Electrical Energy Conservation and Audit of an Educational Institute: A Case Study

Kashish Garg, Divyanshu Bhatia, Siddhant, Aakriti Kaul, Rakhi Kamra

Maharaja Surajmal Institute of Technology

ABSTRACT: Efficient use of energy is what every research department round the world is craving for, millions of dollars have already been spent for the cause and still there's always a scope for improvement. Prudentuse of energy is a social need and Every individual is responsible for it. To enhance the efficiency a detailed and thorough study of final consumption is required which includes listing type of loads, calculating their operating hours and recommending the efficient alternatives for that and also providing the payback period. The energy audit of a building should be conducted after every 5 years for the betterment of energy expenditure and utility bill cost cutting. This research paper emphasizes on practicing new methods and replacing the presently installed equipment**'s** in the Maharaja Surajmal group of Institutions with the better performance equipments of much lower power consumption to maximize the energy saving. Cautious use of electrical power will also lead to minimize the energy billing cost.

KEYWORDS:*Energy audit, Energy savings, Payback period.,EnergyConservations Measures (ECM), energy management, Demand.*

I. INTRODUCTION

This paper is an assessment of energy need and efficiency of a building or buildings. Collection of data, analyzing the data and load and suggesting the use of better methods or appliances which may help in conserving the energy in the near future. This paper detected the unused sockets and rearranges the lighting scheme of the building. The main aim of energy audit is to curtail the losses and boost the energy efficiency.

The suggestions provided after the audit may include the use of non-conventional methods of energy generation like solar plant, LED Lights, light sensors, timers, devices with the latest technology as well as the introduction of some up to the minute practices

A) NEED OF AUDIT

Electrical energy and thermal energy expenses are the only main barriers which hinder the desired profit rate of any industry or any institute. This paper conceptualizesthat an energy audit will allow us to know the energy expenditure in any building orindustry and to seek the window for improvement. Also, the paper explains that the energy audits entertain the possibility of more savings and less maintenance. An audit allows us to stretch up our leg and take a leap of feasible and reliable expenditure of energy. Contemporary practices of energy expenditure will lead one to the path of economical success.

B) IDENTIFICATION OF ENERGY CONSERVATION OPPORTUNITIES

Within this paper it is systematically showcased that the Audits allow us to improve the energy consumption table of a building by reallocating the supply as per requirements. Steps for optimizing energy conservation have been briefly represented in this paper.Replacingthe heavy loads by the energy efficient appliances with better ratings is one of the crucial part of energy audit. Not only this, cables should also be changed if needed like durable copper cables should be preferred over other metal wires and also their cross-section should be appropriate.

C) ECONOMIC AND TECHNICAL FEASIBILITY

Technical feasibility should mainly focus on reliability and service. Also one important point to ponder while auditing is to check that the maintenance required by the replaced new device should not be very high .On the other hand, economic feasibility deals with the money . For economic feasibility one should keep in mind that the payback period of the replaced device should not be too high.

II. LITERATURE REVIEW

The literature proposes energy audit of various places like academic institutions, industries etc. Ali in the paper has done energy assessment of a building in summer season and had analyze the cost to implement the various energy saving measures[1]. The notion of green building is implemented during the process of energy audit in an institute in the city of Jordan by Hassounehet al.[2].Effective energy saving measures in a building had been assessed using intelligent techniques in [3]. Energy consumption also depends on the user's behavior and this feature has been used in doing energy audit by Tuan Anh Nguyen and Marco [4].To improve the energy performance of a building and suggest retrofit measures to save energy, elaborative results are discussed in the paper by Niu et al.[8].From these articles ,there arose the need to study the energy consumption of our academic institute and then suggest energy saving measures. The academic institution at which the energy audit was done is an engineering college. The main aim of this audit was to stop

reckless expenditure of energy in the institute. Consumption of power by the heavy appliances of the institute were corrected. The loads were relocated as per the sanctioned load and cost of utility bill. Solar panels and smart devices were recommended.

I. TYPES OF ENERGY AUDITS

Energy audit represents a wide study area adding to quick walk supervision of energy efficiency measures that are fulfilling the cost effectiveness [6,7].

