Case Study: Energy Audit and Conservation of Instrumentation Department

A.M. Kamble[1] S.S. Kubal[2] S.R. Deshwal[3] P.S. Kolambkar[4] S.D. Wankhade[5]
[1,2,3,4,5]Department of Instrumentation Department
[1,2,3,4,5]Bharati Vidyapeeth College of Engineering, Navi Mumbai, India

Abstract— An energy audit is an inspection, survey and analysis of energy flows for energy conservation in a building, process system to reduce the amount of energy input into the system without negatively affecting the outputs. When the object of study is an occupied building then reducing energy consumption while maintaining or improving human comfort, health and safety are of primary concern. Beyond simply identifying the sources of energy use, an energy audit seeks to prioritize the energy uses according to the greatest to least cost effective opportunities for energy savings. Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Energy audit is an effective tool in defining and pursuing comprehensive energy management is to achieve and maintain optimum energy procurement and utilization, throughout the organization. Through this project we can prioritize the energy uses according to the greatest to least cost effective opportunities for energy savings in our college campus.

Keywords: Energy Audit, Energy Efficiencies measures, Energy Management

I. INTRODUCTION

Energy Audit is an inspection, survey and analysis of energy flows for energy conservation in a building or system to reduce the amount of energy input to the system without negatively affecting the output. As per the Energy Conservation Act, 2001, Energy Audit is defined as “the verification, monitoring and analysis of use 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”. It is an effective and concrete method to achieve rapid improvement in energy efficiency in buildings and industrial process. First step in identifying opportunities to reduce energy expense. Which is a Systematic procedure includes some steps. Energy auditing is also called as Energy assessment, Energy survey etc… The objectives are

(1) To minimize energy costs / waste without affecting production quality

(2) To minimise environmental effects. The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a “bench-mark” for managing energy in the organization and provides the basis for planning a more effective use of energy throughout the organization.

II. INSTRUMENTS USED IN ENERGY AUDIT

The requirement for an energy audit such as identification and quantification of energy necessitates various measurements; the measurements require the use of instruments. These parameters generally monitored during the energy audit may include the following: Basic Electrical Parameters in AC & DC systems – Voltage (V), Current (I), Power factor, Active power (kW), Energy consumption (kWh), Harmonics, etc.

A. *Electrical Measuring Instruments*

These are instruments for measuring major electrical parameters such as, kW, PF, Hertz, amps and volts. In addition, some of these instruments also measure harmonics. These instruments are applied on line, i.e., on running motors without stopping the motor. Instantaneous measurements can be taken with hand held meters.

B. *Lux Meter*

Illumination levels are measured with a lux meter. It consists of a photocell, which senses the light output, converts to electrical impulses which are calibrated as lux.

Fig. 2.1: Lux Meter

C. *Power Factor Meter*

A power factor meter is a type of electrodynamometer movement when it is made with two movable coils set at right angles to each other. The method of connection of this type of power factor meter, in a 3-phase circuit. The two stationary coils, S and S1, are connected in series in Phase B. Coils M and M1 are mounted on a common shaft, which is free to move without restraint or control springs. These coils are connected with their series resistors from Phase B to Phase A and from Phase B to Phase C. At a power factor of unity, one potential coil current leads and one lags the current in Phase B by 30°; thus, the coils are balanced in the position shown in Figure 2.2. A change in power factor will cause the current of one potential coil to become more in phase and the other potential coil to be more out of phase with the current in Phase B, so that the moving element and

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pointer take a new position of balance to show the new power factor.

Fig. 2.2: Power Factor Meter

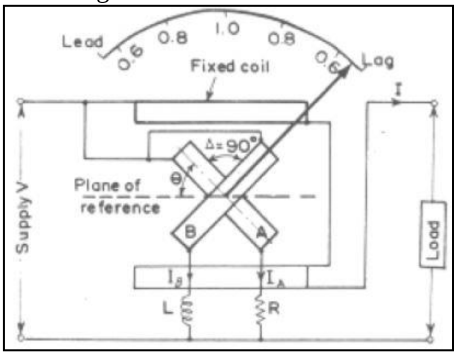

Fig. 2.3: Construction Diagram of PF Meter.

