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Energy Audit Methodology in An Organization and Commercial Utility- A Case Study

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KEYWORDS : Energy audit methodologies, Energy conservation, ENCONs, renewable energy sources and recommendations

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ABSTRACT

This paper proposed energy audit methodology for an Organization and commercial utility. Nowadays in the new trends of power market, it is a very difficult task to satisfy the power balance concepts even though the consumers pay their demands very much costlier. So the energy conservation and energy management concepts are necessary for the flexible utilities. The energy audit is a tool process to identify the facilities from different areas. This paper highly focuses on energy auditing which will make small operating changes that can often used to conserve energy and hence lower energy expenses. A case study has been carried out in an institutional organization based on this Energy audit methodology and the real time results shows energy conservation operation is a routine work which contributes to the improvements in the customer energy conservation, improved facility and reduces energy utility cost.

I. INTRODUCTION

The existing power crisis in Tamilnadu shows that there is a continuous increasing demand in year by year. Therefore the per capita energy consumption needs to provide better living conditions to each citizens also indicates by international studies on human development. A legal growth of a country should be energy balanced and sustainable in all aspects. The two important concepts are main task of this requirement that is energy management and energy conservation studies in this situation. On the energy demand and supply side, country is also facing Peak power and average energy shortages of 12% and 7% respectively [1]. For the tremendous growing demands, there is a very less possibility to install power plants frequently even though forecasted the demands and also very poor resource availability in our hand. Although we have to meet the demand in existence, it is very much difficult task to achieve the power balance scenario. But this paper dictates on to generate ideas to reduce energy consumption in an organization. Because No cost or very low cost operational changes can often save energy, it is directly equal to enhance the power generation. By this way we can save the energy in an industry/organization 10-20% on utility bills Capital Cost Programs with pay back times of two years or less can often save an additional 20-30% [2]. The energy audit can play a vital role for satisfying the above concepts. It is a holistic survey of the specialty, performed to understand how energy is currently used and to identify areas of potential savings. The energy audits 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.

As per energy conservation Act,2001, Energy Audit is defined as "the verification, monitoring and analysis of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption"[3],[4].

The main features of Energy audit are:

- To create an awareness on Energy conservations,
- Energy user should be aware of the trends on energy consumption & energy bills,
- To reduce the Energy Bill by 30% (Target),
- Encourage to implementation of renewable sources with new technologies.

The energy audit is a routine process to solve the method of finding out the ESOs (Energy saving Opportunities)/Energy Conservation Opportunities (ENCONs). The nature of the work would be study by survey or walk through to collect all the data from different areas by using the methodology proposed in this paper and make the recommendations based on pay back Calculation. Purpose of energy auditing is to find out the way of energy saving and to give the recommendations to the Management for improving the energy efficiency, to reduce energy cost.

II. TYPES OF ENERGY AUDIT METHODOLOGY

The audit methodology can be classified into different ways based on time investing to estimate the completion of work. These are

a) Walk through audit / preliminary audit
b) Pre-audit
c) Post audit

a) Walk through audit:

The walk-through audit is a tour of the facility to inspect each system visually. The main objective of this audit is to collection of load data from different areas. It can yield a preliminary estimation of savings potential hence cost is lesser in this type of audit. A list of low-cost savings opportunities or ESOs, through improvements in operational and maintenance practices. The walk-through audit information may be used to Pre audit & Post audit (Detailed audits).

b) Pre-audit:

For pre-audits, more detailed data and information are required. Measurements and a data inventory are usually conducted from different energy equipment (pump, fan, air-conditioner, compressed air, steam, heating processors, etc.) are assessed in detail. The results of these audits are more comprehensive and useful since they give accurate picture of the energy performance of the plant and the specific recommendations are suggested for improvements (see table.1).

c) Post audit:

After collected data by survey should be investigated throughout the organization and reviewed for completeness facility from each and every section/area, check it once again whether any missing data or not. The main objective of this audit is to implement the ENCON (Energy Conservation Opportunities) recommendation measures and monitor the performance.

