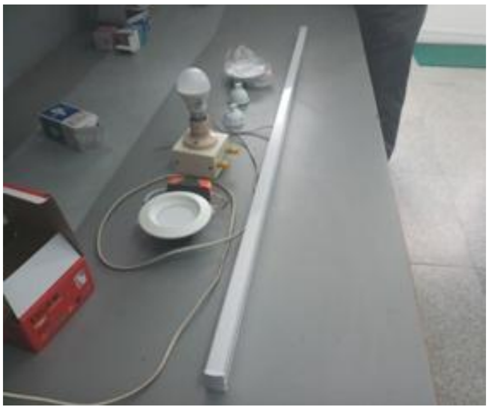

Fig. 1: Energy efficient lighting sources

The analysis was done at two operating condition, one at a voltage at which the lighting source starts to emit light and the other at the rated voltage mentioned by the manufacturer. The results of the experimentation conducted on various lighting sources available in the campus are shown in table 3.

Fig.2 and Fig.3 shows the readings from Hioki 3198 power quality analyzer.

Fig. 2 and Fig 3. Readings from Hioki 3198 Power quality analyzer

Table 3: Experimental results

Sl. No.	Type of lamp	Voltage (V)	Lumen output (lm)	Current (A)	Power (W)	Power factor	I_{THD}	V_{THD}
1	14W LED	Min: 72.74	1540	0.128	5	0.542	53.17	2.85
		Max: 235	1700	0.0613	6	0.423	88.2	2.76
2	12W LED	Min: 43.69	1520	0.137	3.4	0.575	56.7	3.25
		Max: 235	3040	0.0745	7.1	0.373	89.79	2.76

3	11W CFL	Min: 85.67	225	0.071	3.7	0.6	62.30	2.99
		Max: 235	1800	0.085	10.7	0.525	80.6	2.96
4	9W LED lamp	Min:58.17	1250	0.036	0	0	42.44	2.74
		Max:235	3900	0.0373	8.6	0.9813	10.4	2.8
5	**20W LED tube light**	**Min: 79.5**	**1250**	**0.1134**	**8.1**	**0.899**	**42.28**	**2.64**
		Max:235	**2400**	**0.087**	**19.8**	**0.9716**	**13.88**	**2.76**
6	36Wx2 – Electromagentic choke – double TL	Min:206	2000	0.5625	63.5	0.555	12.48	2.86
		Max:235	2800	0.73	86	0.509	10.47	2.88
7	36W Tube light-Electronic choke	Min: 79.3	320	0.178	13.1	0.93	29.42	2.72
		Max: 235	1360	0.167	36	0.922	27.21	2.8

The experimental result provided very interesting and significant conclusion regarding the light sources. It was observed that conventional fluorescent lamps have a very poor power factor and cannot operate at low voltages. The harmonic levels are acceptable CFL lamps have a better lumen output and ability to operate at low voltages. But the mercury in CFL can cause health hazards and the operating power factor is poor. LED lamps have the advantage of having highest lumen output, acceptable THD, high power factor and can operate at low voltages also. Hence LED tube lights have better performance and can be the most energy efficient lighting option. They have a high initial cost but a long life makes it more suitable as energy efficient alternative for lighting system.

VII. Lighting based Energy saving at BNMIT:

BNMIT located in Banshankari, Bengaluru was selected for the case study. The institution has 3 major blocks. Main building block was selected for the study, The number and type light source used, average hours of usage were determined.. The summary of the data collected are listed in Table 4.

Table 4: Data collected at Main building block, BNMIT

Sl. No.	Description of Equipment of study	No. of equipments	Power in watts	Approximate Hours of usage	Average Energy consumed in kWh per day	Average Energy consumed in kWh for a month [assuming 25 days]
1	Tube lights	210	36	5	37.80	945
2	Twin tube lights	63	72	5	22.68	567
	Total				60.48	1512

VI. ENERGY SAVING OPTIONS AND ANALYSIS:

Based on the data collected the analysis was done to identify the various energy saving options as listed in table 5. The calculations are made considering all inefficient equipments are replaced by energy efficient equipments,. Considering the lumen output of the lamps the following requirements are decided:

- A 36w Twin tube light can be replaced by a 20w LED tube light. Therefore 63 20w LED tube lights are required.
- A 36w tube light has a lumen output of 1360 lux while a 20w LED tube light has a lumen output of 2400 lux. Therefore required intensity is 210 * 1360 = 285600 lux. Considering a 5% additional requirement at the corners the required intensity is 299880 lux, approximately 300000 lux. To realize the same lumen output the no. of LED tube lights required are = 300000 / 2400 =125.
- Therefore total number of 20w tube lights required is = 63 + 125 = 188

Table 5: Energy saving options at Main building, BNMIT:

Sl. No.	Energy saving option	No. of replacement	Power saved in kW	Usage duration in Hrs	Saving in energy per day in kWh	Saving in energy in kWh [assuming 25 days]
1	Replace 36w tube lights by 20w LED tube lights	210 tube lights replaced by 125 LED tube lights	=210*36-125*20)/1000 = **5.06**	5	25.3	632.5
2	Replace 36w Twin tube lights by 20w tube lights	63	=63*(72-20)/1000 = **3.276**	5	16.38	409.5
	Total saving					**1042**

The cost of branded 20w LED tube light in the market is approximately Rs.280/-

The cost of energy is assumed as Rs.7 per kWh. The monthly saving and payback period is calculated as shown in table 6.

Table 6: Average saving and payback period

Sl. No.	Energy saving in KWH	Cost saved in Rs.	Approximate cost of replacement in Rs.	Pay Back period in months
1	1042	7,294	52,640	7.2 ≈ 7

VII. CONCLUSION

It was seen that an average of 1042 units of energy can be saved per months by implementing DSM measures The DSM measure requires initial investment by the payback period is just 07 months. The author feels implementation of DSM can improve utilization and provide substantial saving in energy consumption. By proper awareness program people can be motivated to implement DSM measures. DSM will also be a future need to save environment from over usage of energy and save the world from global warming.

VIII. ACKNOLEDGEMENT

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