D. *Energy Meter*

An electricity meter, electric meter, electrical meter, or energy meter is a device that measures the amount of electric energy consumed by a residence, a business, or an electrically powered device. Electric utilities use electric meters installed at customers' premises to measure electric energy delivered to their customers for billing purpose. They are typically calibrated in billing units, the most common one being the kilowatt-hour [kWh]. They are usually read once each billing period. When energy savings during certain periods are desired, some meters may measure demand, the maximum use of power in some interval. "Time of day" metering allows electric rates to be changed during a day, to record usage during peak high-cost periods and off-peak, lower-cost, periods. In addition, in some areas meters have relays for demand response load shedding during peak load periods.

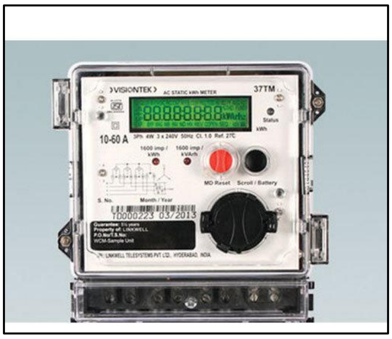

Fig. 2.4: Energy Meter

III. LOAD DETAILS

Load calculations of the department are done by taking all the equipments that work on electricity into consideration.

The below table shows the number of equipments and its total load connected on the main block of the campus

EQUIPMENT	RATING OF EQUIPMENT	NO. OF EQUIPMENT	CONNECTED LOAD	UNITS
(1) FANS	74W	90	6,660	6.66
(2) LIGHTS	18W	65	1,170	1.17
(3) COMPUTERS				
(A) MONITORS	360W	69	24,840	24.84
(B) CPU	600W	69	41,400	41.4
(4) PRINTERS	315W	9	2,835	2.835
(5) SCANNERS	4.2W	1	4.2	0.0042
(6) PROJECTOR	16W	2	32	0.032
(7) AIR CONDITIONER	1970	4	7,880	7.88
(8) EXHAUST FAN	50W	1	50W	0.05
(9) FRIDGE	1000W	1	1000W	1

Fig. 3.1: Load details of the Department.