In all, the three major audit parameters are explained beneathIn all, the three major audit parameters are explained beneath , working may be differentiating. The right technique to guarantee that the audit meets our requirement is by matching these requirements with a vast scope of work Using appropriate time to make a formal solicitation would ensure building the owner to get unique and generous offer.[9][10]

A) PRELIMINARY AUDIT

The preliminary audit is the most basic type of audit also known as screening audit featuring certain discussions with the in command officials.

utility bills and other operating data, and a tour of supervision of the facility to become familiar with the building operation and highlight areas of energy waste or inefficiency. Sectors with vital faults are revealed in this and calculations of payback period and approximated execution cost are derived.

This level of detail, while not enough to declare the verdict on implementing the recommended measures, is suitable to prioritize energy efficiency projects and determine the need for a more detailed audit.

B) GENERAL AUDIT

The general audit also called mini-audit or complete site energy audit step up on the preliminary audit mentioned above by compiling more detailed information about facility operation and performing a more described evaluation of energy conservation measures identified. Utility bills are collected for upto 3 years period to allow the auditor to analyze the facility's energy/demand rate structures, and energy usage .. In-depth conversations with facility operating staff are conducted to provide a better understanding of energy consuming systems as well as peep into variations in daily and annual energy consumption and demand. This audit will be able to identify all energy conservation techniques appropriate for the facility given its operating parameters. A financial inspection is done for each alternative depending on detailed implementation of cost estimates, cost savings, and the customer’s investment method. Sufficient detail is provided to justify project implementation.

C) INVESTMENT-GRADE AUDIT

Within the various corporate settings, advancing to a facility's energy interior should have an edge over non energy and likewise investments for major funds. Straight principle for investments of energy and non energy investments is the return on investment (ROI). We require projected operating savings to be high on confidence by the developed implemented energy projects. As it is generalized that investors posses to claim a guaranteed savings. Terms like comprehensive audit, detailed audit, maxi audit are used as an alternative to represent the investment grader audit . These audit terms advance the basic of audit as discussed about before by presenting and understanding a dynamic model of utilized features of present facility and all the observed levels of conservation of energy. The calibration of building model against real used data is to present a truthful baseline against which it is to manage working savings for offered noted levels. The present usage study is supplemented by sub metering the main energy utilizing systems and observing of working features of the system.

IV. ENERGY AUDIT METHODOLOGY

STEP 1 – INTERVIEW WITH KEY FACILITY PERSONNEL

In starting of audit, a meeting is scheduled between the auditor and all main operating staff to elevate the project. The meeting agenda focuses on: audit objectives and scope of work, maintenance and all the respective parameters are widely referred and then taken into the consideration.

STEP 2 - FACILITY TOUR

Post first meeting, group of facilitators analyzed the different workings first hand, aiming on the major energy consuming systems identified during the interview, including the architectural, lighting and power, mechanical, and process energy systems.

STEP 3 - DOCUMENT REVIEW

During the initial visit and subsequent kick-off meeting, available facility documents are reviewed with facility representatives. It should be noted that the available plans should represent "as-built" rather than "design" conditions.

STEP 4 - FACILITY INSPECTION

After a thorough review of the construction and operating documentation, the main energy utilization processes in the facility are further diagnosed. Where accurate, field readings are collected to prove working parameters.

STEP 5 - STAFF INTERVIEWS

Subsequent to the facility inspection, the audit team meets again with the facility staff to review preliminary findings and the recommendations being considered.

STEP 6 - UTILITY ANALYSIS

The utility analysis is thorough study of energy bills from the previous 12 to 36 months. This should includeall purchased

energy, including electricity, natural gas, fuel oil, liquefied petroleum gas (LPG) and purchased steam, as well as any energy generated on site. Billing data reviewed includes energy usage, energy demand and utility rate structure. The utility data is normalized for changes in climate and facility operation and used as a baseline to compute projected energy savings for evaluated Energy Conservation Measures(ECM)s.

STEP 7 - IDENTIFY/EVALUATE FEASIBLE ECMS

The audit will generalize the two main salient features of system working, main facility modification with need of economical study and analysis, Also, minor working modification presenting easy and fast paybacks. For every main energy utilization systems a list of main ECMs is made (i.e., HVAcetc).

It relies on the final feedback of complete observations and study collected about the facility and keeping in note the feedbacks received from the facility personnel at the end of the field survey feedback. A last key list of ECMs is made and studies with the manager.

