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Energy Auditing: A Case Study

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ABSTRACT: The need to reduce energy costs is a crucial business practice for successful organizations, and energy audits have begun to play a more significant role in managing energy expenses. Anenergy audit help to determine the energy-wasting deficiencies in the institution and can show exactly how to address those problems. Even more useful, an energy audit will tell an authority how much money and energy they can save each year by implementing the recommendations. This paper sketches some of the options that energy auditor can consider while conducting an audit in an institute. This paper put forwards some energy saving methods in a methodological approach, experienced while conducting an energy audit in an institution.

KEYWORDS: Energy auditing, payback period, energy consumption survey, power factor.

I.INTRODUCTION

Energy is the major input for the development of any nation. For the effective management of energy in each sector or organization, energy auditing is preferred. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital for production and utility activities. Such an audit will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.The process of energy audit includes historical energy data collection and analysis, formulation of ECOs to the actual implementation. In the present analysis, College of Engineering Perumon, located in Kerala, India, is selected for the research object, and we ventured on the energy saving methods in the College facilities. An audit has been conducted on the energy conservation in the college and some directions leading to energy conservancy are presented in this paper.

II.ENERGY AUDITING METHODOLOGY

Energy Audit is a periodic examination of an energy system to ensure that energy is being used as efficiently as possible. Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. It attempts to balance the total energy inputs with their use, and serves to identify all the energy streams in a facility. It quantifies the energy footprint according to its discrete functions.
Energy utility survey in the institution consists of four phases:
Phase 1: Electric Energy utilization survey and analysis
Phase 2: Light energy utilization survey
Phase 3: Thermal energy utilization survey
Phase 4: Substation survey

III.ENERGY CONSUMPTION SURVEY

This energy audit is aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities. The target is to achieve savings in the electrical energy consumption to the extent of10%.

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A. *Electrical Energy Consumption*

College of Engineering Perumon being an HT consumer takes its 11kV supply from Perinad section of KSEB. Energy auditing has been conducted in the College in order to estimate the Energy consumption of each day, month and year. For energy auditing, it is necessary to analyse consumption of electrical energy in the previous years. The electricity utility bills from 2012 to 2015, December have been collected for the purpose. The energy consumption pattern was inferred from the graph. The inferences of the graph offers the possibilities of energy conservation .These findings can be used for making recommendation to high authority. This collected data of electricity bills of institution was taken from records of the institution. A total connected load of 202.7 kW with a contract demand of 90.2 kVA is the power utility scenario in January 2016.

YEAR	*ENERGY SOURCE*	*TOTAL CONSUMPTION*		*ANNUAL COST(RS)*	*MJ/student*	*TONNES OF CO2*
		MWh	*MJ*			
2103	*ELECTRICITY*	*73.294*	*263858.4*	*9,21,925*	*188.4*	*55.7*
2014	*ELECTRICITY*	*94.108*	*338788.8*	*10,37,494*	*241.99*	*71.5*
2015	*ELECTRICITY*	*123.743*	*445474.8*	12,25,055	*318.19*	*120*

Table 1. Energy consumption, annual cost and equivalent tones of CO2 rejections

Table 1 shows the total energy consumption during the year 2013, 2014, and 2015. And the equivalent MJ and CO2 are emitted during the production. As inferred, the consumption of each year is increasing.The graphs for electricity bill payment and energy consumption by the institution during three years are plotted; Fig 1 shows the pattern of the energy consumption.

B. *Analysis of collected electricity bills*

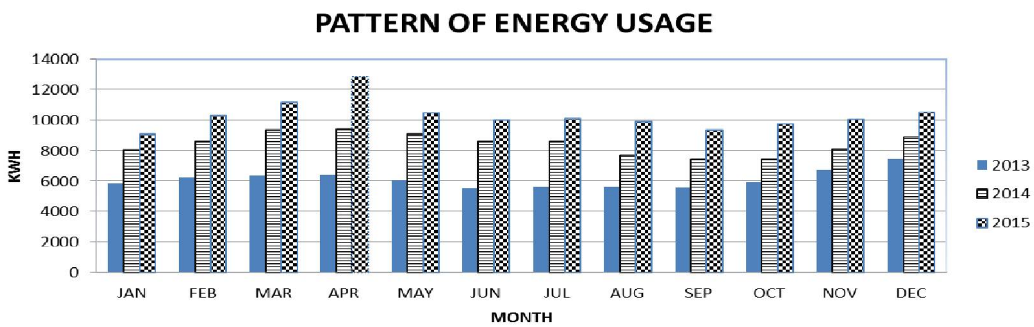

Fig 1. Pattern of energy usage in each year

- There is a sudden increase in the energy consumption during the months of March, April and May of all year
- A sinusoidal pattern can be observed in all the three years.
- The maximum electricity demand of the campus has increased by an average of 20 kVA within these 3 years. The peak value of MD was attained during the month of March which was 85 kVA.
- The highest value of power factor (pf) achieved in the campus was 0.89, it never crossed above 0.9 shown in fig 2.
- A total of Rs14707.46 has been paid in the year as penalty to the KSEB in the year 2015.

