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ENERGY AUDITING OF AN EDUCATIONAL INSTITUTION

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ABSTRACT
Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions.
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 programme 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 primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. The institute having total connected load of 0.3 MW and paying electricity bill of Rs. 1,50,000 approximately each month. Finally 7to9 % of energy savings achieved by replacing tube lights, motors and compressors. Approximately Rs. 9000 is saved through this energy auditing work.

INTRODUCTION
The objective of this Energy Audit is to promote the idea of Energy Conservation in the Campus. The purpose of the energy audit is to identify, quantify, describe and prioritize cost saving measures relating to energy use in the Departments and Institute Central Facilities. The work eligible for Energy Audit Study should be directed towards:
Important Points to Consider When Collecting Load Data:

Usage – The usage of the equipments in terms of hours per day and days per year can be collected from key persons in departments, laboratories and hostels etc. It is important to ensure the accuracy of this data because much of the potential for energy savings lies on wise allocation of the equipment's operating hours (1).

Actual power consumed – Actual power consumption is measured by Wattmeter or Power analyzer.

Supplementary Information – Some other supplementary information are also collected such as state of insulation in case of ACs or availability of natural light etc.

OBJECTIVE AND METHODOLOGY
OBJECTIVE
The objective of this project is to reduce the energy consumption of the institution by 25% of the total power consumption and suggesting energy conservation measures and implementing them into that institution.

METHODOLOGY
The methodology adopted for this audit was a three step process comprising of:

Data Collection – In preliminary data collection phase, exhaustive data collection was performed using different tools such as observation, interviewing key persons, and measurements.

Data Analysis - Detailed analysis of data collected was done using energy meter.

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Recommendation – On the basis of results of data analysis and observations, some steps for reducing power consumption without affecting the comfort and satisfaction were recommended along with their cost analysis.

IDENTIFICATION OF ENERGY CONSERVATION OPPORTUNITIES

Energy generation: Identifying Efficiency opportunities in energy conversion equipment/utility optimal loading of DG sets, ac systems, computers etc(2).

Energy distribution: Identifying Efficiency opportunities network such as transformers, cables, switchgears and power factor improvement in electrical systems and chilled water.

Energy usage by processes: This is where the major opportunity for improvement and many of them are hidden. Process analysis is useful tool for process integration measures.

DATA COLLECTION

For suggesting any corrective measures to reduce power consumption, it is first necessary to know the power consumption pattern in detail. For this, the exhaustive data collection exercise was performed at all the departments, library, laboratories, canteen and hostel(4).

Following steps were taken during data collection:

- Information about the general electrical appliances was collected by observation and interviewing.
- The power consumption of appliances was measured using power analyzer in some cases (such as fans) while in other cases, rated power was used (CFL for example).
- Light intensity was measured using lux meters at the places where light intensity was either very low or very high.
- In case of Air Conditioning, insulation was checked by visual inspection.
- Approximations and generalizations were done at places with lack of information.

DATA ANALYSIS

In data analysis, the data collected is processed to draw significant conclusions to pinpoint loopholes and identify the areas to focus upon. Analysis of the power consumption observations obtained was used to obtain the power consumption pattern and also to get the information about the points where electric power is wasted.

INSTITUTE POWER PATTERN

Total connected load of the institution = 361 HP

Transformers available in the institution = 150 KVA & 70 KVA

Diesel generator set capacity = 125 KVA & 70 KVA

Diesel consumption of the DG Set = 180 liters for full day power shedding

ENERGY CONSERVATION OPPORTUNITIES FOR ENERGY EFFICIENCY

Recommendations for better energy efficiency:

Based on the analysis of the power consumption data, certain steps have been recommended for improving energy efficiency of the campus. Complete cost analysis of implementation of recommended measures has been performed wherever necessary. Also, a number of general measures for energy efficiency have been listed.

Described below are some important recommendations for better energy efficiency:

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Replacing Conventional Ballast FTLs with Electronic Ballast FTL:

Dominant light source at most places in the campus is traditional 40W FTLs with Conventional Ballast which consumes 14-16W in addition to the 40W. As per my data collection, the campus has 265 in total conventional Ballast FTLs and 163electronic Ballast FTLs. If these conventional Ballasts are replaced by electronic Ballast, 10-12W power can be saved per FTL.