STEP 8 - ECONOMIC ANALYSIS

Data collected during the audit is processed and analyzed back in our offices. We build models and simulations

With software to reproduce our field observations and develop a baseline against which to measure the energy

Savings potential of ECMs identified. We then calculated the implementation cost, energy savings and simplePaybacks of all the ECMs were enquired.

STEP 9 - PREPARE A REPORT SUMMARIZING AUDIT FINDINGS

The outputs of all the research and feedbacks are collected in the final report. Which also contains of significance of facilities followed by their working , all points about complete main energy utilization systems, a significance of completes ECMs followed by the particular energy output ,total investment, advantages and payback. The report displays a summary of complete performances and hard work performed during the project with reasonable outputs and feedbacks.

STEP 10 - REVIEW RECOMMENDATIONS WITH FACILITY MANAGEMENT

A formal presentation of the final recommendations is presented to facility management to supply them with Sufficient data on benefits and costs to make a decision on which ECMs to be implemented.

V. ANALYSIS OF LOAD IN M.S.I.T.

Percentage of load consumption is depicted in the following Figure1:

M.S.I.T.

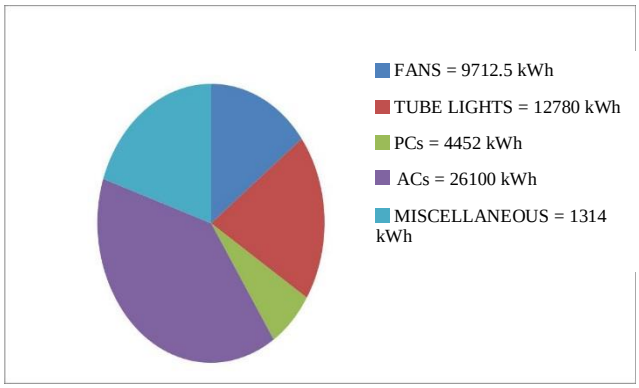

Fig1: Energy consumption in MSIT building

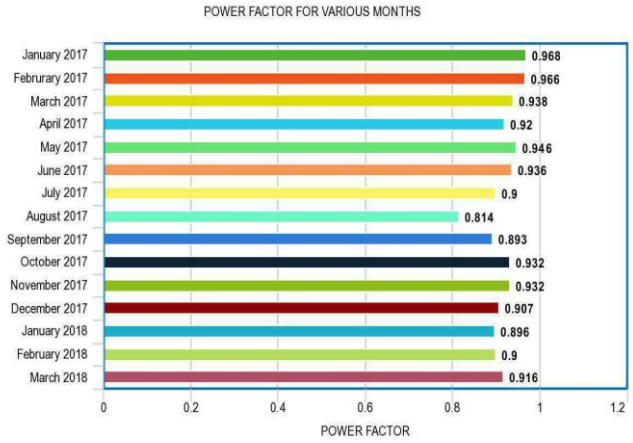

Fig2: Power factor variation over months

VI. RECOMMENDATIONS FOR LOW POWER CONSUMPTION IN EEE DEPARTMENT

1. LIGHTING

1.1. Light switch is arguably the best energy-saving device. Turn off lights whenever not required.

1.2. Apply the concept of task lighting which refers to increasing luminance in specific area to focus light where it is needed. For e.g. using reading lamp lighting only the reading material rather than the whole room.

1.3. Replace ordinary light bulbs with LED bulbs. Incandescent lamps waste the most amount of electric energy replace them as soon as possible.

1.4. Infrared sensors, motion sensors, dimmers, automatic timers are some of the many automatic devices which can help in saving energy used for lighting. Use them to switch on\off lighting circuits automatically.

1.5. Dusting of sources of lights (bulbs, tubes, lamps etc.) should be performed regularly as they emit less light and could absorb 50 percent of the light when dirty.

1.6. Incandescent bulbs are very inefficient as ninety percent of the energy consumed by the bulb is given off as heat rather than visible light.

1.7. About 50 percent electricity could be saved if we use LEDs instead of incandescent, fluorescent or halogen bulbs. This results in huge energy savings for spaces where lights are on for long periods of time.

