IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE)
e-ISSN: 2278-1676,p-ISSN: 2320-3331,
PP 112-122
www.iosrjournals.org

Statistical Method of Energy Audit and Conservation to Assess the System Power Deman

J. Nandana[1] T. Charan Singh[2] Dr. Pannala Krishna Murthy[3]
Department of EEE, SBIT, Khammam – 507002, T.S., India
Department of EEE, SBIT Khammam – 507002, T.S., India
Department of EEE, SBIT Khammam – 507002 T.S., India

Abstract: *Electricity is the most utilized useful form of energy in the modern society without it the present infrastructure would not all be feasible. The maintenance and attentive usage of electrical energy has become increasingly important in recent years, and now has reached a vital point. The optimum utilization of society of this form of energy can be ensured by an effective energy conversation.*

This paper deals with the area of energy management that Energy Audit is the key to a systematic approach for decision-making. It is an inspection, study and analysis of energy flow for energy conservation in a building, process to reduce the amount of energy input into the system without affecting the output. It attempts to balance the total energy inputs with its use, and serves to identify all the streams in a facility. It quantifies energy audit usage according to its discrete function. An institution is taken as a proto type to analyze and implement the energy conservation techniques. The results are presented in this paper will clearly explain about the important electrical energy with a motto o minimize the expenditure involved.

Keywords: *Energy Audit, Enegy Conservation, Energy Management,*

I. INTRODUCTION

I. Importance of Energy Conservation

The careful use and conservation of electrical energy has gain importance in recent years due to the deficit of electric power when compared to the demand, and now has reached a crucial point. It practices of utilization of electrical energy results in poor efficiency, wasted power and often higher electric bills. The situation is really that simple and should be corrected whenever possible [1].

Saving energy makes environmental sense too, because it is universally recognized that we are changing our climate in ways we cannot predict, by altering the composition of the earth's atmosphere as a result of our burning fossil fuel for heat and electricity. The more efficient utilization practices use of electrical energy, the less we need of it to maintain our life style, and the less carbon dioxide will be released into the atmosphere. The social benefits of investment in energy conservation include creating significant numbers of opportunities in energy related services such as manufacturing and installation of energy saving equipment.

International competition has really put a lot of squeeze on profit margin as inefficiencies can no longer be passed on to the end user, energy conservation, productivity improvement and cost cutting are given the most importance. One must set right his (industrial) house to be internationally competitive. No wonder even small & medium are opting for TQM, ISO, Energy Audit, Quality circles etc. Energy conservation and energy audit a field of expertise, has al lot to offer to industries, as irrespective of type and size.

- Most of industries can save around 15% to 25% energy
- Almost half of which needs negligible investment
- Conservation of energy improves productivity and enhances equipment utilization.
  Unlike other productivity improvement tools, the solutions are simple and easy to implement, like
- Adopting systematic approach for conservation of energy
- Indentifying & eliminating wastage
- Improving efficiencies
- Encouraging improvements in process & operation
- Creating awareness through systematic training & campaigns
- Making energy conservation a way of life- professionally & personally.

In today's world of fierce competition, it is imperative to produce the desired quality of product at a minimal cost. Energy cost contributes to significance percentage in the total production cost.

II. ENERGY MANAGEMENT & ENERGY AUDIT PROGRAM

An Energy Management Program and Energy audit is a systematic approach for controlling a building's energy utilization so as to reduce energy waste to the absolute minimum without adversely affecting the building's functional requirements.

Any organization to implement a successful energy management program, it must create an environment of established goals to prevent waste and protect the assets of facilities; management must understand and support the importance of energy efficiency, environmental quality and the programming of energy improvements; and a significant portion of energy savings must be reinvested in the energy management program[2].

Goals and Objectives

- Audit the energy consumption of selected buildings to determine which types of energy are used and the amount of each.
- Analyze which operations/processes consume extensive amounts of energy in each building.
- Plan measures by which individual building can conserve energy used in their high-energy using operations/processes.
- Provide consultation to managers of buildings that were audited in an attempt to reduce the consumption of energy in their facility.
- Provide a pathway to benchmark energy conservation methods that can be used in other buildings and facilities.
- Identify the major construction, maintenance and design features that make building efficient.

