International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, 2015
ISSN 2091-2730

Energy Audit on Academic Building

Manoj Kumar Lamba , Abhishek Sanghi
Department of Electrical Engineering,
JaganNath University ,Jaipur ,India
Manojlamba2678@gmail.com

Abstract- Today, the energy consumption is increased very sharply. This paper is just one step, towards our destination of achieving energy efficiency and we would like to emphasis that an energy audit is a continuous process .In this paper, we discuss about possible actions firstly i.e. How to conserve and efficiently utilize our scarce resources and identified their savings potential; second thing is important to implement on it. In this thesis, an energy audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options. Energy Saving can be done by improved techniques, better instrumentation and more efficient machinery.

Keywords:- Energy Audit, Energy Consumption, Energy efficiency, Bill, Saving, Payback Period, Measure

I. INTRODUCTION

An energy audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options. This energy audit of the academic area has been carried out and reported in this thesis.

II. ENERGY AUDIT AND ENERGY MANAGEMENT

1) Energy Audit Objectives

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. [4]

2) Energy Management

The Energy Management is the stragegy of adjusting and optimizing energy using systems and procedures so as to reducing energy requirements per unit of output. The main objective of energy management is:

- to achieve and maintain the load requirement.
- To minimize the cost of energy
- To minimize environmental effects

As per the Energy Conservation Act, 2001, passed by the government of India, energy audit is defined as " The verification, monitoring and analysis of use of energy including submission of technical reports containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption."[3].

3) Energy Conservation

Principle of Energy Conservation :- Energy Conservation means reduction of consumption but without reduction in the quality and quantity production.[1],[2]

Energy Conservation Required Due To :-

- To reduce energy/fuel shortage
- To reduce peak demand shortage
- To save fuel, natural resources and money
- To reduce environmental pollution

- Only 1 % of natural resources available in India, while
- population is 16% of the world
- Provides Energy security

4) Energy Consumption Methodology

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

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

4.2. Data Analysis - Detailed analysis of data collected was done using Elektra. The database generated by Elektra was used for producing graphical representations.

4.3. 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.

5) Stages In Energy Programme

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

1) The **first stage** is to reduce energy use in areas where energy is wasted and reductions will not cause disruptions to the various functions.

2) The **second stage** is to improve efficiency of energy conversion equipment and to 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. Hence the ECOs would include the following:-

- Building equipment operation,
- Building envelope,
- Air-conditioning and mechanical ventilation equipment and systems,
- Lighting systems,
- Power systems and
- Miscellaneous services.

The first two stages can be can be implemented without remodeling buildings and existing facilities.

3) The **third stage** would require changes to the underlying functions of buildings by remodeling, rebuilding, or introducing further control upgrades to the building. This requires some investment.

4) Th**e last stage** 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.

III. SURVEYING THE ACADEMIC CAMPUS

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

1) Preliminary Survey:-

Prior to the walk-through survey, the auditor may need to know the building and the way it is used. The information can be obtained from:

- Architectural blueprints,
- air-conditioning blueprints,
- Electrical lighting and power blueprints,
- utility bills and operation logs for the year preceding the audit,
- air-conditioning manuals and system data, and
- building and plant operation schedules extensive in order to identify more

ECOs for evaluation, but at an increased need for heavier capital expenditure to realize these opportunities.

2) Walk-Through:-

When we familiarized with the building, the walk-through process could be carrid out, if the blueprints and other preliminary information available describes the building and its operation accurately. The process could begin with a walk around the building to study the building envelope. If a model analysis is included in the study, the building must be divided into zones of analysis. The survey inside the building would include confirmation that the air-conditioning system is as indicated on plans. Additions and

alterations would be noted. The type and condition of the windows, effectiveness of window seals, typical lighting and power requirements, occupancy and space usage are noted. This information could be compared against the recommendations in the relevant Codes of Practices. System and plant data could be obtained by a visit to the mechanical rooms and plant room. Name plate data could be compared against those in the building's documents, and spot readings of the current indicating panels for pumps and chillers recorded for estimating the load on the system.

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.

