Assessment of Energy Saving Potential in a BPO Building through Energy Audit

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Abstract— Energy plays an important role in the economic activities along with production sector, utilities etc. In developing countries like India, increase in energy needs results in energy shortage due to lack of resources and generating units. So it is necessary to conserve energy through various measures like auditing, efficient utilization of energy through proper investments. Energy audit acts as important methodology to balance energy inputs along with actual utilization. Based on suggestions provided by audits, utilization of energy and efficient use of resources can be improved. The scope of this paper is to conduct an energy audit program in a commercial building and reduce energy consumption based on conserving measures suggested through auditing

Index Terms— Economic activities, utilization, energy consumption, audit, generating units, investment, harmonics

1 INTRODUCTION

Energy is one of the major inputs for the economic developments of any country. The global energy needs are increasing at the rate of 1.5% every year. Hence energy sector assumes critical importance in view of the ever increasing energy needs. There should be continuous availability of energy in sufficient quantities at reasonable prices. Energy cost is a significant factor in the economic activity, with factors of capital, land and labor. Reducing energy requirements and increasing the energy efficiency are the two important measures that have to be given highest priority in recent days. The imperatives of energy shortage call for energy conservation measures, which use less energy for the same level of activity. In this paper the energy conservation, energy efficiency, energy audit and its scope and measures to be taken for energy conservation are discussed. The methodology of saving energy through energy audit by various means namely: Audit, House Keeping, Lighting, Personnel, Capital Investment, Monitoring. A case study of a Business Process Outsourcing (BPO) building is discussed in this paper.

2 OVERVIEW OF ENERGY AUDIT, CONSERVATION AND MANAGEMENT

2.1 Energy audit

Energy Audit is a systematic approach for decision-making in the area of energy management. An effective tool in defining and pursuing comprehensive energy management program is an Industrial energy audit. Energy Audit attempts to balance the total energy inputs with its use and serves to identify all the energy streams in the systems and quantifies energy usages according to its discrete function.

2.2 Energy conservation

Energy Conservation is the purposive practice or an Attempt to save electricity, fuel oil or gas or any other Combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money

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2.3 Energy management

Energy management incorporates planning and operation of Energy-related production and unit consumption. While the users have permanent access to the energy they need, the major Objectives are resource conservation, climate protection and cost savings. The environmental management, production management, logistics and other established business functions are connected closely to the objectives given above.

3 NEED, METHODOLOGY FOR ENERGY AUDIT AND CONSERVATION

3.1 Need for energy conservation

Energy in any form is a scarce commodity and an expensive resource. However, if we look at the predicted future human pollution figures and consider the probability that the individual life expectation will increase, , also energy be in short supply. Unless that supply is increased it will be a source of friction in human affairs

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3.2 Objectives of audit and conservation

Broadly energy conservation program initiated at micro or macro level will have the following objectives of manufactured goods availability and profitability, and in consequence raise the standard of living both of the workers in industry and of those who buy the products.

a) To reduce imports of energy and reduce the drain on foreign exchange.

b) To improve exports of manufactured goods or of energy, or both.

c) To mitigate environmental pollution per unit of industrial output.

d) Thus reducing the costs that pollution incurs either directly as damage, or as needing, special measures to combat it once pollutants are produced.

e) Generally to cut down shortage and improve development

3.3 Types of audit

Energy Audit to be performed depends on following conditions :

- Function and type of industry
- Depth to which final audit is needed, and
- cost reduction based on Potential and magnitude

This gives the Classification of energy audit into the following two types.

- Preliminary Audit
- Detailed Audit

3.4 Detailed Energy Audit Methodology

Energy auditing is carried out in detail through three phases: Phase I, II and III.

Phase I - Pre Audit Phase
Phase II - Audit Phase
Phase III - Post Audit Phase

4 TYPES OF ANALYSIS

4.1 Lighting system analysis

Electric lighting is a major energy consumer.Extensive energy savings are possible using energy efficient equipment, better controls, and deliberate design.