III. BLOCK DIAGRAM FORMULATION OF ENERGY AUDITING METHODOLOGY

The energy audit process is starts by collecting information about operating facilities were followed and its history of energy recorded bills. In this block diagram a unique audit methodology is imposed to identify ENCONs and evaluated to determine their benefits and their cost effectiveness as shown in

fig.1. In order to carry out the energy audit effectively, as an initial stage an energy audit team has to be formed and they have to prepare a special schedule plan (energy action plan) to carry the process. The load data and energy utility data information is noted on particular forms from different areas. The data then analyzed to get charts of how the facilities uses and finding out the possible energy wastages, as well as to help the auditor to learn that areas to examine to reduce energy cost.

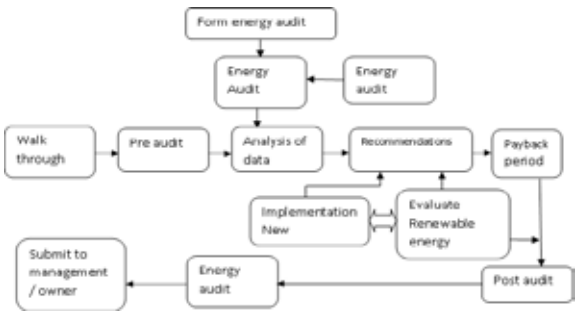

Fig.1 Block diagram of Energy Audit Methodology

A very suitable recommendation is to suggest based on ENCONs with short time pay backs & flexible capital costs. The preparation of recommendation is very important because of during follow-up (post audit) period, the audit goal has to be accomplished effectively. At the end of the process an action plan is formed whether certain ENCONs are selected for implementation and the actual process of energy saving & cost benefits are begins. Finally the energy audit report has to be prepared by energy auditor's knowledge and submit to the management.

IV. REPORTING ON ENERGY CONSERVATION & RECOMMENDATIONS

By following Recommendations are suggested by Energy Conservation Opportunities with short time pay backs. [5, 6 & 7]

1.Air-conditioning (AC)	• Prefer Split Air conditioners. • Do not over cool – maintain ideal temperature 22ºC to 24ºC. • Installation of energy saver for each AC. • Ensure proper functioning of thermostat of ACs • Insulate walls & ceiling • Routine maintenance for air filters & cooling pins to make proper operation at regular interval. • Use air curtain in front of door to avoid false air entry • Keep doors and windows closed in air-conditioned space, particularly doors leading to stairwells and external areas. • Avoid usage of air conditioners in the evening hours & favourable climatic conditions. • Use pedestal fan instead of air-conditioners during non-laboratory hours.
2.Lighting systems	• Switch off lights when absent from your work area for more than 30 minutes including in bathrooms, meeting rooms, lecture theatres and corridors. • Maximize the use of natural light and turn on lights only when there is inadequate lighting. • Promote CFL, LED lamps instead of incandescent bulbs. • Promote electronic chokes for florescent lamps instead of EMT chokes.
3.Computers and Monitors	• Switch off monitors when absent for more than 30 minutes • Switch off computers and monitors at the end of the day. • Do not use screen savers as this does not save energy. Set screensaver to 'none' or 'blank screen'. • Adjust your power management settings to put your screen to sleep if it is not in use for more than five minutes. • Online UPS – Battery Status Indication · It can be switched-off during non-use period. · To minimize no-load power consumption. • Switch-off the Offline UPS · When the power failure is less. · Improves life of SMF Batteries. · Over charging will leads to bulging of batteries and leads to battery failure. • Advice on PC energy saving features like advanced LED monitor.
4.Xerox machines (photo-copiers), printers, faxes	• Where possible use email, circulation lists and electronic archiving in preference to printing. • Switch off printers and fax machine if they are not being used. • Ensure power management functions are operational. • Use double-sided copying and printing whenever possible
5.Purchasing equipment and appliances	• Buy equipment that has double-sided printing and photo-copying facilities. • Buy the most energy efficient star compliant equipment and appliances.
6.Kitchens and-bathrooms	• Load up the dishwasher before running it for maximum efficiency. • Turn off the auto boiler at night. (Before you do this, check to see if it is already on a timer to automatically switch on and off). • Minimize hot water usage.
7.Labora-tories	• Turn off laboratory equipment that can sensibly be turned off when not in use, especially anything with a heating or cooling function e.g. AC plant. Arc furnace etc.
8.Pumping systems	• Prefer to submersible pump which operated by centralized automatic controller.

