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Energy Audit of an Engineering Institute: A Case Study

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Abstract:

An energy audit is a study of a plant or facility to determine how and where energy is used and to identify different ways for energy savings. There is now a universal recognition of the fact that recent technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The good fortune lies in the use of existing renewable energy technologies, greater attempts at energy efficiency and the dissemination of these technologies and options.

This energy audit of the Engineering College building academic area and the hostels was gained out by the student of the Department of Energy Science Engineering as a part of the course work for the dissertation. This report is just one step, a mere mile marker towards our goal of achieving energy efficiency and we would like to highlight that an energy audit is a continuous process. We have compiled a list of attainable actions to conserve and efficiently utilize our scarce resources and identified their savings potential. The next step would be to program their implementation. We look forward with optimism that the institute authorities, staff and students shall ensure the maximum application of the recommendations and the success of this work.

Key Words:

Energy Audit, Engineering Institute, Energy Saving, Energy Consumption, Measurement

Introduction:

The engineering college, set up by an Act of Rajasthan government, was founded in 1999, at Bikaner in Rajasthan. Today, the Institute is recognized as one of the cores of academic excellence in the country. Over the years, there has been sound progress at engineering college in all academic and research activities, and improvement in facilities and infrastructure, to keep it on par with the best institutions of the world. Institutes in positions of excellence evolve with time. As on date, it has eight Departments; the student strength of the institute is about 3000, with faculty strength of about 250 and supporting staff of about 350 over an area of about 150 acres.

A. Energy audit objective:

This energy audit assumes acceptance due to the fact that the Engineering college electricity bill had crossed Rs. 40 lakh during 2010, and it was aimed at obtaining a detailed idea about the various end use energy consumption activities and identifying, enumerating and

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evaluating the possible energy savings opportunities. The target is to achieve savings in the electrical energy consumption to the extent of 20%. The audit was also aimed at giving the student a feel of the practical problems and difficulties in carrying out energy audits. As energy engineers, the students of the department enthusiastically participated in the dry run.

B. Present energy scenario:

The energy consumption in college is mainly in the form of electricity, apart from the use of LPG as cooking fuel in the hostels. The campus had a connected electrical load of 500 KW as on April 2011 and a contract demand of 450 KVA. The monthly recorded peak demand for the year 2011 is given in Figure - 1. The Engineering college energy bill for the year 2011 was Rs. 40 lakh. The electricity bill comprises two parts: one related to the energy consumed (per KWh or per unit energy consumed) and the other is the maximum demand charge (per KVA of maximum demand during the month). There also exists a penalty for low power factor.

C. Specific Energy Consumption:

The Specific Energy Consumption (SEC) is defined as the energy consumption per unit of product output. The specific energy consumption considering students, faculty and staff members were calculated which forms the institute SEC and was taken as reference for comparison. The SEC was calculated to be 1111 kWh/person/annum for the academic area and Rs. 6944 per person per annum.

D. Segmentation:

This energy audit report has segmented the energy consumption patterns both by departments/ hostels/ offices and by end use activities (lighting, cooling, pumping, washing etc.). The details are provided in the subsequent chapters.

Energy Audit:

A. Energy audit methodology:

- Formation of audit groups for specific areas and end use
- Visual inspection and data collection
- Observations on the general condition of the facility and equipment and quantification Identification / verification of energy consumption and other parameters by measurements
- Detailed calculations, analyses and assumptions
- Validation
- Potential energy saving opportunities
- Implementation

B. Grouping and strategy:

The following steps were formed with specific target areas and end users assigned.

- Lighting and fans in Main building, Library and staff canteen
- Lighting and fans in Departments (all departments, offices, class rooms and labs)
- Lighting common area – Covering street lights, corridors, grounds
- Lighting and fans in Hostels
- Electric water heating and washroom/ironing loads in all Hostels
- Total energy audit of guest house-I, guest house-II and guest house-III
- Energy use in Kitchen – Hostels and staff canteen
- Room air conditioners in main building, departments and labs

- Computers/printers – All departments, labs, library and main building
- Water Pumps in the entire campus
- Benchmarking of electricity consumption

They were allowed the use of various measuring instruments like Power demand analyzers and Lux meters to assist in the auditing activity. Also, cooperation of the Electrical Maintenance Section was sought to collect past data and for taking measurements.