IV. ENERGY CONSUMPTION

LOADS	ENERGY CONSUMPTION (in Watt)	CONSUMPTION (in %)
Light	698040	36
Fan	300690	15.61
Air Conditioner	40000	2.077
Personal Computer	863750	44.85
Gyser	8000	0.41
Misllaneous	15000	0.77
Total	1,925,480	

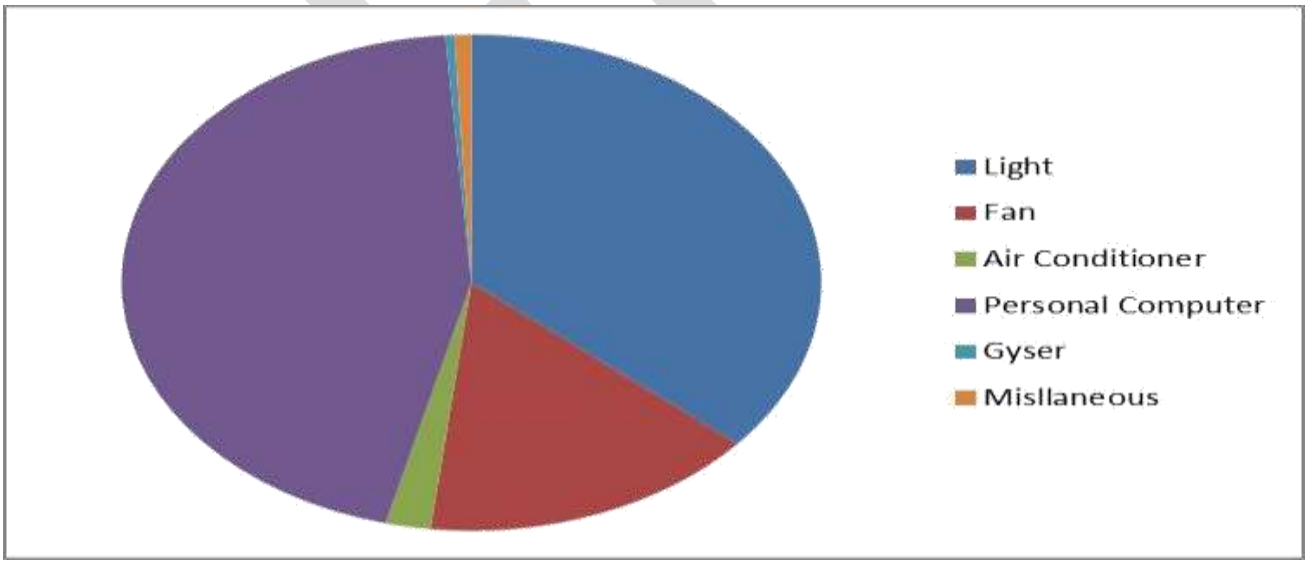

Fig 1.**CONNECTED LOAD PIE CHART**

V. ENERGY SAVING CALCULATION

(A) Cost Analysis Of Replacing Conventional Ballast[Choke] FTL With Electronic Ballast[Choke] FTL

- Total No. of conventional Ballast[Choke] FTLs in Campus = 12465
- Average Power of conventional Ballast[Choke] FTL = 56W

- Average Power of electronic Ballast[Choke] FTL = 44W
- Power saved per FTL = (56-44)W =12W
- Total Power saving = 12465*12W = 149580W = 149.580kW
- Average Use of FTL per year = 260*8h=2080h
- Total Energy saved per year = 149.580*2080 kWh = 311126.4kWh
- Saving in Rs. Per year = 311126.4*8.5= Rs. 2,644,574.4
- Average Cost of Replacing each FTL = Rs. 150
- Total Cost of Replacing all Conventional Ballast[Choke] FTLs = 12465*150 = Rs.1869750
- Capital Cost Recovery time = (1869750)/(2644574.4) = 0.7 yr

Hence, the capital cost recovery time for replacing all conventional Ballast[Choke] FTLs of the campus is around 0.7 year.

