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## **ENERGY AUDIT OF A COLLEGE CAMPUS**

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### **Abstract:**

Today the energy consumption of every country are increased very sharply. In all sector energy is very much important for country economy. The energy demand is increasing very fast with the development of society. The prices and demand of energy is increasing with time so to control the price and demand a more effective and sustainable energy system becomes necessary. The aim of this paper is to make an energy survey of the building, evaluating different sources of energy supply and losses in the building.

**Keywords:** Energy Audit, Energy Efficiencies measures, Energy Management

### **INTRODUCTION**

An energy audit is a process to study of a building or industry to know the energy consumption of the building and identify methods to reduce the energy consumption for energy savings. In Commercial Building, the present electrical consumption is about 8-10 percent of the total electricity. To meet the international level comfort and facilities the electrical demand is increasingly by 11-12 % annually. This is a challenge for every industry to ensure that energy growth in commercial building does not become unmanageable, but also give and presents an opportunity to influence and identifies energy management issues in various commercial buildings and facilities. As the natural resources are limited and energy uses are increasingly very sharply so it is very necessary to save natural resources by reducing energy consumption which can be achieved by using energy efficient equipment's and also by awareness of peoples about energy conservation [1]. Energy audit in industrial and commercial, is the process to identifying opportunities to reduce carbon footprints and energy conservation.

### **ENERGY AUDIT**

An energy audit is a process for energy inspection, building survey and analysis of energy flow for energy conservation in a building or industry, or to reduce the amount of energy into the building without affecting the output of the building. Energy audit is a process of testing and analysis energy uses the industries and other organizations. National energy conservation laws states that the regulations for energy consumption, investigation and energy audit management. In energy audit the survey of all electrical devices which use energy in a building

after a period of time. Energy audit includes the supply of energy, use of energy and energy losses for all normal buildings.

## ENERGY CONSERVATION

### 3.1 Measures

In Energy Conservation, some important point should be implemented which are discussed as below [10].

- Energy conservation should be given the pride of place in official policy.
- Distribution companies should use energy conservation program for industries in co-operation with various industrial associations and other related agencies.
- Electricity should be realistically priced. Peak load and time off day pricing must be made mandatory for large industrial users.
- Staggering of holidays must be made permanent for industrial consumers.
- Maintenance of existing power stations should receive more importance than reckless expansion of capacity.
- Suitable tax incentives should be provided for installing new energy efficient equipment's.
- Co-generation of heat and power should be encouraged in industries.
- Norms of consumption should be drawn up for all important industries.

### 3.2 Benefits of Energy Conservation [10]:

- Individual consumer or industry can save energy cost.
- Grid can increase Capacity without increasing capital investment.
- Natural resources can be save for the betterment of next generation.
- Due to Reduction in the emission of greenhouse gases helps protecting the environment for controlling the global warming.
- Nation can develop faster and Gives Energy security.

### 3.3 Energy Conservation Potential [5], [11]

As shown below, Table-1 various sector gives a fairly conservative potential for energy conservation. Different sectors use different amount of energy so energy audit in every sector is required through energy efficiency estimation.

**Table - 1:** The various sectors energy conservation potential economy [10]

Sector	Potential (%)
Economy	Up to 22
Agricultural Sector	Up to 33
Industrial sector	Up to 26
Transport sector	Up to 19
Domestic and	Up to 18

### 3.4 Case Study in Campus

We are taking this opportunity to express our heartily gratitude to Bharti College University of Delhi for giving opportunity & encouraging us in the new concept of energy audit. We once again put up our appreciation for full cooperation & valuable guidance for perfect auditing of the Campus to technical as well as commercial persons for providing all the required information & data as well as for providing cooperation with all the departments & extend his best help in our work. We have tried our level best for the work of Energy Audit up to their satisfaction. The major activities carried out during the audit are as follow:

- Collection of College's records regarding Electricity Power Bills, Power Distribution Diagram, Specifications of major power handling equipment – such as Fans, lighting and pumps.
- Analysis of above calculations, isolating the areas vulnerable to energy consumption not related to production.
- Recommendation of various methods of rectification.
- Making case study of projected saving by following our recommendations; and estimating potential investment & payback period.