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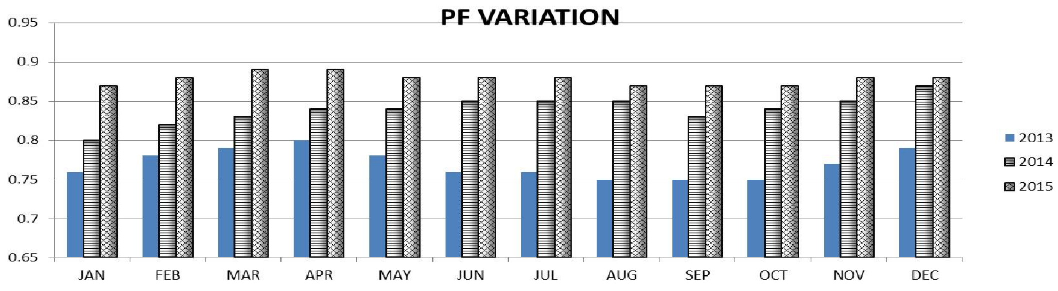

Fig 2.pf variation in last three years of the campus

C.*Light energy utility survey*

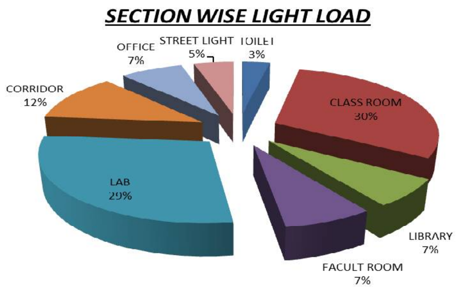

Fig 3. Section wise light load

Fig3.Shows the section wise light load i.e. the light load distributions in corridor, class rooms, laboratories, toilet, library, faculty room and office. Fig 3 exhibits the fan load distributed to each sectors.

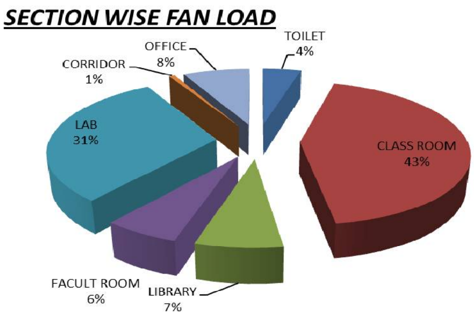

Fig 4. Section wise fan load

About 27% of total load is due to light and fan loads. Major part of both load are there in class room and later in laboratories. The least light load can be observed in the toilet, and least fan load is observed in the corridor.

D. *Substation Auditing*

College of Engineering Perumon is a HT consumer and takes 11 kV supply from KSEB Perinad substation. The supply main enters to a substation and power is distributed to each block. Using the power logging instrument the current THD, voltage THD, power factor, phase current, neutral current, phase voltage, active power, etc of each block is logged in a period of 24 hours. The total active power consumption in each block with respect to each phase is plotted shown in Fig 5.Greater variations were observed in R phase and less in B phase for current THD. The value of THD is lower during the class hours. Wide variation in THD is observed in the B phase in F blocks. And slight peaks are observed in E block.

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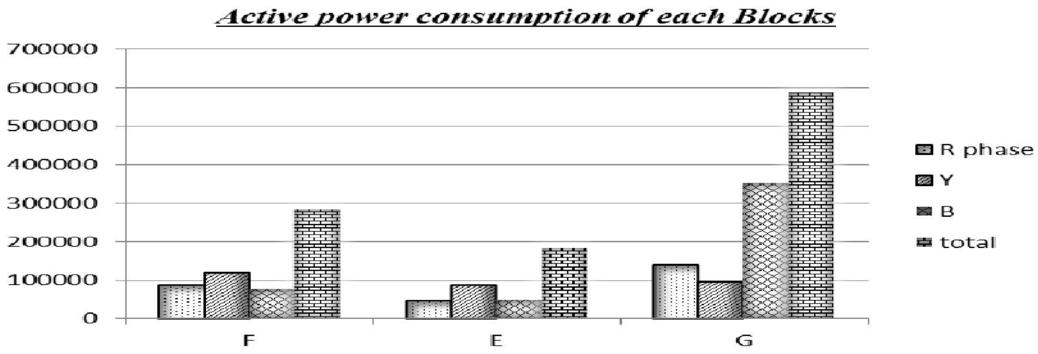