Objectives of lighting audit:

- Using less electric lighting & using natural lighting scale down heat gain, thus saving air-conditioning energy and improving thermal comfort.
- Electric lighting design also deeply affects visual performance and visual comfort by aiming to maintain adequate and appropriate illumination while controlling reflection and glare.
- Energy efficient lighting system installations.
- With reasonable payback Replacing the inefficient lighting equipment

4.2 Air conditioning system analysis

In office buildings 60-80% of electricity consumption is used to provide HVAC. Effect utilization and proper design of air conditioning reduces large level energy consumption.

Objectives of Air conditioning system audit:

- Improving the air conditioning performance by providing better design
- Proper maintenance of installed system

Major considerations for proper AC design:

- For improved annual cost saving choose AC system with higher EER value and better star rating
- Consider lighting load, total number of persons & computers, area and number of windows for calculating the cooling load for efficient cooling

4.3 Harmonic analysis

Harmonic analysis provides details about power quality issues in the given system. Major considerations are harmonic current, harmonic voltage and power factor.

- **Problems caused by harmonic currents:**

1. overloading of neutrals
2. overheating of transformers
3. nuisance tripping of circuit breakers
4. over-stressing of power factor correction capacitors skin effect

- **Problems caused by harmonic voltages:**

1. voltage distortion
2. zero-crossing noise
3. Problems caused when harmonic currents reach the supply

- **Common effects of harmonics in equipment:**

1. Flickering in lighting system and reduction in life of lights
2. Harmonic current causes stress on power factor capacitor which results in breakdown of dielectric strength.
3. Largely affects the computer operation and memory storage devices

5 DISCUSSION ON EXISTING ENERGY UTILISATION OF THE BUILDING

An energy audit has been conducted in a BPO building near Salem. It is having four floors. In all the floors the major loads are air-conditioning and computers. The total loads shared by the equipments have been given as pie chart in figure no. 1. The energy consumption over a year has been given as bar chart in figure no.2. Table 1 gives the details of average values of power factor, running load, energy consumption per day and connected load.

Table 1. Load data of the Building

1.	Average power factor	0.92
2.	Connected load	112 kW
3.	Average Running load	99.8 kW
4.	Average Per day energy consumption	1300 kWh

As mentioned in the table 1, the total connected load for the building is 112 kW. On an average the running load is about 99.8 kW

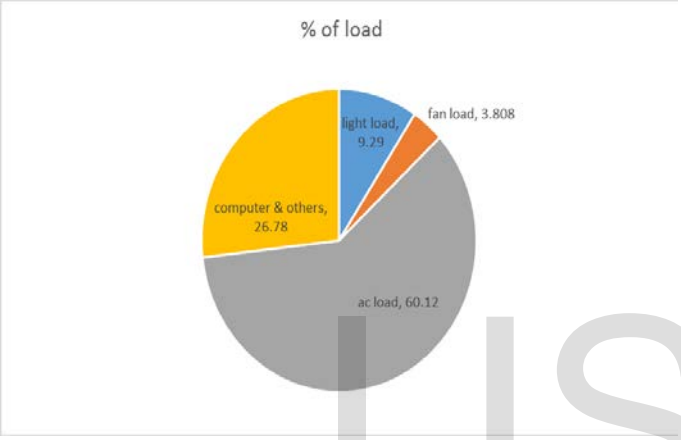

Fig. 1 Total load shared by each equipment

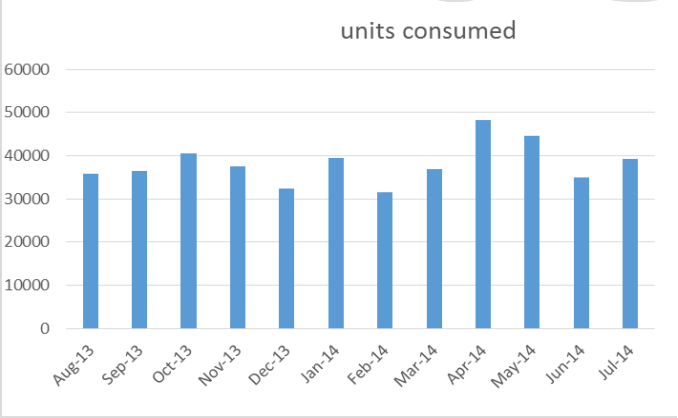

Fig. 2 Energy consumption for one year

5.1 Major problems in energy management

Based on the above details, the major problems in energy management of the building have been discussed.