2. COMPUTERS

2.1. Save energy by using energy efficient products having logos like Energy Star that offer good energy efficiency.

2.2. Most computers come with operating systems that have power saving features. These put hardware like monitor or hard drive into idle mode or even turn them off when not in use.

2.3. Turn the brightness of screens down to save energy. It is okay to set it to

50% as much benefit won't be gained below that.

2.4. Make a habit of turning off the monitor when not in use instead of using a screensaver as they do not save energy. Choosing to turn off the monitor saves a lot of energy.

2.5. **Turn off the computer whenever not needed. Turning off computers doesn't**

reduce their lifetime unlike popular belief.

2.6. Share hardware like scanners, routers or printer wherever possible. Sharing them conserve energy as having them individually for every computer system would consume a lot of energy.

2.7. Pull the plug on battery chargers, for cell phones, digital cameras and laptops, as they draw power when plugged in.

3. AIR CONDITIONERS

3.1. **The optimal temperature to set on an AC unit is 22˚C. This temperature** setting provides the most comfort at the least cost.

3.2. Thermostat could be set higher if we use supplementary fans as the air movement will cool the room even more.

3.3. Use window curtains and drapes to keep the sun off. They help to keep the room cool. This way air-conditioning energy could be reduced by 40%.

3.4. Regular ACs should be turned off for some time after every 30 minutes as the room is cooled and dehumidify in this time period.

3.5. Doors should be kept closed while the AC is in use.

3.6. Air filters inside the AC should be cleaned every month. A dirty filter uses makes the AC to use more energy for cooling and may also damage the unit. A clean filter also allows faster cooling.

3.7. Replace AC units which are more than 10 years old, with newer units with higher energy savings.

3.8. The AIRCONSAVER is a retrofit electronic control unit that adds intelligence to existing air conditioning systems and improves their energy efficiency.

4. FANS

4.1. Replacing the current fans with ones with better energy efficiency would help to conserve energy.

4.2. But again we suggest replacing a fan with an energy saving one when the former has stopped working or is damaged.

4.3. Our college is well ventilated and therefore fans from the college corridors could be removed to save energy.

4.4. Reducing the amount of fans in well-ventilated rooms.

VII. PAY BACK PERIOD AND ANALYSIS OF THE POWER CONSUMPTION

As in this department the more power consuming applications are

1. Computers
2. Low Pf Motors
3. Tube Lights
4. Fans
5. Air Conditioners

Energy Saving when these retrofit measures are considered:

- Total number of tube light(40 W) replaced to LED tube lights(20 W)is - 1278
- No. of Air conditioners with 3-star rating(1500 W) should be replaced to 5 star(1400 W) - 87
- Total number of fans (75 W) changed to 50W energy efficient fans -1278

Total energy conserved if these applications are replaced with the energy efficient appliances is calculated as follows

1. 1278(40-20) =25560x10(no.of hrs. per day)=255.6KWh
2. 87(1500-1400)=8700x8(no.of hrs. per day)=69.6KWh
3. 518(75-50)=12950x10 (no.of hrs. per day)=129.5KWh

Total no. of electrical energy units conserved 454.7 KWh per day

Total no.of electrical energy units conserved per year 454.7 x 365 = 165965.5 units per year

Total money saved in a year taking Rs.8.8 as rate of one unit consumed

165965.5 x 8.8 = Rs.14,60,496.4 per year are saved i.e Rs. Fourteen Lakhs sixty thousand four hundred ninety six are saved every year, that's a considerable amount.

Payback Period calculation :

Initial investment for the retrofit measures are:

Payback period :

Total cost of all applications to be changed are = Rs.81,86,430

Cost saved on electricity bill every year is = Rs.14,60,496

In 5 years and 6 months, is the payback period to recover the initial investment.

VIII. CONCLUSION

Analysis, survey and inspection of energy flow and expenditure of the building has been done and in corresponding to the cause certain energy conservation measures have been recommended. Applications equipped with heavy loads were re organised with the improved power factor and power quality. Certain retrofit measures as well as behavioral changes have been suggested to save a considerable amount of energy as well as money. The payback period is only around six years ,also the installation changes can be done in stages during maintenance or new purchasing. Further, solar installations could also be included to lessen the burden on non renewable energy as the only source of power. We aim to adapt our institute to the concept of green building

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