### 3.5 Steps in Energy Auditing

The energy audit may range from a simple walk -through survey at one extreme to one that may span several phases: -

- 1) The **first steps** is to identify those areas where energy is wasted and reduced energy without affecting the outputs of various functions.
- 2) The **second steps** is to implement energy efficient appliances in place of normal appliances which reduce energy use by proper operations and maintenance. For this reason, it is necessary to reduce the number of operating machines and operating hours according to the demands of the load, and fully optimize equipment operations. Energy audit depends on following factors: -
  - Building equipment operation.
  - Lighting systems.
  - Power systems.
  - Building envelope.
  - Air-conditioning and ventilation equipment systems.
  - Miscellaneous services.The first two steps can be implemented without changing buildings and existing appliances.
- 3) The **third steps** would require investment for remodeling, rebuilding, or introducing further control upgrades to the building.
- 4) The **fourth steps** is to carry out large-scale energy reducing measures when existing facilities have past their useful life, or require extensive repairs or replacement because of obsolescence. In this case higher energy savings may be achieved. For these last two stages, the audit may be more extensive in order to identify more ECOs for evaluation, but at an increased need for heavier capital expenditure to realize these opportunities.

### COLLEGE CAMPUS SURVEYING

The primary stage of energy auditing is survey. Survey means knowledge about the college campus area, their building structure, and their equipment used in it, how much energy consumed etc. The survey of building can be divided into three parts:

#### 4.1 Preliminary Survey: -

In this Preliminary survey, the auditor may need to know the building envelope and its energy consumption. The data of a building can be obtained from: -

- Building Architectural blueprints.
- Building Air-conditioning blueprints.
- Building Electrical lighting and power drawings.
- Electrical bills and operation logs for the year preceding the audit.
- Air-conditioning manuals and system data.
- ECOs for evaluation, but at an increased need for heavier capital expenditure to realize these opportunities.

#### 4.2 Walk-Through: -

The walk-through process can be start after familiarized with the building, if the building blueprints and other electrical appliance information available describes the building and its operation accurately. In the walk-through audit, the building envelope can be study by a walk around the building. In the model analysis, the building must be divided into zones for analysis. The building survey would include that the air-conditioning system is as indicated on plans. In the building envelope, the type and condition of the windows, effectiveness of window seals will be noted. In the building, typical lighting and power requirements, occupancy and space usage are also noted. This information regarding building could be compared against the recommendations in the relevant Codes of Practices. The survey of mechanical rooms and plant room can give system and plant data. Name plate information could be compared against those in the building's documents, and pumps and chillers room can be visit for estimating the load on the system.

#### 4.3 Operator's Input

The auditor may discuss with the building maintenance staff further on the operating schedules and seek clarification on any unusual pattern in the trend of the utility bills. Unusual patterns such as sudden increase or decrease in utility bills could be caused by changes in occupancy in the building, or change in use by existing tenants. It is not uncommon for tenants to expand their computing operations that may increase the energy use significantly.