- Efficiency of air conditioning system is not up to the mark due to extension of AC system without proper design. It results in higher level of power consumption.
- They had a plan of establishing an additional floor. Due to this problem, extension of load for new floor is not feasible
- As all loads are connected to a single transformer voltage regulation problem occurs when any one of the load fails.
- Existing lighting on second floor has mechanical ballasts which consume power of 30% higher than electronic ballasts.
- High current harmonics is detected in all the three Floors which may reduce efficient operation of computers by 2-2.5% in table 2
- Current Harmonics results in reduction of life of lighting system
- All the above problems lead to economical imbalance in energy management system.
- Average Electric utility bill for a month is around 2.25 lakhs due to inefficient energy management in the building

Table 2. Current and Voltage harmonics

Floor	Current Harmonics	Voltage Harmonics
1st floor AC	9.60%	4.70%
1st floor lighting	41.00%	4.40%
2nd floor AC	6.70%	5.40%
2nd floor lighting	25.50%	4.30%
3rd floor AC &lighting	19.80%	5.30%
ground floor AC	10.10%	5.20%
ground floor-lighting	56.80%	4.80%

6 Proposal for Energy Conservation

The energy conservation measures in the light of lighting system, air-conditioning system, power factor improvement, harmonics reduction and implementation of renewable energy system has been given as proposal.

6.1 For lighting system:

- Replacement of conventional mechanical ballast by electronic ballast with reduces the consumption by 35% in second floor.
- Installation of separate transformer for lighting which reduces voltage related problems provides better voltage regulation & increases the efficiency of lighting System. (Total lighting load - 9202W)
- Reduction of feeder voltage for lighting by 10% can save 5-15% of power for lighting

6.2 For air conditioning system:

- To change the speed of compressor motor according to the requirement provide variable frequency control and hence the temperature range can be increased to a higher level so that the power consumption can be reduced
- Efficient use of air conditioning system in ground floor through redesigning
- Installation of Energy saver for split air-conditioners.

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6.3 For power factor improvement:

- Provide capacitors for improving power factor from 0.92 which results in improved incentive and penalty saving in a reasonable payback period
- Capacitor bank of range 5 kVAR improves power factor in first and second floor to 0.95

6.4 For reduction of harmonics:

- Current harmonics are higher in lighting system which results in voltage stress on power factor capacitor
- Due to this effect dielectric strength of capacitor reduces, resulting in power factor decrement

- Installation of active filters is advisable instead of installing power factor capacitor

6.5 For further extension

- Provide renewable energy source for 10 kW which may conserve 5-6 kW/day

7 Cost analysis

Cost analysis is carried out for one year taking into the implementation of lighting system, energy saver and installation of renewable energy system. Table 3 gives the details of cost analysis with payback period

Table 3. Cost analysis and pay back period

Sl. No.	Details	Energy saved in units / year	Cost Savings (Rs)	Payback period
1	Replacement of ballast	2177.59	17420.72	4 months
2	installing energy saver	8060.95	64,487.61	3 months
3	renewable energy source	43800-52560	3.50 to 4.21 lakhs	2 years
4.	Installing capacitor bank	5455	43,640	18 days

8 Conclusion

Through this audit various levels of energy utilization is analyzed practically. Results of energy audit provide opportunity to find energy wastage through various equipments. Areas for energy conservation are selected. Based on proposed techniques for conservation, cost analysis and payback period is calculated. Through this audit energy management in BPO building can be balanced in both economical and efficient utilization of energy source

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