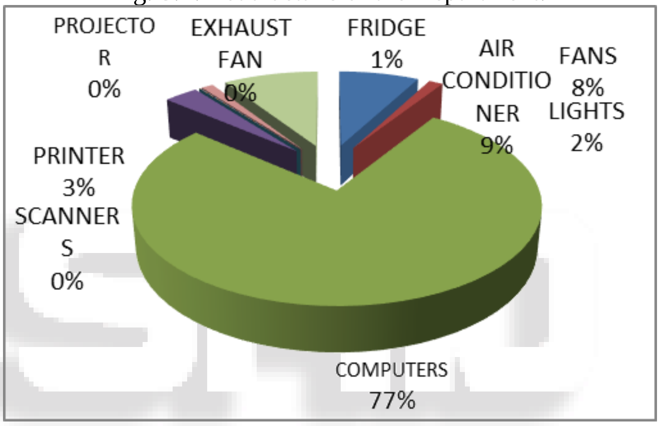

Fig 3.2: Graphical representation of load

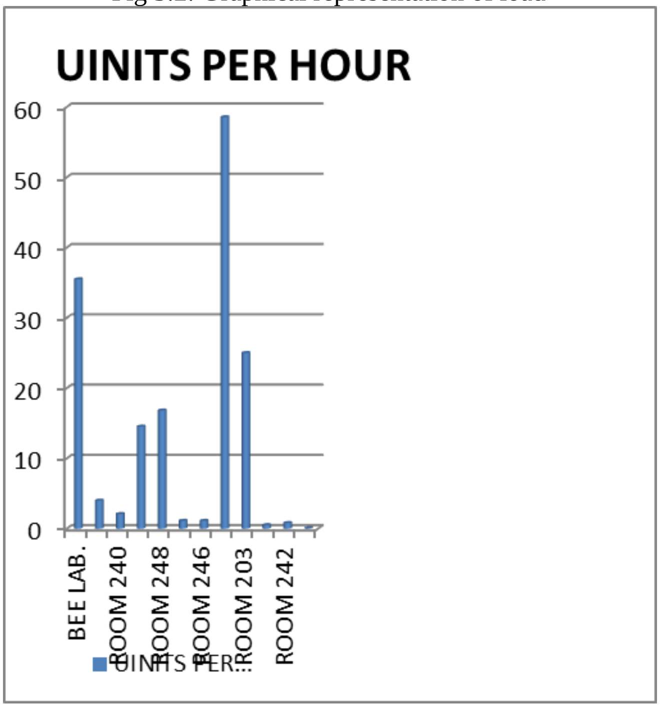

Fig. 3.3: Graphical representation of energy consumed per hour.

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IV. Design for Energy Saving

A. Illumination

Lighting or illumination is the deliberate use of light to achieve a practical or aesthetic effect. Lighting includes the use of both artificial light sources like lamps and light fixtures, as well as natural illumination by capturing daylight. Day lighting (using windows, skylights, or light shelves) is sometimes used as the main source of light during daytime in buildings. This can save energy in place of using artificial lighting, which represents a major component of energy consumption in buildings. Proper lighting can enhance task performance, improve the appearance of an area, or have positive psychological effects on occupants. Indoor lighting is usually accomplished using light fixtures, and is a key part of interior design. Lighting can also be an intrinsic component of landscape projects.

To find number of light fittings, 'N'

$$N = \frac{E * A}{O * CU * MF}$$

N: No of Light Fittings Needed
E: Required Illumination (lux)
A: Working Area (m2)
O: Luminous Flux Produced Per Lamp (Lumens)
CU: Coefficient of Utilization MF: Maintenance Factor

1) Lux

The lux is the SI unit of luminance and luminous remittance, measuring luminous flux per unit area. It is equal to one lumen per square metre. In photometry, this is used as a measure of the intensity, as perceived by the human eye, of light that hits or passes through a surface. It is analogous to the radiometric unit watts per square metre, but with the power at each wavelength weighted according to the luminosity function, a standardized model of human visual brightness perception.

2) Lumens

The lumen (symbol: lm) is the SI derived unit of luminous flux, a measure of the total quantity of visible light emitted by a source. Luminous flux differs from power (radiant flux) in that radiant flux includes all electromagnetic waves emitted, while luminous flux is weighted according to a model of the human eye's sensitivity to various wavelengths. Lumens are related to lux in that one lux is one lumen per square meter. The lumen is defined in relation to the candela as

1 lm = 1 cd·sr.

3) Coefficient of Utilization

It is the ratio of the lumens actually received by a particular surface to the total lumens emitted by a luminous source. It is an indication of the effect of the lighting equipment and the interior combined in producing horizontal luminance. For example, UF of 0.3 means that the lumen reaching horizontal plane is 30% of the lumens of the lamp operated bare under standard conditions. The value of this factor varies widely and depends on the following factors: Type of lighting system, whether direct, indirect etc, the type and mounting height of fittings, the colour and surface of walls and ceiling to some extent the shape and dimensions of the room.

4) Maintenance factor

It is the ratio of luminance halfway through a cleaning cycle, to what the luminance would be if the installation were clean. This factor allows for the fact that the effective candlepower of all lamps or luminous sources deteriorates due to blackening and/ or accumulation of dust or dirt on the globes and reflectors etc. Similarly, walls and ceilings also do not reflect as much light as when they are clean.