V. SUGGESTION ON RENEWABLE ENERGY TECHNOLOGIES

The implementation of renewable energy sources is needful for everywhere in facility also insists this paper of renewable energy sources through energy audit methodology because of it provides for an economic evaluation of solar energy system recommended to be installed for commercial and institutional/ organization's facilities. The evaluation covered the economic feasibility of installing a solar / wind system under a new technological construction contract and to assume full responsibility of the operation of such system. Initially the capital investment is required for either renewable system based on a simple payback periods. But the government may be provided subsidiaries to install the renewable sources for institutional organizations premises.

VI. ENERGY ACTION PLAN AND ENERGY AUDIT REPORT :

After described ENCONs are made by recommendations to be implemented, to fix the target date and ready to follow-up. Prepare the schedule which should implement first and suggest starting the process for all ENCONs as per the schedule. Initially starts the recommendation from very short payback period. So saving from that these ENCONs can be used to generate capital to pay for implementing other ENCONs.

VII.CASE STUDY

By adopting energy audit methodology the measurements are taken from different location of facilities. Here an emerging institutional organization is chosen for case studies. The total energy utility is found in form of energy and cost shown in Table.1. In this paper have investigates the energy consumption in both pre-audit and post audit. Initially collect all the information about energy facility and its measurements are taken based on the specific energy consumption instantaneously, to made bar charts and suggested ENCONs for which areas needed then constituted a framework on the recommendation of each facility. All the process has been done in walk through and pre-audit methodologies. The management of institution has followed by steps of ENCON recommendations that we could seen the im-

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provement of small operating changes of energy utility in post audit period. The target date is also mentioned in the action plan itself.

Table 1: Details of Energy consumption in Overall Institution:

Loads	Energy consumption in KWhr	Cost* per Month
Light	1680	9238
Fan	2729	15008
Air Conditioner	27562	151589
system load	3099	17046
Lab Motor Loads	473	2604
Pumping Motor	882	4850
Water cooler	1568	8624
Xerox	279	1534
Electr. Equip. in lab	309	1698
Server	268	1473
Miscellanies	475	2615
Total	39323	216279

Note: * cost will be depending on tariff which is fixed by distributors.

Since the facility information is collected from different areas and to made detailed statistics provided about consumption of energy in percentage, and there is no investment in measures. (Shown in fig.2)

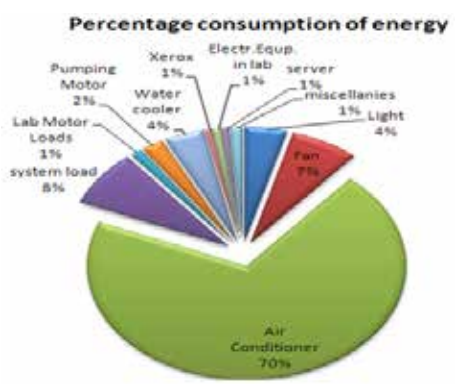

Fig.2. Distribution of connected load by end use in Institution

It used to identifying the reasons and range energy consumption of each department as shown in fig.3. The computer science engineering department was consumed more energy. Because of the air conditioner and system (computer) loads operating were longer.