Energy Management Programme

An energy audit and subsequent implementation of EMOs should provide certain energy savings. However, in order to maintain these savings over time, the building management needs a long-term Energy Management Programme (EMP).

Firstly, the building management develops an Energy Policy and then makes a corporate commitment to energy efficiency and conservation as well as appoints a senior member as energy manager to take charge of the Building Energy Performance (BEP) and to develop energy efficiency strategy. To meet the policy, the building management defines the objectives and energy efficiency targets in terms of energy savings, sets time frames for achievement and allocates adequate staff and financial resources. The building management should develop in-house energy experts and should engage energy manager/energy consultant to look after energy issues. These experts and energy manager/energy consultant should plan for further or periodic energy audits, formulate an action plan for implementation of EMOs and consider the need for staff awareness training to be provided as appropriate. A budget for EMP should be established and based on all these activities.

These activities should be regularly reviewed and the policy should be reassessed and redefined as appropriate. A not-cost-effective-enough EMO may be implemented, when there are major retrofits associated with this EMO. An example is the availability of fresh water for heat rejection method. This kind of "long-term" EMO can be implemented as an activity of the EMP.

During energy audit, the building management might have installed some meters to monitor energy consumption for certain equipment/systems. Whilst some of them will be removed after the audit, some could be remained as part of the equipment/systems. There may be also areas that meters could not be installed, due to site constraints or operational constraints. As an activity of the EMP, the building management should install meters (permanent type) or make provisions for ready connection of meters for each main system, its sub-systems and its associated components. Based on these metering facilities, the building management should better assess the energy consumption in the long run.

To verify the amount of energy savings through the implementation of EMOs. The building management should record the required operational data for energy saving assessment whenever any retrofits associated with these EMOs are implemented. For example, in terms of housekeeping, the building management should record the effectiveness in execution of housekeeping procedures being laid down for a particular venue, before and after retrofit. Sample checks at regular intervals are expected

III. HOW TO CONDUCT ENERGY AUDIT

The Energy Audit should be carried out by a competent person having adequate technical knowledge on Building Services (BS) installations, particularly Heating, Ventilation and Air-Conditioning (HVAC) Installation, Lighting Installation and any other BS Installations. This competent person is referred to as the "auditor" and a team of auditors forms the "audit team". The number of auditors and time required for an audit depends on the audit scope and objectives. During the audit process, the auditor needs assistance and cooperation from the auditees, such as end-users, operation and maintenance (O&M) personnel, etc [3].

To gain a better knowledge of the building and its energy consuming equipment/systems, the audit team must collect information on the building operation characteristics and the technical characteristics of its various energy consuming equipment/systems. Its performances have to be identified through checking O&M records, conducting site surveys and reading metering records. The audit team will then identify areas that can be improved and write up an energy audit report on the findings for record purposes and for subsequent EMO implementation and follow-up actions. The flow chart on conducting energy audit is shown in flow chart for reference.

Defining Scope of Energy

The scopes of works and the available resources for conducting the energy audit should be determined. The available resources mean staff, time and budget. Recognizing the extent of support from the building management, the audit team should then determine the scope of the energy audit such as the areas to be audited, the level of sophistication of the audit, the savings anticipated, any EMOs to be implemented, the audit result to be used as reference for improvement on O&M, the need for any follow up training or promotion of results achievable, etc. The plan for conducting the energy audit should then proceed.

Forming an Energy Audit

An audit team should be formed by determining the members of the audit team and their duties. Involving the O&M personnel to provide input. Facilitating meetings for sharing of information and familiarizing among different parties. Should in-house expertise or resources be regarded as not adequate, energy audit consultants should be employed. Many of the local BS consultants and tertiary academic institutions have the expertise on energy audit.

Estimating Time Frame & Budget [5].

Based on the available resources, the time frame and the budget can be fixed. The budget is mainly built-up on cost of auditor-hours from collection of information to completion of the audit report. The audit team should check whether they have adequate testing instruments. In addition, the cost for employing BS consultants and/or tertiary academic institutions may be included, if so required.