- Total No. of conventional Ballast FTLs in Campus = 250
- Average Power of conventional Ballast FTL = 56W
- Average Power of electronic Ballast FTL = 44W
- Power saved per FTL = (56-44) W =12W
- Total Power saving = 250X12 = 3000W
- Average Use of FTL per year = 250X7h=1750h
- Total Energy saved per year = 3000WX1750 h = 5250000Whr
- Saving in Rs. Per year = 5250X2.50= Rs.13125
- Average Cost of Replacing each FTL = Rs. 150
- Total Cost of Replacing all Conventional Ballast FTLs = Rs.37500
- Capital Cost Recovery time = (37500)/ (13125) = 2.85yr

Hence, the capital cost recovery time for replacing all conventional Ballast FTLs of the campus is around 2.85 years.

Replacing Resistance Regulator of Fans by Electronic Regulators:

Most of the buildings in this polytechnic campus are very old and so are the fans. Most of the fans here have resistance regulators. According to the data collected, there are a total of 350 fans with resistance regulator while number of fans with electronic regulator is only around 50. A saving of 8-10W per fan can be obtained by replacing resistance regulators by electronic regulators.

Cost Analysis of Replacing Resistance regulators with Electronic regulators

- Total No. of resistance regulated fans in Campus = 350
- Average Power saved per fan = 9W
- Total Power saving = 350X9W = 3150W=3.15kW
- Average Use of fans per year = 220X7h=1540h
- Total Energy saved per year = 1540X3.15kWh = 4851kWh
- Saving in Rs. Per year = Rs. 4851X2.50 = Rs. 12127.5
- Average Cost of Replacing per fan = Rs. 150
- Total Cost of Replacing all resistance regulated fans = 350X150 = Rs. 52500
- Capital Cost Recovery time = (52500)/(12127.5) = 4.32yr

Hence, the capital cost recovery time for replacing all resistance regulated fans of the campus is around 4.32 years.

Use of Motion Sensors in Corridors and Toilets:

Corridors and toilets have large potential of saving energy by use of automation tools. Motion sensors can be used there to automatically switch on the light when there is any movement and switch off the light when there is no movement. This can greatly reduce the total load in corridors and toilets.

Cost analysis of Installing Motion Sensors in a Corridor:

- Average number of tube lights in a corridor = 4
- Average power of the tube lights = 50W
- Average number of motion sensors required = 3
- Average reduction in usage per day by motion sensor = 4h
- Total energy saved in corridor per year = (4X50X4X365)/1000 = 292kWh
- Saving in Rs. Per year = 292X2.70 = Rs. 788.4
- Cost of installation per motion sensor = Rs. 250
- Total cost of installing motion sensors in a corridor = 3X250 = Rs. 750

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- Capital Cost Recovery Time = (750/788.4) = 0.95 yr

Hence, the capital cost recovery time for installing motion sensors in corridors is 0.95 years. Toilets are also having comparable capital cost recovery time. Hence, this is a highly recommended step to largely reduce the consumption in corridors and toilets.

Minimizing Repair Works in Fans:
During data collection, the repaired fans have been found to be consuming very high power as compared to the rated power. Fans repaired once and twice were consuming 16W and 43W more than the average consumption of new fans respectively. Thus, effort should be made to minimize the repairing of fans and also repair work should be supervised properly.

Better Practices for AC:
The institute has in total 4 window type ACs and 20 split type ACs which make a very large part of total energy consumption of the campus. But, at many places it was found that AC is not used with best recommended practices. Even simple things, such as insulation. Also at certain places ACs were found to be used without keeping curtains. These poor practices account for increase in AC load and thus consumption.
Summarized below are some guidelines for most efficient use of ACs:
Proper Insulation – Good quality insulation must be maintained in the air conditioned rooms by keeping all doors and windows closed properly so as to prevent cool air go out and hot air come in.
Curtains – Always keep curtains on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.
Maintenance – Proper maintenance and cleaning of ACs is required at regular intervals to make it work at highest efficiency. Any dirt in filter may reduce efficiency of AC very significantly.
Operating – The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room.