(B) **Replacing The CRT Monitors With LCD Monitors**

Computers with CRT and LCD monitors are nearly equal in number. In total, there are 1160 computers with CRT monitor and 965 computers with LCD monitors. On an average, CRT monitors consume 520W while LCD monitors consume only 270W. This saving of 250W per monitor is very large. But, the LCD monitor is also costlier by Rs. 4000 to 8000.Cost Analysis of Replacing CRT monitors with LCD monitors

- Total No. of computers with CRT monitors in Campus = 1160
- Power saved per monitor = 250W
- Total Power saving = 1160*250W = 290000W = 290 kW
- Average Use of computers per year = 5*260h = 1300h
- Total Energy saved per year = 290*1300 = 377000 kWh
- Saving in Rs. Per year = 377000*8.5 = Rs. 3204500
- Average Cost of Replacing each Monitor = Rs. 6000
- Total Cost of Replacing all monitors = 1160*6000 = Rs. 6960000
- Capital Cost Recovery time = (6960000)/(3204500) = 2.171 yrs

Hence, the capital cost recovery time for replacing CRT monitors by LCD monitors is 2.171 years. Since the product life is much more than that, the move is economically beneficial.

(C) **Replacing Geysers By Solar Water Heating System:**

Geyser is the device with highest consumption in academic area . It is the appliance where maximum power is wasted. Heating water by electricity is the most inefficient way to heat water. Alternatively, heating water for bathing can be accomplished by solar water heating system.

Cost Analysis of Replacing Geysers by SWHS:-

- Cost of a domestic SWHS = Rs. 17000
- Capacity of the SWHS = 100LPD
- Average Capacity of Geyser = 50L
- No of geysers one SWHS can be used to replace = 2
- Average power of Geysers = 2kW
- Average use per year = 5*180h = 900h
- Energy saved per year by replacing Geysers by SWHS = 2*2*900kWh = 3600kWh
- Saving in Rs. Per year = 3600*8.5 = Rs. 30600

Capital Cost Recovery time = (17000)/(30600) = 0.55 yr

Hence, the capital cost recovery time for replacing geysers by SWHS is 0.55 years. So, the step of replacing geysers by SWHS will not only help in increasing energy efficiency, but also will reduce the cost of bathing water.

(D) 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 Typical 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 = (4*50*4*365)/1000 = 292kWh
- Saving in Rs. Per year = 292*8.5 = Rs. 2482
- Cost of installation per motion sensor = Rs. 250
- Total cost of installing motion sensors in a corridor = 3*250 = Rs. 750
- Capital Cost Recovery Time = (750/2482) = 0.30 yr

Hence, the capital cost recovery time for installing motion sensors in corridors is 0.30 year. Hence, this is a highly recommended step to largely reduce the consumption in corridors and toilets.

VI. CONCLUSION

The Energy audit and Energy conservation measures described in the research paper does not only provide a very different perspective to the wastage and energy crisis and energy security but also an implementation platform that addresses all aspects of managing several energy sources. It can lead to lower energy expenses, identification of possible usage of renewable sources of energy, increased comfort of building occupants, increased flexibilities of future expansions and reduced environmental impacts.

REFRENCES:-

[1] HarishkumarAgarwal, Smart Grid Initiative in India and Supremes' Experience in the Electrical India, Vol 53, No.9 September 2013, page 78.

[2] B S Srikanthan&Srinivas S, Minimization of Distribution losses for domestic appliance – A Case Study, Electrical India, Vol. 53, No. 9, September, 2013, page no. 68.

[3] "Energy management and Audit" Bureau of Energy Efficiency pp.57-81

[4] Zhang Jian, Zhang Yuchen, Chen Song, Gong Suzhou; "How to Reduce Energy Consumption by Energy Audits and Energy Management" Issue Date: July31 2011- Aug.2011 on page(s): 1 - 5 Date of Current Version: 12 September 2011.

[5] Mendis N.N.R, Perera N. "Energy Audit: A case Study" Information and automation, 2006, ICIE 2006. IEEE International Conference, page 45-50, 15- 17 Dec.2006

[6] Panesar B.S., "Energy Management Systems- Designing, Initiating, And Managing, Audit, Budgeting And Management Of Energy And Energy Costs". Lectures on Energy Audit, Conservation and Renewable Energy Studies for Agriculture", Punjab Agriculture University, Ludhiana