Collecting Building Information

The audit team should then proceed to collect information on the building. The information should include:-

- General building characteristics such as floor areas, numbers of end-users, construction details, building orientation, building facade, etc.;
- Technical characteristics of energy consuming equipment/systems, design conditions and parameters;
- Building services design report with system schematic diagrams and layout drawings showing system characteristics;
- Equipment/system operation records, including data logs of metered parameters on temperature, pressure, current, operational hours, etc.;
- Record of EMOs already implemented or to be implemented
- Record of maximum demand readings;
- O&M manuals and testing and commissioning (T&C) reports; and
- Energy consumption bills in previous three years.

In general, it should be assumed that the building manager would have information on general building characteristics and the O&M personnel would keep the equipment/system technical and operation records. The audit team should determine the appropriate parties to be approached for information collection, the need to discuss with these parties for familiarization of the building, the equipment/systems to be investigated and data verification and the need to discuss with selected end-users [4].

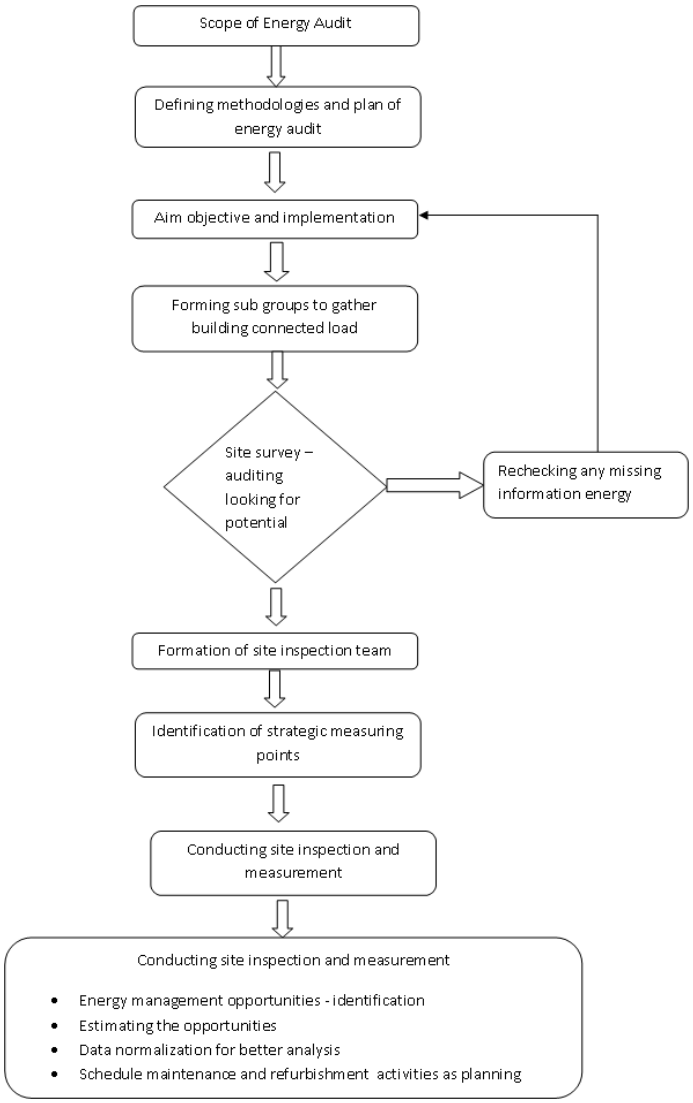


Figure 1: Flow Chart on Conducting Energy Audit

IV. CASE STUDY EVALUATION

Objectives of Energy Accounting:

The main objectives of energy accounting are:

- Preparing an energy account on each feeder to record the quantum of energy received and the quantum of energy supplied and billed to various categories of consumers.
- Identifying areas where billing of revenue collection does not commensurate with energy supplied.
- Improvement in metering, billing and revenue collection.
- Study and analysis of the energy accounts to identify high loss areas.
- Segregation of energy losses into technical/commercial losses.
- Identification of areas of high technical losses vis-à-vis normal system losses.
- Identify remedial steps for reduction of both technical and commercial losses.
- Constantly review, at least on a monthly basis, the progress made in regard to the remedial action already initiated earlier.