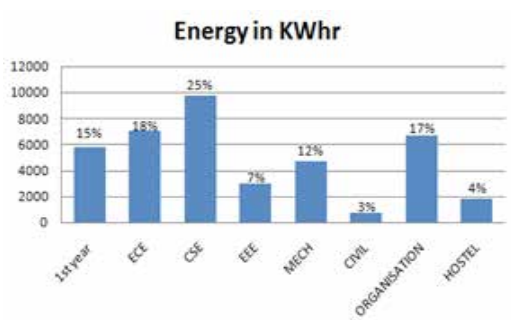

Fig.3. Department wise Energy Consumption

In this case study mainly focused on the large consuming energy facilities or loads are concerned here for the analyses which are followed the recommendations. There are i) Air-conditioning system, ii) Lighting system, iii) Computer system, and iv) Pumping system.

i) Lighting system:
The different types of lamps are using at various locations in campus but before follow the recommendations, should to know the knowledge of lamps like illumes, power rating and efficiency. The better ENCONs are to be followed by recommendation (ref.chapter.IV.2). After followed recommendations the improved result as shown in fig.4

ii) Water Pumping system:
The power consumption of pumping system is dependent on rate of flow and various pressures, efficiency. The problem of pumping is over design of bore well with lower than pumping pressure. This is so check the problem whether it can be found, resize the pressure prefer valve control system.

iii) Air-conditioning system:
The figure.2 shows more energy to consume by air-conditioner that is 70% of the entire institution energy consumption. So mainly focus on to reduce the energy consumptions in air conditioners usage patterns. The rate of energy consumption of the air-conditioning system was 27562 KWhr/month. After implement the above recommendation (ref.chapter.IV.1), overall energy consumption would be 17766KWhr saved per month.

iv) Computer system:
The computer is the Second Largest Power Consumer in the Institution. The above recommendations are made to save the energy consumption in computer systems (ref.chapter.IV.3). The improved results are shown in fig.4

Table.2. Energy savings is achieved by follow-up the Recommendations

Loads	Before follow-up Recommendations		After follow-up Recommendations		% savings
	Energy consumed in KWHR	Cost per Month	Energy consumed in KWHR	Cost per Month	
Light	1680	9238	925	5085.5	45
Water Pumping system	882	4850	478	2627	46
Air Conditioner	27562	151589	17766	97713	36
System (computer) load	3099	17046	3046	16753	2
Total	33223	182723	22215	122178.5	32

VIII. Result and Discussion
By adapted energy audit methodology, suggested the recommendations steps to be taken by management for improving the energy efficiency and reduced energy utility cost. From the figure.4 the energy improvement is notified that the comparison of energy consumption before and after follow-up the recommendations shown in table.2. Some major facilities is concerned here, the details of savings after implemented the recommendations (follow-up) are the lighting system 45%, water pumping system 46%, air-conditioning system 36% and computer system 2%. Therefore the 28 % of overall energy would be saved in the entire college campus. Hence the total energy savings is also be achieved the maximum peak demand and reduced the energy bill near to 30 %.(target)

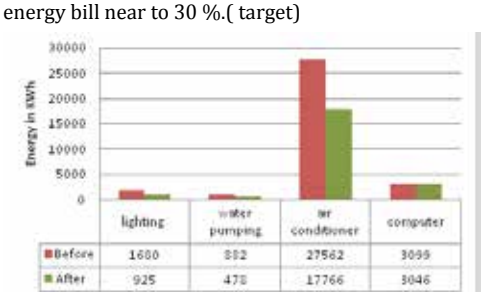

Fig.4. Result of Energy saving after post audit

IX. CONCLUSION

This paper has proposed energy audit methodology for an organization and commercial utility of energy management solutions that improved energy saving activities. Energy audit is an effective tool to know about energy facility and also to find per capita consumption. 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.

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