Quantification by End Use

The loads were segregated based up on the end use as lighting and fans, air conditioning, Computer/printers, water pumping, hostel mess cooking loads, washing machines and irons. Quantification, types and necessary measurements were carried out. The details are given here.

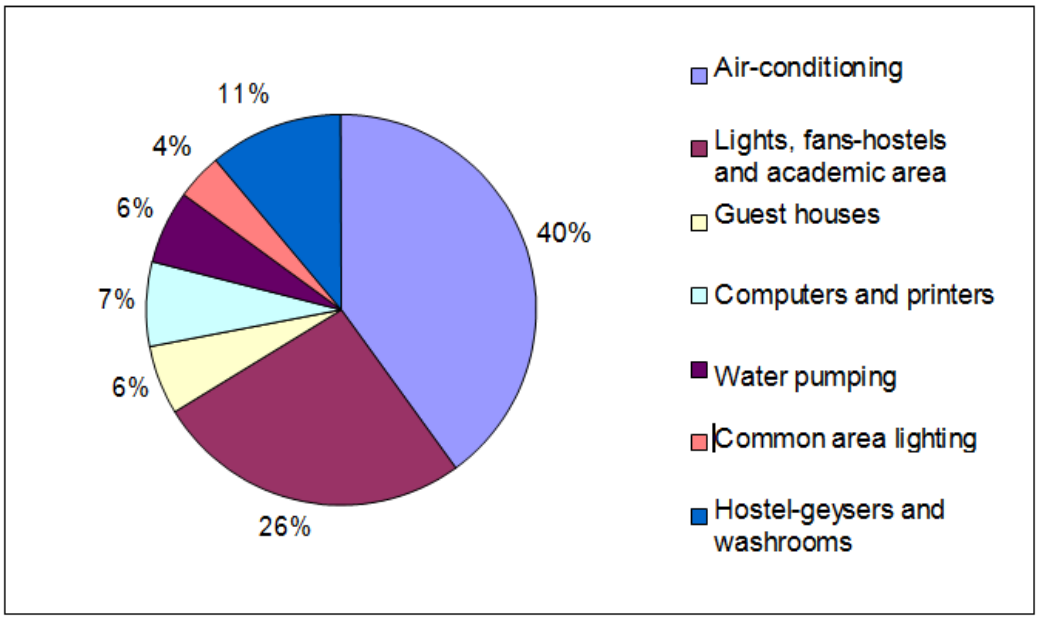

Figure – 1: Distribution of connected load by end use

Measurements Performed:

Data obtained based on measurements are included in this point –

A. Room air conditioners:

A commercially available energy saver for room ACs was procured and measurements were carried out for over 60 hrs, with and without the saver, for a typical 1.5 ton Voltas Vertis AC in the Computer science Lab.

B. Lighting and fan loads:

The energy consumption of FTLs (Fluorescent Tube Lights) which are commonly used in the campus is shown below. The energy consumption of the FTLs used in hostels is found to be high compared to 28W T5 FTL. Measurements for lighting in hostels are shown in following tables.

Table I

FTL with Electronic Ballast			
V (volts)	I (Amp)	P (W)	P. F.
226.5	0.54	38	0.522

Table II

FTL with Magnetic Choke			
V (volts)	I (Amp)	P (W)	P. F.
224.3	0.532	42.5	0.5813

C. Fans:

From the power consumption of ceiling fans with resistance and electromagnetic regulators, it was seen that the latter consumes less power at lower speeds of the fan Sample measurements on fans in hostels

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Table III

Sample reading

Ceiling Fan		Resistance regulator		
Fan Speed	V(volts)	I(Amp)	P(W)	P.F.
1	224.7	0.43	41	0.791
2	225.6	0.43	56	0.9
3	223.81	0.453	63	0.956
4	223.4	0.45	66	0.984
ON	223.3	0.452	70	0.996

Table IV

Ceiling Fan		Electronic Regulator		
Fan Tab	V(volts)	I(Amp)	P(W)	P.F.
1	233.7	0.26	13	0.385
2	233.6	0.396	37	0.66
3	233.7	0.382	49	0.815
ON	233.18	0.405	68	0.997

Energy Conservation and Efficiency:

A. Implementation Measures:

- Replacing Electromagnetic ballast by Electronic ballast in FTL in study room and using 18W CFLs in staff canteen
- Replacing Electromagnetic FTLs by T5 in Departments.
- Replacing common area lighting in departments with T5 FTL /CFL
- Replacing 197 FTLs used in student rooms in with 28W ballast FTLs.
- Replacing rheostat speed regulators of 195 fans in the student rooms with

electronic speed regulators

- Replacing 170 FTLs used in student rooms with 28W ballast FTLs.
- Replacing rheostat speed regulators of 104 fans in the student rooms with electronic speed regulator
- Installing solar water heaters in all hostels
- Solar Water Heater for Guest Houses
- Biogas plant for food waste processing
- Installing 60 Aircon savers for 1.5 Ton ACs with a higher duty cycle (> 8 hrs./day)
- If 70 AC users can be made to switch off the ACs 15 mins. prior to leaving the office.
- Adopting a normal energy saving power setting for computers
- Rescheduling the pump operating pattern
- Replacing faulty non-return valves o pumps, replacing 10 hp motors with 7.5 hp and 20 hp motor with 15 hp motor

B. Energy Management Structure:

In order to streamline the use of energy in the college campus and to ensure its complete utilization, we propose three possible energy management structures. A final decision on the type of energy management structure according to the institute should be taken by the Institute management.

I. Appointment of an Energy Manager for the institute, with acceptable experience and a proven track record. The person shall be accountable for the day to day energy conservation activities. New staff should be provided to the Energy Manager or some staff members from Electrical Maintenance Section be made responsible to him/her. An periodic annual review of the energy performance of the institute is to be performed and a certain percentage of the quantified savings be shared with the Energy Manager.

II. The Executive Engineer (Electrical) should himself take over the charge of ensuring efficient energy use on the campus.This will ensure prompt implementation of measures. This system may also require additional staff. A performance related incentive in the form of a bonus can be alotted to the Electrical Maintenance staff based on savings achieved.

III. Formation of an Institute level committee headed by the Dy. Director to review the implementation of energy conservation measures. All departments and section heads should submit a bi-annual report of compliance for review and action. Sections/ departments not achieving savings to be penalized and suitable incentives may be given to the performing departments.

IV. An annual review of the implementation of the energy saving measures should be taken up and performance should be monitored. A report of the same should be sent to the Director.

V. Electrical energy consumption should be made a subject in the Institute budget with separate heads for departments and hostels. Energy performance can be a basis for providing incentives to hostels and departments.

Recommendations

In addition to the recommendations given in section 6.1, a few more general ones are presented here. The savings due to their implementation could not be easily quantified, but

their importance cannot be understated. Implementing all these measures, a total saving of 20-25% can be achieved without compromising much on the existing facilities and comforts.

A. Lighting:

Photo sensors should be installed in central library to utilize optimum day lighting. A Scheme for the same has been proposed here –

- Central Library Ground Floor Reading room near window: Currently 10 FTL are controlled with one switch. Since it is near to window, sufficient day lighting is available. So if we use photo sensor to control this lights we can reduce the duty cycle and energy consumption.
- Central Library Ground Floor Reference section near window: Presently 5 FTL are controlled with one switch. By slight modification in the circuit we can use photo sensor to control 5 lamps.

Currently, approximately 50% of the street lights are controlled by timers. It is recommended that all the lights be taken under this control scheme to reduce chances of over-usage due to human error.

B. Geysers:

It is advisable to have manual switching of the geyser in peak periods, as most of the geysers were ON for 24 hours.

C. Room air conditiner:

It was found that in many cases, the utility type of the area has changed and the AC may no longer be required there. This can save expenses on procurement of new ACs. Proper maintenance of ACs is not being done. Many of the older ACs could be replaced. About 20-22 % of all installed ACs suffer from some or the other defect. In a large number of cases, the filters were found to be dirty (3%), thermostats not working (7%), ice formation/ water leakage (1%), rusting (3%), fans not working (4%), swing problems (3%) etc. were observed.

The heating load can also be reduced by reducing the consumption by other sources like lights, computers etc. and the occupancy needs to be considered. Explore the possibility of occupancy sensors.

D. Pumping:

Rescheduling recommended of small pumps at individual buildings to late night timings. Installation of water meters at every building to make sub-sections inside college accountable to the water being used.

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