To conduct the Energy Audit in the entire campus proper support and co-ordination has to be achieved. For this we have followed a systematic approach in the following manner:

- Form an environment committee and select audit team representative of administration, students, parents, teaching and support staff.
- Assign goals, tasks and responsibilities.
- Write goals (and outcomes) of the audit E.g. Increase awareness, change attitudes, link with curriculum, reduce waste, etc,
- Consider resources for the audit-Establish a fund to provide for the audit, decide on related activities, competitions and events for the college calendar e.g. Environmental Youth Forum, World Environment Day.
- Publicize concept of the environment audit energy, materials and water.
- Each member to obtain all relevant bills and consumption data and outline scope of audit.
- Locate all meters and record waste statistics to establish audit baseline.
- Evaluate the best ways of presenting data.
- Teams collaborate to establish a database of relevant information.
- Create "profile of college" in terms of use of all resources and associated costs.

The whole college environmental audit provides:

- A baseline from which improvements can be measured.
- A plan of action which will allow the organizations or educational institutions to improve their environmental practice.
- Participation from all sectors of the community towards the better changes.
- Write reports from data gathering during audit.
- Set timelines for changes to routines and goals for predicted savings.
- Write final report and action plan, and then publicize it.
- Share the positive results.
- Implement new plan (start again at the audit stage).
- Evaluate and assess the success of the audit.
- Identify problem areas and devise plans to tackle problems.

Calculations & Results Analysis

S.no	Name Of The Equipment	Power Usage (W)
1	Ceiling fan	60
2	Ceiling light	40
3	CFL Bulb(60W-equivalent)	18
4	CFL Bulb (40W-equivalent)	11
5	CFL Bulb (75W-equivalent)	20
6	CFL Bulb (100W-equivalent)	30
7	Systems(CRT)	240
8	Systems (LCD)	150
9	Air Conditioner(1 Tone)	1400
10	Air Conditioner(1 .5 Tone)	1800
11	Exhaust fans	90
12	Exhaust fans	30
13	AC central (2006 and after)	2700
14	AC central (Before 2006)	3500

15	AC room (6000 BTU)	750
16	AC room (9000 BTU)	1050
17	Radio	15
18	Printer (Ink Jet)	15
19	Printer (Laser)	50
20	Scanner	50
21	Fax machine	300
22	Table fan	40
23	T.V	150
24	Refrigerator	500
25	Cell phone Recharge	4
26	Overhead Projector	500
27	LCD Projector	200
28	CC TV Camera	82
29	Xerox Machine	1240
30	Copier	1240
31	Air Cooler	790
32	Server	750
33	Electric Bell	10
34	Biometric	15
35	LAN	90
36	Speakers(Big)	350
37	Speakers(Small)	100
38	Fed Lights	150
39	UPS (10KVA)	9800
40	Amplifier	100
41	Displays	57
42	Counting Machine	80

Table 1: List of equipments with their power consumption values

S.No	Block Name	CL in M W	In Units
1	Main Block-G	0.106	152.0
2	Main Block -1	0.093	118.3
3	Main Block -2	0.017	48.6
4	Main Block -3	0.149	190.0
5	Arya Bhatta block - G	0.200	239.2
6	Arya Bhatta block -1	0.056	67.2
7	Arya Bhatta block -2	0.070	84.7
8	PG Block -G	0.024	62.0
9	PG Block- 1	0.047	71.9
10	PG Block -2	0.071	104.9
11	Work Shop	0.036	53.4
12	Outer	0.015	26.6
Total		0.938	1218.8

Table 2: Total connected load of institution and units consumption

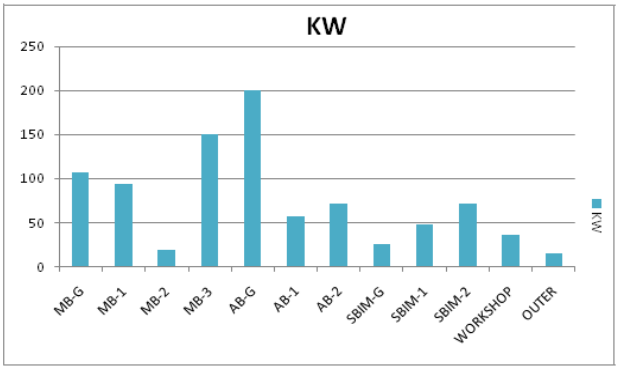


Figure 2: Connected Load on each block in Institution

Graphs from Institution College Energy Bills

The following graph represents the annual energy power consumption of institution in 2010 to 2014. In this graph 2013 to 2014 year power consumption is very high. The main reason for sudden increment of power consumption is under construction of college.