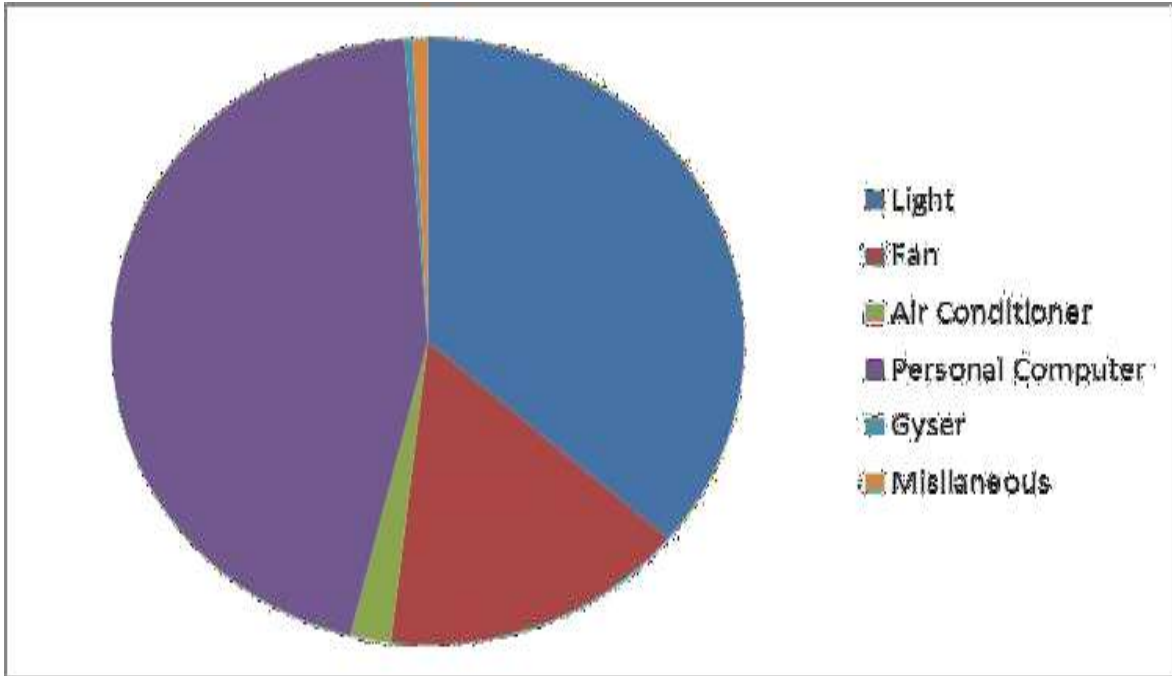
### INDENTATIONS AND DATA

#### 5.1 Energy Consumption

The electrical devices which are connected in college Campus are not energy saving devices. These devices can be changed by electrical efficient appliances. The appliances are of high watt equipment so the electrical consumption is high in college campus.

Table 2 Energy Consumption

Equipment	Quantity	Actual load	Actual Consumption(watts)
Fan	325	70	22750
2X18 tube light	363	36	13068
2x36 tube light	70	72	5040
1x40 tube light	275	40	11000
Wall Fan	19	70	1330
2x40 light	103	80	8240
Flood light	12	400	4800
outdoor light	18	70	1260
Computers	97	70	6790



**Figure 1** Connected Load Pie Chart

The electrical devices which are connected in college campus are not energy saving devices. These devices can be changed by electrical efficient appliances. The appliances are of high watt equipment so the electrical consumption is high in Bharati college campus. Now a day's low wattage appliances are used in building. They are helpful in saving electricity. In the above table, some appliances are replaced by energy saving appliance which are as follows.

- Tubes and CFL are replaced by LEDs.
- Normal Fan and Wall fan are replaced by 5-star Fans.
- Flood lights are replaced by Led lights.
- Outdoor lights are replaced by Led lights.
- Normal PC are replaced by 7 gen PCs.

## 5.2 EnergySaving Calculation

Cost Analysis of Led light with Conventional tube light.

- Total No. of conventional Tube Lights in Campus = 811
- Conventional Tube Light average power = 40 W.
- LED Tube Light average power = 20 W.
- Difference in power saved per Tube Light =  $(40-20) \text{ W} = 20 \text{ W}$ .
- Total Power saving =  $811 * 20 \text{ W} = 16220 \text{ W} = 16.2 \text{ kW}$ .
- Average Use of Tube Light per year =  $270 * 8 \text{ h} = 2160 \text{ h}$ .
- Energy saved per year =  $16.2 * 2160 \text{ kWh} = 34992 \text{ kWh}$ .
- Per year saving =  $34912 * 9.5 = \text{Rs. } 332424$ .
- LED tube light average cost = Rs. 450.
- Total Cost of Replacing all Conventional tube lights =  $811 * 450 = \text{Rs. } 364950$ .
- Payback time =  $(364950 / 332424) = 1.09 \text{ yrs}$ .

Hence, the payback time for replacing all conventional tube lights of the campus with LEDs is around 0.7 year.

### 5.3 Replacing the CRT Monitors with LCD Monitors

In the college campus computers with CRT monitors are 97 numbers and the power consumption of CRT monitor is 520 W which is very large. The power consumption of LCD monitor is 250 Watts so the difference between CRT monitors and LCD monitor is large but the LCD monitor are costlier than CRT monitors. This saving of 250W per monitor is very large. LCD monitor cost analysis with CRT monitors.

