Volume 2, Issue 2 ISSN: 2320-5288

International Journal of Engineering Technology & Management Research
Journal homepage: www.ijetmr.org

Assessment of Energy Audit in Technical Institute

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***Abstract*—**This paper presents a physically based model and formulation for industrial load management. Lighting is an essential service in all the industries. The power consumption by the industrial lighting varies between 2 to 10% of the total power depending on the type of industry. Innovation and continuous improvement in the field of lighting, has given rise to tremendous energy saving opportunities in this area. Lighting is an area, which provides a major scope to achieve energy efficiency at the design stage, by incorporation of modern energy efficient lamps, luminaries and gears, apart from good operational practices. It provides merely to indicate some of the options that energy auditor can consider when performing an analysis of an industry. Energy conservation and exploration of new energy avenues are the well accepted solution to fulfill the growing industrial demand in future. Implementation of energy audit can improve the plant efficiency and thereby reducing the energy wastages.

Keywords:— Energy Audit, economic analysis

1. INTRODUCTION

India has one of the world's fastest growing energy markets due to rapid economic expansion. It is expected to be the second largest contributor to the increase in global energy demand by 2035. Energy demand of India is increasing and limited domestic fossil fuel reserves. The country has ambitious plans to expand its renewable energy resources and plans to install the nuclear power industries. India has the world's fifth largest wind power market and plans to add about 20GW of solar power capacity. India increases the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9%. The country has five nuclear reactors under construction. Now, India became third highest in the world who is generating the electricity by nuclear and plans to construct 18 additional nuclear reactors by 2025, then India will become second highest in the world. Over 2010–11, India's industrial demand accounted for 35% of electrical power requirement, domestic household use accounted for 28%, agriculture 21%, commercial 9%, public lighting and other miscellaneous applications accounted for the rest. Energy conservation means reduction in energy consumption without making any sacrifice of quantity or quality. A successful energy management program begins with energy conservation; it will lead to adequate rating of equipments, using high efficiency equipment and change of habits which causes enormous wastages of energy.

2. ENERGY AUDIT

An energy audit is an inspection, survey and analysis of energy flow for energy conservation in an industry, process to

reduce the amount of energy input into the system without negatively affecting the output. Energy audit is a testing and analysis of how the enterprises and other organizations use energy. According to national energy conservation laws and regulations for energy consumption, investigation and energy audit management. Audit activities in general order include:

1. Identification of all energy systems.
2. Evaluation of conditions of the systems.
3. Analysis of impact of improvement to those systems.
4. Preparation of energy audit report.

The analysis which includes the economic analysis is done after the audit work using all the data gathered. Studies and researchers have shown that energy auditing and conservation can save India Rs.1800 crore per year as there is a big potential for saving energy in industrial sector. In terms of electricity, these saving are equivalent to installation of 5250MW.

3. TYPES OF ENERGY AUDITS

The energy audit orientation would provide positive results in reduction energy billing for which suitable preventive and cost effective maintenance and quality control programmes are essential leading to enhanced production and economic utility activities. The type of energy audit to be performed depends upon the function or type of industry. There can be three types of energy audit.

- Preliminary energy audit
- General energy audit
- Detailed energy audit

(a) Preliminary Energy Audit

The preliminary energy audit alternatively called a simple audit screening audit or walk through audit, is the simplest and quickest type of audit. It is carried out in a limited span of times and it focuses on major energy supplies and demands. It aims at taking steps which are necessary for implementation of energy conservation program in an establishment. It involves activities related to collection, classification, presentation and analysis of available data in arising at the most appropriate steps to be taken in establishing energy conservation. It involves collection of necessary data, minimal interviews with site operating personnel, a brief review of facility utility bills and other operating data and identifies glaring areas of energy waste or inefficiency. Typically, only major problems area will be uncovered during this type of audit, corrective measures are briefly described and quick estimates of implementation cost, potential operating cost savings and simple payback periods are provided. This level of detail, while not sufficient for searching a final decision on implementing proposed measures, is adequate to prioritize energy efficiency projects and determine the need for more detailed audit.