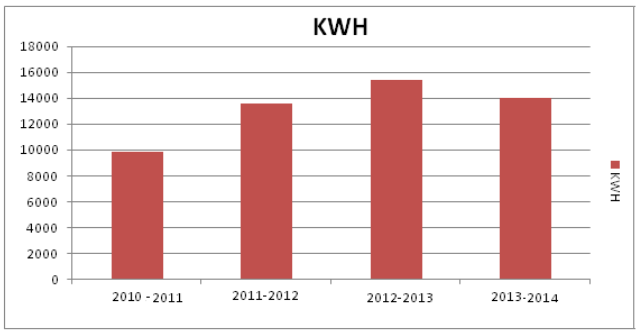


Figure 3: Annual Energy Consumption of institution in 2010 to 2014

The following graph represents the energy consumption of a month. It is useful to find out the base load and peak load of institution and how the load is varying from year to year.

Figure 4: Monthly Energy Consumption of our in 2013 and 2014

The following graph represents the comparisons between KWH and KVAH. It is useful to find out the power factor. It is clear that institution power factor approaches unity power factor as the KWH and KVAH curves were overlapped.

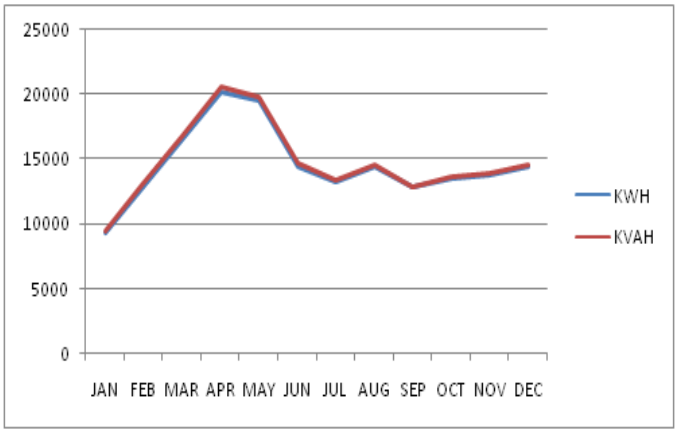
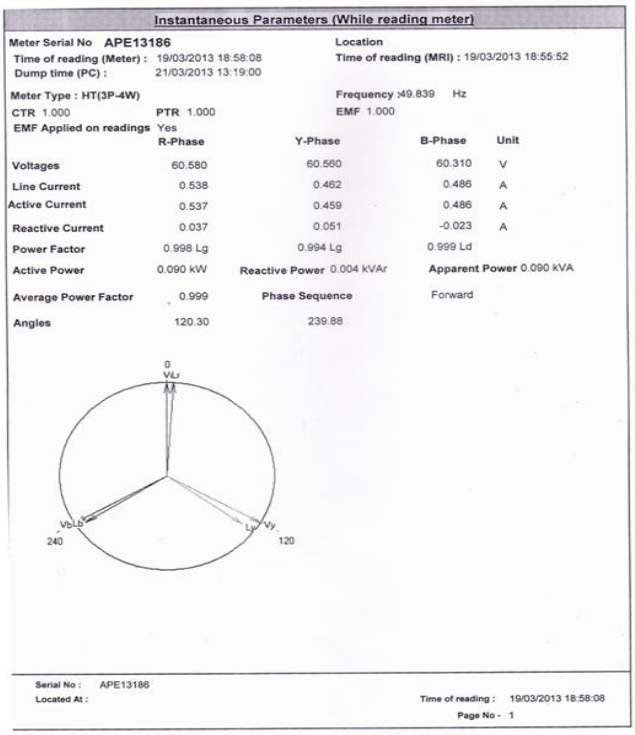


Figure 5: Comparisons between KWH and KVAH in 2014

Graphs from Institution Energy Meter

Institution is classified under HT 2 category. The abbreviation of HT is High Tension. Commercial Buildings, colleges, theatres, hotels etc., fall under HT 2 category.