Fig 5. Active power consumption of each Building

Greater variations were observed in R phase and less in B phase for current THD. The value of THD is lower during the class hours. Wide variation in THD is observed in the B phase in F blocks. And slight peaks are observed in E block. Fig 6 shows the neutral current in the G block, there is a constant current flow during off peak time about 10 A, and huge current is observed in the remaining period. Irrespective of G block the neutral current in the F and E blocks during off peak hours is nearly zero and random variation in this parameter is very significant during class hours. An unbalanced distribution in loads during class time cause this wide variation and it reveals out a scope of ECOs

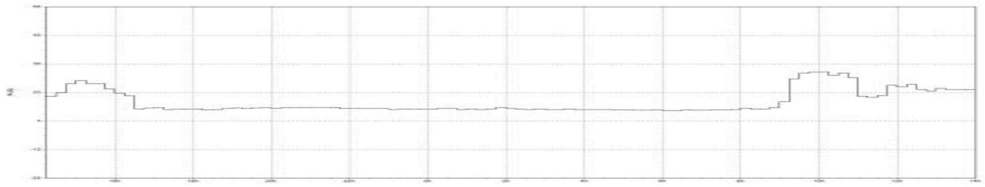

Fig 6. Neutral current of block G

Voltage THD is nearly zero in all phases and peaks are appeared in some times in G block. In case of other blocks, the voltage THD is nearly zero in Y and B phases and slight variation in R phase. Some peaks are also observed in three phases of all blocks.

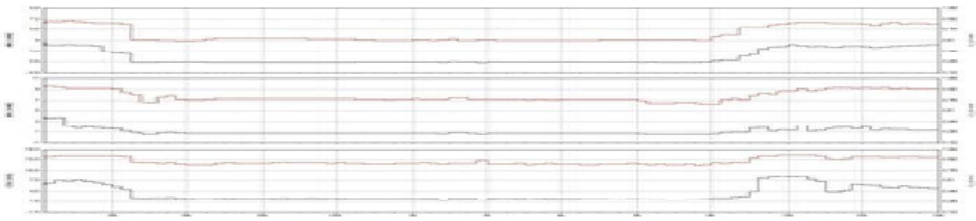

Fig 7. Logged data of power factor and active power of block G

- The load observed in Block G during the peak time in R Y B phases are 3.8 kW, 2.15 kW, 8.2 kW respectively
- Load in block F during peak time in R Y B are 2 kW, 4 kW, 3.9 kW.
- Load observed in Block E during10 am is about 0.9 kW, 3 kW, 2.5 kW in R Y B phases
- pf in Block G during peak time is nearly about 0.92 in all phases and during off peak time it is about 0.6, 0.76, 0.86 respectively in R Y B phases.
- pf in Block F during peak time is 0.9 in all phases and during off peak time is 0.6 in all phases
  pf in Block E in off peak time is 0.25 in all phases and 0.89 during peak time in all phases

  Fig 8 shows the pattern of the power consumption of block E, in off peak periods there is a slight power consumption in R phase about 0.3kW, and no power consumption in other phase during the of peak hours.

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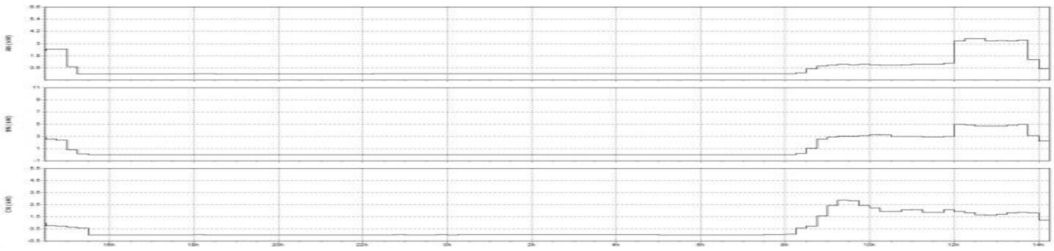

Fig 8. The power consumption Pattern for 24 hours in block E

The power consumption and pf pattern of Block F in shown in fig 9. In the phase B lot of disturbances can be seen in the pattern during off peak time, and only have low pf in that phase.