(b) General energy audit

The general energy audit is also called a mini audit or site energy audit or complete site energy audit. It expands on the preliminary audit by collecting more detailed information about facility operation and performing a more detailed evaluation of energy conservation measures identified. Utility bills are collected for a 12 to 36 months period to allow the auditor to evaluate the facility energy/demand rate structure and energy usage profiles. Additional metering of specific energy consuming systems is often performed to supplement utility data. In depth interviews with facility operating personnel are conducted to provide a better

understanding of major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand. This type of audit will be able to identify all energy conservation measures appropriate for the facility given its operating parameters. A detailed financial analysis is performed for each measures based on detailed implementation cost estimates, site specific operating cost savings and the customer's investment criteria. Sufficient detail is provided to justify project implementation.

(c) Detailed energy audit

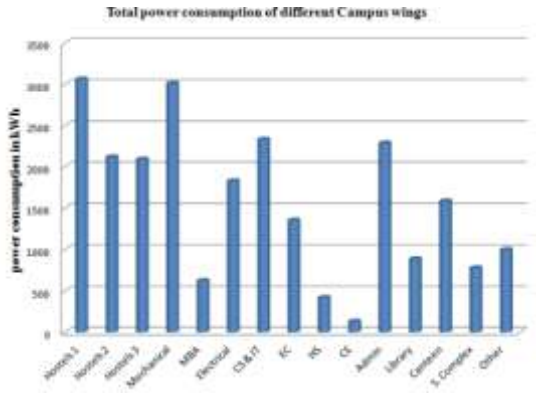
Detailed energy audit is also called comprehensive audit or investment grader audit. It expands on the general energy audit. It covers estimation of energy input for different processes, collection of past data on production levels and specific energy consumption. It is a comprehensive energy audit action plan to be followed effectively by the industry. It provides a dynamic model of energy use characteristics of both the existing facility and all energy conservation measures identified. The building model is calibrated against actual utility data to provide a realistic baseline against which to compute operating savings for proposed measures. Extensive attention is given to understanding not only the operating characteristics of all energy consuming systems, but also situations that cause load profile variations on both an annual and daily basis. Existing utility data is supplemented with sub metering of major energy consuming systems and monitoring of system operating characteristics. Thus, the scope of this audit is to formulate a detailed plan on the basis of quantitative and control evaluation, to evolve detailed engineering for options to reduce total energy costs, consumption for the product manufactured. It should be at 8 to 10 percent savings, detailed audit study shall be completed in a period of three weeks from the date of commencement. After which, preparation of energy audit reports shall be completed in a period of three weeks. The major system that are encountered in industries with regard to which energy audit is to be carried out are: Boilers, furnaces, air conditioning systems, refrigeration or cold room etc., power generation and distribution systems, compressed air generation systems, pumping systems and electric motor driven systems.

4. ANALYSIS OF POWER CONSUMPTION

With the use of the software Elektra, we have analyzed the power consumption by equipment, application as well as location. Here is the summary of the analysis presented in form of charts for better understanding.

Overall Campus

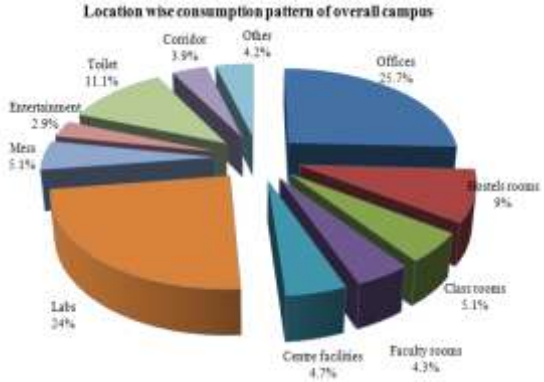
There are 3 hostels, 7 academic departments, 1 academic center, and supporting infrastructures like central library, administrative block (Main Building) in Khalsa Institute Of Engineering And Technology Campus. The analysis implies that Hostels in general, Admin Building, Computer Center power are relatively more power consuming unit of the campus. Hostel 1 is the single largest power consuming unit. A point to note in the above chart is the higher consumption of departments to others which in itself explains ACs and Computers affect the consumption distribution. Small consumption of Humanities and Civil department is due to its small size and few laboratories. Library has lower consumption in spite of having central AC due to steps such as use of CFL and wall fans which greatly reduce the consumption