Instantaneous Parameters (While reading meter)

Meter Serial No APE13186 — Location
Time of reading (Meter) : 19/03/2013 18:58:08 — Time of reading (MRI) : 19/03/2013 18:55:52
Dump time (PC) : 21/03/2013 13:19:00
Meter Type : HT(3P-4W) — Frequency :49.839 Hz
CTR 1.000 PTR 1.000 — EMF 1.000
EMF Applied on readings Yes

	R-Phase	Y-Phase	B-Phase	Unit
Voltages	60.580	60.560	60.310	V
Line Current	0.538	0.462	0.486	A
Active Current	0.537	0.459	0.486	A
Reactive Current	0.037	0.051	-0.023	A
Power Factor	0.998 Lg	0.994 Lg	0.999 Ld	
Active Power	0.090 kW	Reactive Power 0.004 kVAr	Apparent Power 0.090 kVA	
Average Power Factor	0.999	Phase Sequence	Forward	
Angles	120.30	239.88		

Serial No : APE13186
Located At :
Time of reading : 19/03/2013 18:58:08
Page No - 1

Figure 6: Instantaneous parameters from energy meter

Payback period calculations

The below tables are showing the wattages comparison, life period and cost of CFL's and incandescent bulbs in shown below.

Ordinary lamps	60W	75W	100W
Cfl lamps	13W	18W	25W

Table 3: Comparison of Wattages

Comparison of wattages
The following illustrates a cost benefit comparison of ordinary bulb with the CFL's.

Factors of comparison	Ordinary Bulb (100W)	CFL range (18)
Lamp life	1000 hours	8000 hours
Required no of lamps	8	1
Cost of lamps/lamp	8xRs10=80	1xRs235
Cost of electricity Rs.7 Per KWH + cost of lamp	Units=292 2044+80=Rs 2124	Units=52.56 367.92+235=Rs 602.92

Table 4: Comparison of Costs: For one year with 8 hours/day

Comparison of costs
Therefore the saving is 2124-602.92=Rs 1521.08. The payback period will be in matter of 4 months.

Aim is to reduce the consumption of energy and its cost. In this direction the new electrical technologies like low watt but high output lumen fixtures, highly efficient electrical equipment clubbed with intellectual energy management systems have to be considered more widely.

V. RECOMMENDATIONS FOR BETTER ENERGY EFFICIENCY

It is noticed that the usage of power beyond the limit set by the government rules. In general, for the institution sanctioned load is 125KVA but due to the power crisis in the present situation government had changed it to 80% of sanctioned load i.e. 100KVA. Present cumulative maximum demand is 129KVA. As the institution using more than the sanctioned load, institution paying fine of Rs1500/- for every increase of 1KVA load. So institution as to look at this overload.

Based on the analysis of the power consumption data, certain steps have been recommended for improving energy efficiency of the campus. Complete cost analysis of implementation of recommended measures has been performed wherever necessary. Also, a number of general measures for energy efficiency have been listed. Described below are some important recommendations for better energy efficiency

- Over power consumption while filling and cooling, if we utilize the water resource in proper manner, it will result in not only better consumption of power but also preservation of water resource for future generations.
- Substitute the batteries in UPS with standard one i.e. having good dielectric strength.
- During data collection, the repaired fans have been found to be consuming very high power as compared to the rated power. Keep them in proper maintenance.
- Engaging and training staff – teaching all employees to identify ways to save energy through maintenance and operational improvements throughout the campus.
- Better Practices for AC:
  - Good quality insulation must be maintained in the air conditioned rooms by keeping all doors and windows closed properly so as to prevent cool air go out and hot air come in.
  - Always keep curtains and sun control films on windows to prevent direct sunlight inside the room to avoid heating of cooled air. This reduces AC load significantly.
  - Proper maintenance and cleaning of ACs is required at regular intervals to make it work at highest efficiency. Any dirt in filter may reduce efficiency of ACs very significantly.
  - The ACs should be switched on 15 minutes before actual use and should be switched off before leaving the room.