V. Recommendations and Suggestions

1) Pump the cooled water to cold storage plant during night to thermally insulated tank. Advice people not to use cold water until 12 noon of the day .Only they have to use the cold water plant between 12 noon to-10 PM for 10 hours.
2) Workers/Employees are advised to use only cotton clothes. White or relatively white cloth during summer. Therefore, they can avoid too much sweating with that the effect of dehydration can be minimized and the water consumption can be minimized through which cold water storage burden will reduce at least by 10-20% of total consumption.
3) They can use cotton mini size umbrella it is not for rain protection it is exclusively to protect for direct attack of solar radiations, when they walk outside during afternoon. So that soon after reaching home fan use can be minimized and it is healthy. After going home immediate use of AC or FAN should be avoided as biologically certain harmonically imbalance takes place .gradual body cooling is better.
4) Use focused light for reading place or table lamp. Sometime recommended to avoid full room lighting it leads to wastage of illumination and disturbance of sleep to housemates, which disturb their work efficiency at working place. Person-hour efficiency reduction is the national waste. Also insufficient sleeps leads to health problems.
5) All Interior walls should be painted using Enamelled paint which would reflect light.
6) Good light ventilation and Air ventilation to classrooms may solve the problem of Energy Consumption.
7) Energy saving by replacing LCD desktop with LAPTOP illustrate the benefits in terms of portability, space saving, maintenance cost of desktop computers and additional cost of peripherals. Also, cost of damage and other electrical problems. Critical space management and cost involved can be removed. Wiring for LAN and labour cost can also be prevented.
8) Unnecessary power consumption by negligence of user and system administrator for not switching off while leaving the office will have more vulnerability for damage due to short circuit and heavy voltage due to lightning.
9) It is recommended to replace fluorescent lamps by CFL and LED'S which are handy by construction and possibility of breakage is less. Installation is easy and the labour charge required for replacement of burnt

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tubes and defected choke lamps is a costly affair. Disposal of burnt tubes will disturb the habitat place of both human being and animals. The release of krypton and argon gases is more dangerous, it may lead to ecological imbalance if it in mass destruction.

10) Switch off the photocopier machine at the main outlet itself when not in use or in other words machine should not be kept in stand by and sleep mode that consumes power.
11) Avoiding individual mobile phone facility at the working place during working hours is better; as they use charging facility, which consume power and substandard battery chargers draws more current leads to more power consumption. There is also possibility66 of electrical short circuit. Common communication facility may lead to harmony among employs due to uniform facility it keeps the working atmosphere very clean and calm in addition to the cost benefit.
12) Use good lighting system will reduce the power burden as a whole.
13) Energy recycling, when Equipment is operating or motor is running is the research area where young generations have to address.
14) Fans running without capacitor or under rated capacitor will draw more current therefore use of correct rated capacitor will reduce the power consumption.
15) All major equipments should run with good power factor and the integration of Instrument to read the P.F online should be made mandatory. Therefore, immediate care can be taken to improve the power factor.
16) Recommended to use Online harmonics measurement system to monitor the harmonics higher-level harmonics lead generate heat in the equipment may lead to greater power loss .Harmonics suppression equipment is necessary.
17) Recommended to use solar water cooler in place of conventional one.
18) Reschedule the timetable to reduce the maximum demand.
19) Outside lightening of the campus should be placed bit higher.
20) Use pumps on the off peak time so that we can reduce the consumption cost. If the securities are available. Fill the tank by pumping once.
21) Static capacitive banks are recommended to place parallel with the pump to increase the power factor.
22) Recommended to replace the old refrigerator, freezers, grinders and mixers with the new energy efficient ones i.e. five stars rated equipments.
23) Star rating of our campus is labelled 5 stars for the year 2015-2016 and we recommends to check star rating for every year.

VI. Conclusion

The Proposed project gave strong warning to the consumer not only in terms of the energy bills but also in terms of the energy crisis in the near future to all sectors of people. This project's recommendations reduce around 15-20% of the energy and 25-30% of cost reduction excluding some issues likes more payback period. There is a scope of improvement to include the advanced lighting scheme to reduce further 10% of the operating cost. As per the ECBC building ratings, 5 Star labelled buildings are most efficient and we found that our campus could be labelled as 5 star as per ECBC criterion. As per ECBC, a building exceeding an EPI of 1000kWh/sq.m/year comes under the ECBC complaints. In the AIT campus, we observed that only an EPI of 3.3kWh/sq.m/year, so the campus found to be free from the ECBC complaints.

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