Location Wise Analysis of Campus:

The location wise distribution of power consumption in the campus has been shown in the following chart:

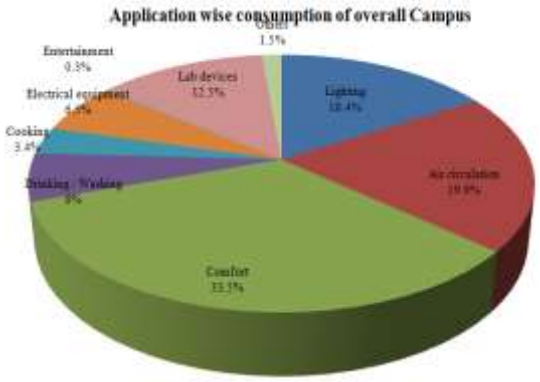
As the chart suggests, major power consuming areas are laboratories and offices in departments (24%) and rooms in hostels (9%). After that there are faculty offices (4.3%), central facilities (5%), toilets (11%), corridors (4%), mess (5%) and class rooms (5.1%). Laboratories with 24% share in power consumption are very important area to focus for improving energy efficiency of the campus. In case of computer labs, wise use of computers and ACs is required to reduce the consumption. In other labs also, wise use of lighting and other appliances can largely reduce the consumption.



Rooms in hostels are major contributor to energy inefficiency due to poor practices. Also, for new hostels to come, it is advised that T5 lamps or CFL should be used for lighting and star rated fans should be used. Corridors and toilets are the areas where automation can be used to reduce the consumption largely

Application Wise Analysis of Campus:

Application wise analysis of overall campus has been carried out to find out the application areas with relatively higher power consumption. The results of the application wise analysis of power consumption in Khalsa Institute Of Engineering And Technology Institute campus have been summarized in the following chart:

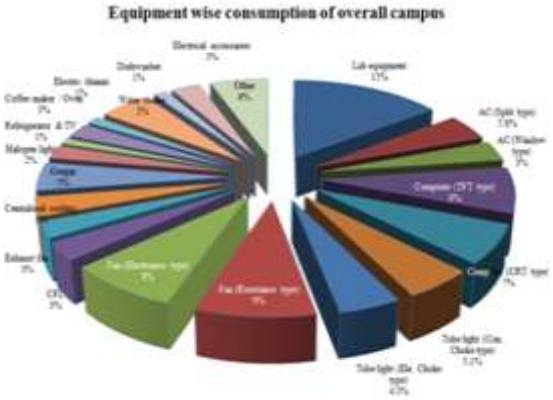


It's quite clear from the chart that maximum power is wasted in comfort applications (33.5%) such as room coolers, air conditioners, central cooling etc. To reduce the consumption in these applications, awareness about the energy conservation is very important and effective step. Lighting with 16.4% of total power consumption is an application where energy efficiency can be achieved very easily by replacing old appliances by new efficient ones. Office applications include computers, printers, scanners, Xerox machines etc. and contribute as high as 6.5% of total consumption. Replacing CRT monitors by LCD monitors can drastically reduce consumption of this application area.

Air circulation appliances (fans) having share of 19.9%, are also among major culprits in energy inefficiency. Washing/ bathing/cleaning include Geyser's, water coolers, water purifiers etc. accounting for 6% of total consumption. Cooking applications utilize 4% of total energy. Other applications do not consume significantly.

Equipment Wise Analysis of Campus:

Equipment wise analysis has been performed in order to identify the equipments, within same application area, which consume more power as compared to others. During equipment wise analysis of the overall campus, the equipments with power consumption less than 1% of total power consumption of the campus were ignored so as to make the analysis results simple and easy to observe. Following chart summarizes the results of equipment wise analysis of power consumption of Khalsa Institute Of Engineering And Technology Campus:

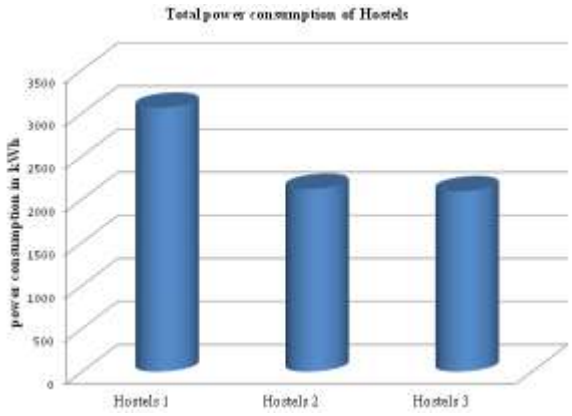


AC consumes 8% of total power consumed out of which 3.4% is window type and 4.5% is split type. For lighting, dominant appliance is the conventional Ballast [Choke] tube light with 9% share and relatively efficient electronic Ballast [Choke] tube lights and T5 lamps have negligible share. CFL has 3% share in total power consumption.

Computers also have a contribution of 14.3% (CRT-6.6% and LCD-7.7%) to total power consumption. Resistance regulated fans have 16.9% share (8.7% fans and 9% old fans) and electronic regulated fans and efficient wall fans have negligible share in total power consumption. Geyser's with 4.8% share in total consumption are another significant contributor. Water coolers (5.2%) and refrigerators (1.1%) are other significant appliances.

HOSTELS

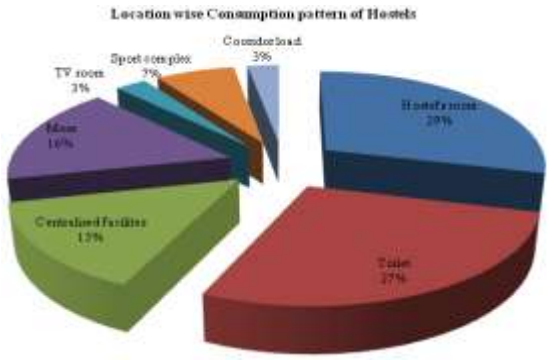
There are 3 hostels in Khalsa Institute Of Engineering And Technology Institute which are called hostel 1, 2 & 3. Out of these, 2 are for boys and 1 for girls. All hostels have capacities ranging from 60 to 40 seats. Most of the rooms are double seated, but some hostels have single seated rooms as well. In single seated rooms, one tube light and one ceiling fan has been provided while in double seated rooms, two tube lights and two ceiling fans are provided. In addition, each hostel has a mess, indoor games room, TV room and gym.



Our analysis suggests that hostel-2 has relatively less consumption as compared to other hostels. This may be due to average occupancy.

Location Wise Analysis of Hostels:

The location wise analysis of all hostels done together suggests that maximum power consumption after toilets is in mess. The reason is mostly poor practices. It is a general complaint of all supervisors that students DONOT switch off the geyser after use. High consumption of mess is not a surprise as they use a number of other appliances in addition to general appliances in their kitchen.



The rooms, consuming 29% of total consumption, have major role in reducing total energy consumption, just by using better practices. Some students don't switch off the lights and/or fans even when they are not in room. Most students keep their computer/laptop in standby mode all the time. Lots of power is wasted due to these poor practices.

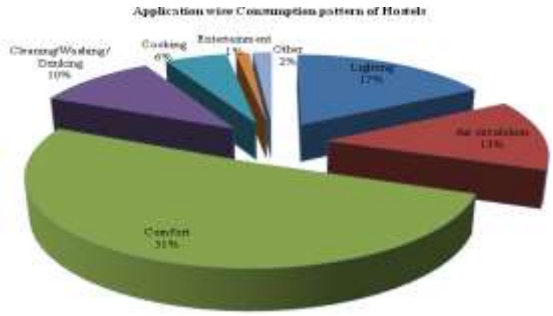
Toilets are also a major area to focus upon, from energy conservation point of view. Power consumption here can largely be reduced by simply using geyser a little more wisely. In lighting of toilets also, there is large potential of saving by using automation so that the light is not switched on all the time.

Corridors, though having smaller share in power consumption than above two, have large potential for saving electric energy. Motion sensors can be utilized to automatically switch off the lights when there is no motion in the corridors.