RESULTS AND DISCUSSION

In this Energy auditing programme it was found that the total electricity consumption of the institution is too high due to the utilization of air-conditioning systems. It is due to not using energy efficiency devices in that college and it will lead to more power consumption.
The tariff also too high due to the high transmission electrical supply and most of the equipments are connected through 3 phase supply. In electrical and mechanical laboratories they are using old generation motors and they consuming more power. There is no awareness for students about the consumption of electricity and they are using fans in the non class hours also.
In common computer centres using of air conditioning should be for a particular time and a proper temperature should be maintained and also in language laboratory proper temperature should be maintained in the air conditioning systems

ENERGY CONSUMPTION OF THE INSTITUTION

S.No	**Month and year**	**Unit consumption(kWhr)**	**Cost(Rs)**	**Tariff(Rs)**
1	August 2015	14880	140691	6.35
2	July 2015	13390	124390	6.35
3	June 2015	8976	91069	6.35
4	May 2015	11004	108179	6.35
5	April 2015	13387	124428	6.35
6	March 2015	14928	134566	6.35

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7	February 2015	11210	109676	6.35
8	January 2015	10709	93702	6.35
9	December 2014	8080	67848	4.50
10	November 2014	9768	76450	4.50
11	October 2014	15753	112724	4.50
12	September 2014	14540	102711	4.50
13	August 2014	15049	104222	4.50

EQUIPMENT WISE ENERGY CONSUMPTION

S.No	Equipment	Total load(kW)	Running hours per week	Unit consumption per week(kWhr)
1	Air conditioning	60	80	210
2	Computers	55	70	180
3	LCD Projectors	20	15	120
4	Fans	30	35	110
5	Lights	15	18	170

LABORATORY WISE ENERGY CONSUMPTION

S.No	Type of laboratory	Total load (kW)	Running hours per day	Unit consumption per day (kWhr)
1	Civil	60	5	50
2	Electrical	25	3	60
3	Electronics	12	3	20
4	Garment	2	2	15
5	Mechanical	109	5	65
6	R&A/C	20	4	40
7	Science	10	6	35
8	Textile	85	4	45

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ENERGY CONSUMPTION ANALYSIS OF HOSTEL

S.No	**Type of room**	**Light (W)**	**Fan (W)**	**TV (W)**	**A/C (W)**	**Computer (W)**
1	Living room	170X40=6800W	141X60=8460 W			
2	Dining hall	24X40=960W`	14X60=840W			
3	Computer centre	3X40=120W	3X60=180W		3000	26X350=9100W
4	Gym	3X40=120W	3X60=180W			
5	TV Room	3X40=120W	3X60=180W	1800		
6	Office	2X40=80W	1X60=60W			1X400=400W
7	Veranda	Sodium light- 2X650=1300W				
8	Tutor room	4X40=160W	2X60=120W			
9	Alumni room	2X40=80W	2X60=120W		3000	
10	Toilet and bathroom	128X40=5120W				

SAVINGS IN AIR CONDITIONING UNITS

S.No	**Make of the a/c unit**	**Ton**	**Quantity**	**kW**	**% of savings and EER**	**Operation in days**	**Energy consumption with star**
1	Blue star	7	1	7	7.95	250 days & 6hrs	1800
2	O General	2	1	2	6.86	365 days &15 hrs	2130

ENERGY SAVINGS FOR THE MONTHS JANUARY TO APRIL

S.No	**MONTH**	**ENERGY CONSUMPTION (Kwhr)**	**ENERGY SAVINGS (kWhr)**	**TARIFF (Rs)**
1	JANAUARY	15780	550	1,10,900
2	FEBRUARY	16560	1230	1,00,540
3	MARCH	15850	1270	99,583
4	APRIL	13330	1310	89,645

CONCLUSION

Based on the Data collected from the institution the following details are achieved through the auditing process.

- The total connected load of the institution is 0.3 MW.
- The total electricity tariff for the college for one month is Rs.1, 50,000.
- In class rooms and hostel rooms the 116 normal fluorescent lamps are replaced by CFL and LED lamps.
- In Mechanical and Electrical laboratories 7 old motors are replaced by energy efficient motors.
- Conducted a energy awareness program for the college students.

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- Total 12 % energy conservation is achieved.
- For the month of February, march and April totally 8%of energy savings is achieved in the college by adopting energy saving devices and energy conservation procedures.
- In future it will be increased based on the recommended suggestions.
- Installation of solar panels for class rooms and laboratories
- Bio-plant construction is going to start.
- Solar water heaters for hostels.

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