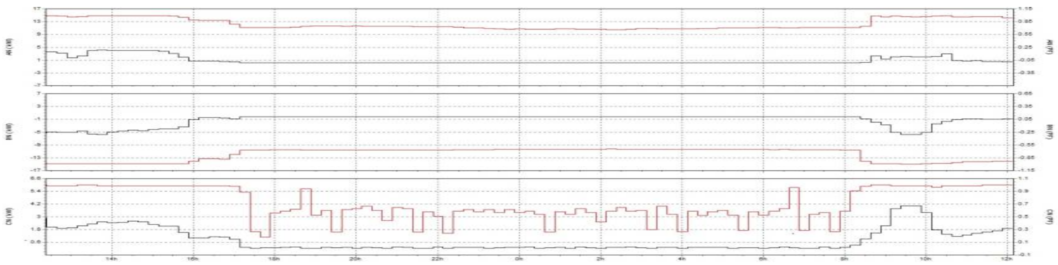

Fig 9. The power consumption and pf of block F

IV.MEASUREMENTS AND CALCULATION

The empirical formula for finding the payback period (P. P) is given below

$$P.P = \frac{I-Lx}{6.2(W-W1)hd} \quad (1)$$

I: Installation cost
Lx: cost of equipment with depreciation factor x
W: Wattage of existing equipment
W1: Wattage of proposed equipment h: no: of hours
d: no: of days

E.*Calculation for energy conservation of Light loads*

(i): Fluorescent Lamp T8 WITH T5
Replacing the T8 with T5 FTL an annual saving of Rs. 43559.71 can be obtained and period obtained as 0.63 years using equation (1). Life of T5 is approx 4 to 5 years. The additional cost incurred towards the replacement will be paid back in 7months time period.
(ii): Fluorescent Lamp T8 WITH LED
Re-establishing the existing system with the new trend LED tube lights an amount of Rs116159.per annum can be obtained. The payback period is about nearly 6 years.

F. *Calculation for energy conservation of fan loads*

The most of energy loss in the class room is through the poor performance of the fan installation, replacing the existing fan installations with good quality Havells / Khaitan fans. An amount of Rs.163577.7 per annum can be saved. The additional cost incurred towards the replacement will be paid back in 2.5 years' time

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V. PROPOSED RECOMMENDATIONS FOR ENERGY CONSERVATION

The general recommendations are given below. The savings due to their implementation could not be easily quantified, but their importance can't be understated. Implementing all these, a total saving of 10-12% can be achieved without compromising much on the existing system and comforts.

- *Replace T8 with T5 or with LED tube*
  Replacing T8 with T5can save 7025.76kW per annum.Replacing the T8 lamp with LED tube light can save an amount of 116159.2 per annum. And 18735.36 kWh per annum can be saved.
- *Replacement of exciting fans with 50 watt good quality Havells*
  Replacing the existing fan with energy efficient fan can give an appreciable saving in energy utilization and it has another advantage of less maintenance.
- *Balancing the loads in each phases*
  Balancing the load in all phases will improve the efficiency of the transformer
- *Proper maintenance and servicing the battery and ups system*
  The significant power consumption observed during the off peak period can be controlled by proper maintenance and servicing of the ups and battery system.
- *Reduce lighting*
  There are a couple of ways to do this to take advantage of natural daylight. Turning off the lights or dimming them during the day allows for lower energy utility and a comfortable environment.
- *Use timers and sensors*
  By installing the occupancy sensors, timers, or photocells in laboratories and restroom will ensure that interior and exterior lights are turned off at the appropriate time which reduce lighting costs by up to 40 per cent.
- *Installing shading devices*
  Some constructional changes in building envelop can conserve electrical energy via improving the efficiency of air conditioner.
- *Automatic Door closing in the air conditioned rooms*

VI. CONCLUSION

Well-managed energy utilization can be an efficient method to reduce energy consumption. There are many aspects involved: equipment modification, and a little attention.By adopting proper measures as suggested in the report, i.e. de-lamping, replacements, balancing, energy awareness to make the people aware the importance of energy,etc.it is possible to reduce the energy utilisation by 10%. In a broad concept, these energy savings will add up to improve the environment by reducing greenhouse gases, also the cost reduction in electricity bill of institution and development of the Nation.

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