Messes are more or less using electricity wisely and have very low potential for reducing energy consumption (except in the case, LPG replaces electricity completely for cooking purpose). Central facilities (Water collar and centralized cooling system) have major share in power consumption but very small potential for saving energy.

Application Wise Analysis of Hostels:

Application wise analysis helps to pinpoint the application areas to attain maximum savings with minimum efforts. Application wise analysis of Hostels indicates that Bathing/Washing is consuming power nearer to lighting and air circulation.



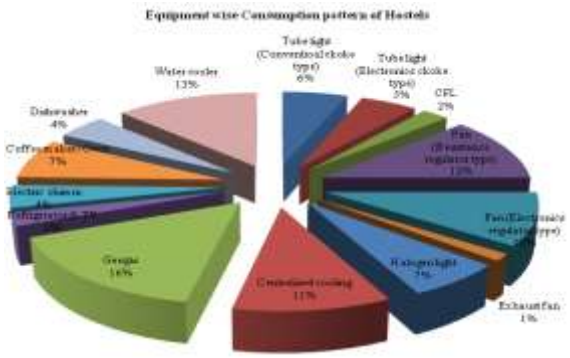
Washing/Bathing/Cleaning is consuming application and comprises of Geysers, dish washer machines etc. Here energy efficiency mostly requires good practices.
Then are the air circulation comprising of fans, centralized coolers etc. In this category, replacing old appliances by new ones can be very helpful to energy efficiency. For example, resistance regulators of fans may be replaced by efficient electronic regulators.

Next is lighting which consists of tube lights, CFLs, Incandescent light bulbs, halogen lamps etc. Here also, energy efficient appliances can be used to reduce energy consumption.

Cooking is also a significant part with 5.4% share in total power consumption of the Hostels. Others (offices, comforts etc.) are having insignificant consumption share and offer very small space for reducing consumption.

Equipment Wise Analysis of Hostels:

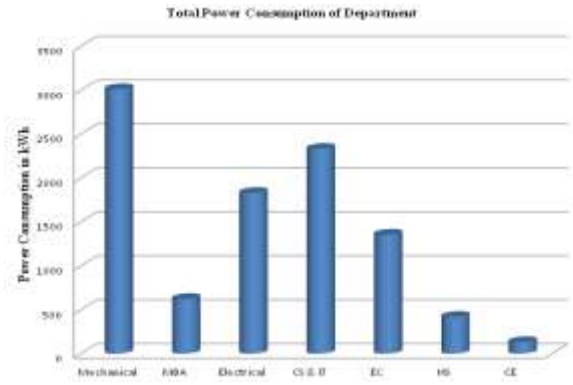
Considering the viability of representation, the appliances having power consumption less than 1% has been ignored while doing equipment wise analysis of Hostels.



DEPARTMENTS

Khalsa Institute of Engineering And Technology Institute has 7 academic departments. Each department has laboratories, classrooms, faculty rooms, and central facilities (such as departmental library etc.).

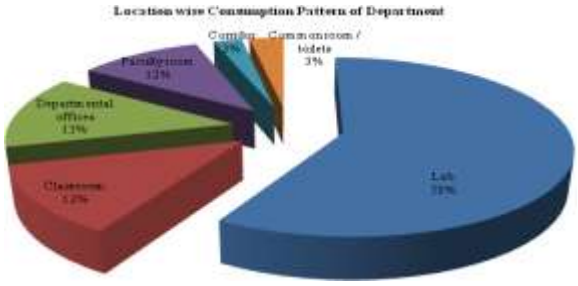
Following bar graph gives the total power consumption estimates of different departments:



Above chart shows the Department of Mechanical and Computer Engineering is the maximum power consuming department. Second is the Electrical and Electronics then is the MBA Department. The least consuming department is Department of Humanities and Civil engineering department.