- Total no. of computers with CRT monitors is = 97.
- Power saving per monitor = 250 w.
- Total Power saving =  $97 \times 250W = 24250W = 24.2 \text{ kW}$ .
- Average Use of computers per year =  $5 \times 270h = 1350h$ .
- Energy saving of LCD per year =  $285 \times 1350 = 384750 \text{ kWh}$ .
- Saving in Rs. Per year =  $384750 \times 9.5 = \text{Rs. } 3655125$ .
- Cost for replacing Monitor = Rs. 4500.
- Total Cost of Replacing all monitors =  $97 \times 4500 = \text{Rs. } 436500$
- Capital Cost Recovery time =  $(436500)/(365512.5) = 1.1 \text{ yrs}$ .

Hence, the payback period for replacing CRT monitors by LCD monitors is 1.1 years. Since the product life of LCD is much more than that, the move is economically beneficial.

### 5.4 Replacing Geysers by Solar Water Heating System:

The power consumption of Geyser is very high in hostel area. Maximum power is wasted in geysers. This is the most inefficient and old method of heating water. Heating water. Solar water heating is the very effective method of water heating.

Calculation of Replacing Geysers by Solar Water Heater System:

- Price of a domestic SWHS = Rs.18500.
- SWHS Capacity = 100LPD.
- Average Geyser Capacity = 50L.
- One SWHS can be used to replace geysers = 2.
- Geyser Average power = 2kW.
- Average use per year =  $5 \times 135 = 675h$ .
- Energy saving per year by replacing Geysers by SWHS =  $2 \times 2 \times 675 \text{ kWh} = 2700 \text{ kWh}$ .
- Saving in Rs. Per year =  $2700 \times 9.5 = \text{Rs. } 25650$  Capital Cost Recovery time =  $(18500)/(25650) = 0.72 \text{ yrs}$ .

Hence, the payback period for replacing geysers by SWHS is 0.55 years. So, Solar water heater system will reduce the energy consumption.

### 5.5 Use of Motion Sensors in Corridors and Toilets:

Campus Corridors and toilets use more lights. Lights in corridor and toilets may be ON in day time also. 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 reduce the total load in corridors and toilets. Cost analysis of Motion Sensors in a Corridor and Toilets:

- Total number of tube lights in a corridor = 10.
- tube lights average power = 40W.
- motion sensors = 4.
- Energy consumption reduced by use of motion sensor = 5 h.
- Per year energy saved in corridor =  $(10 \times 40 \times 5 \times 365)/1000 = 730 \text{ kWh}$ .
- Per year saving in Rs =  $730 \times 9.5 = \text{Rs. } 6935$ .
- motion sensor approx. cost = Rs. 450.
- Total cost of installing motion sensors in a corridor =  $4 \times 450 = \text{Rs. } 1800$
- Capital Cost Recovery Time =  $(1800/6935) = 0.25 \text{ yrs}$ .

Hence, the payback period for installing motion sensors in corridors is 0.25 year. Hence, this is a highly necessary process to largely reduce the consumption in corridors and toilets.

## CONCLUSION

Natural resources on earth are limited and consuming very sharply. It can be saved by employing energy efficiency and it is very necessary to prevent depletion of natural resources. The Electrical audit of college buildings shows that the load of electrical equipment's is significant and should be taken some necessary step for reducing energy conservation. Today energy conservation plays a very important role for energy conserving because energy consumption is increasing day by day but the natural resources are not increasing and also generation is not match with consumption People should aware about energy conservation and reduce energy consumption by adopting modern technologies.

Table Energy Efficient Electrical Equipment

S.No	Equipment	Make	Rating	Specification	Cost INR
1	20w LED Tube light	Wipro	18W	LED	450*
2	Fan (1200 mm)	Usha	50W	BEE 4 Star	1255*
3	Fan (700 mm)	Usha	43W	BEE 4 Star	1135*
4	Exhaust Fan	Usha	50W	BEE 4-star 486m3/min	1650*
5	Tube light	Philips	36w	Lumen	250*

\*Price is based on Market rates

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