Location wise Analysis of Departments:

Location wise analysis of power consumption in departments points to a surprising fact that in spite of ignoring the special equipments installed in the laboratories and taking into account only general appliances, laboratories comprise nearly half of total power consumption of the departments. The chart below summarizes the results of location wise analysis of departments:

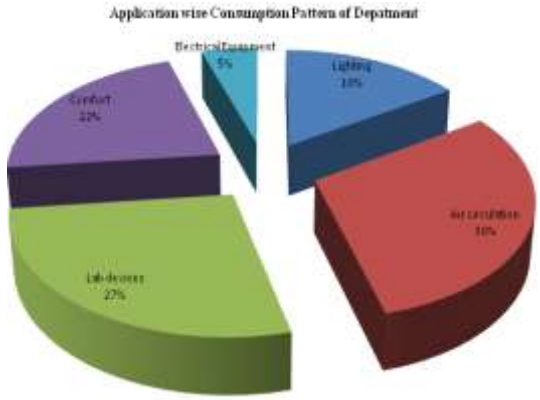


So, laboratories consume 58% of total power consumed in the departments. This is partly because laboratories are large in number and partly because all the appliances are on for the entire duration a laboratory is open. Many of the labs are air conditioned.

Faculty offices come with 12% of total power consumption in departments. It is important to note here that since the audit has been conducted in the months of May and June, a room heater has been assumed to be in operation for 75days a year for 4 hours a day in each faculty room.
Central facilities consume 13%, corridors 3%, class rooms 12% and toilets 3%.

Application wise Analysis of Departments:

Results of application wise analysis hint at excessive use of ACs, room coolers etc in departments. Also the office appliances (which include computers, printers, scanners etc.) contribute largely to the total power consumption in the departments. The distribution of power consumption by different application would be clearer from the distribution pie chart given below:



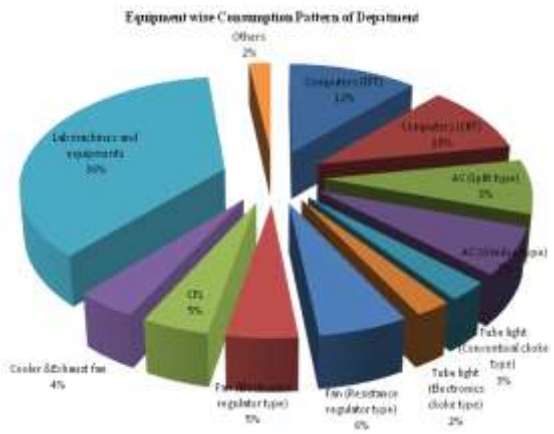
Comfort applications are consuming maximum power (22%). This clearly indicates that the ACs and coolers are not used wisely.

Lab devices (27%) come second and its contribution is not a surprise due to large number of Machines and computers in departments.

Lighting (16%) is third in the list. It can be brought down further by using modern efficient appliances and automation.

Electrical equipment consumes 5% of total consumption and includes water coolers, water purifiers, refrigerators and other appliances.

Equipment wise Analysis of Departments: Following chart has been generated from the equipment wise analysis of power consumption in departments (ignoring the equipments having power consumption less than 0.5% of total power consumption):



AC is the maximum power consuming appliance making up to 15% of total power consumption of the departments out of which 7% is the window type AC.

Computers account for 22% of total power consumption in departments. 10% of this is in computers with CRT monitor while 12% in computers with LCD monitor.

Conventional Ballast [Choke] tube lights have 3% share in total power consumption in departments, CFLs have 5% and electronic Ballast [Choke] tube lights have negligible share in total power consumed in departments. 2% of total consumption is in fans (6% in old fans and 5% in new fans). Refrigerator and water cooler consume 4%.

Geyser's and Tube lights are maximum power consuming appliances accounting for 10 to 15% each. Fans account for 20% of total consumption. Consumption in water coolers is 12.6% of the total power consumption. All other devices have not that much significant consumption.

5. CONCLUSION

The Proposed report gives strong warning to the consumer not only in terms of the energy bills also the energy crisis in the near future to all sectors of people and in this project the recommendations reduces the around 10-15% of the energy and cost reduction excluding some issues takes more payback period and some are economically not fit will not be taken in to account in a long run. There is a scope of improvement to include the advanced lighting scheme to reduce further cost. By detailed analysis of location, application and equipment it's easy to identify targeted area. Total annual energy consumption of institute is 2, 86,310.9 units. After implementing suggestion 57,589.2 units can be reduced. By reduction of these unit annual saving of institute will Rs. 3, 10,981.

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