It is the time to switch to the alternating energy resources like solar panels and wind turbines. Between them solar panels is the best alternate energy resource. Why because SBIT is spacious and is more suitable to place solar panels as well as solar heaters on top of its blocks. If they install solar panels major amount of load will easily run by solar panels and bulk equipments can run through power system.

Technical factors in conservation of Electrical Energy. Energy conservation in some other places in commercial and residential sector is

- Using automatic switch for street lighting reduce power consumption those operated by intensity of sun light.
- There should be greater use of day light illumination so that light load demands may be reduced in day hours.
- Regular cleaning of light and fixtures reduce the lighting requirement up to 20 to 30%.
- Always use light color paint for walls of the room because it helps to reduce lighting requirement up to 30 to 40%
- Since cooler pumps run continuously after switching on the power of fan and consume electrical energy but it can be saved up to 80% by using an electronic timer in series with pump. Now it switches on and off the pump intermittently instead of running continuously so it saves energy, water and life of cooler pumps.
- The excessive light for decoration should be avoided as far as possible.
- The low height partition will improve the illumination and reduces the load of air conditioners.
- Always update the appliances with energy efficient ones**.** Even though the initial costs are high but it can be beneficial in terms of less power bills.

VI. CONCLUSION

Power management is not only a major constraint but also a need to supply electric power to the satisfaction of consumer.

In this paper various issues discussed, analyzed and SBIT is taken as prototype to audit, recommended various energy management techniques for the efficient use of electric power. The energy management techniques suggested flattening the maximum demand so as to minimize the power bill.

Implementing the suggested techniques will not only result in reduce tariff but also will contribute for the society in terms of various direct or indirect efforts discussed including one of the major concerning area today's society i.e environmental pollution

REFERENCES

[1]. Clark, William. 'Retrofitting for energy conservation'. Mc Graw Hill. ISBN; 0-07-011920- 1 1998
[2]. Thumann, Albert, 'Handbook of Energy Audits.' Edit. The press, ISBN: 0-88173-294-X.
[3]. Annon, "Energy Audit Manual for Use in the Operation of Buildings," 1988.
[4]. O.I. Okoro, E.Chikuni, P.O. Oluseyi: Introducing an energy efficiency awareness programme at the University of Nugeria ,Nsukka (UNN), Inductrial & commercial use of energy conf. 2008, pp 99- 103.
[5]. Irawati Naik Prof. Mrs. S.S.More & Himanshu Naik "Scope of Energy Consumption & Energy Conservation in Indian auto part manufacturing Industry" Innovative Systems Design and Engineering ISSN 2222-1727 (Paper) ISSN 2222-2871

AUTHOR BIOGRAPHY

J. Nandana received her B. Tech degree from JNTUH, Hyderabad in 2007. She has completed her M.Tech in Power Electronics from JNTUH, in 2012. She is at present working as Assistant professor in Swarna Bharathi Institute of Science & Technology. She is also a life member of the Indian Society of Technical Education. Her areas o f interests include HVDC, power electronic devices, energy management and power electronics applications in control systems and power systems.

T. Charan Singh he did his B.Tech in Electrical and Electronics Engineering from JNTUH, Hyderabad in 2001.Obtained M.Tech in Energy Systems in 2006 from JNTU college engineering Hyderabad and pursuing Ph.D at JNTUH, Hyderabad. He has teaching experience of 13 years. He guided more than 20 UG projects and guided 07 PG projects. He has eight International Journal publications to his credit. At present he is working on the research problems of Multi phase transmission system and smart grid technology, he is at present working as Associate professor in Swarna Bharathi Institute of Science & Technology, Khammam, Andhra Pradesh-5007002.

Dr. Pannala Krishna Murthy has secured his B. Tech from SSGMCE- Shegoan. He obtained his masters degree from JNTU College of Engineering, Kukatpally, Hyderabad. He received Doctor of Philosophy in Electrical Engineering for his work titled "Analysis & Identification of HVDC system faults using Wavelet Transforms" from JNTU, Hyderabad in 2010. He got more than 26 Technical Publications to his credit at National / International level. He is supervising Ph.D. scholars registered with various universities of Andhra Pradesh. He guided more than 30 UG projects and guided 10 PG projects. At present he is working on the research problems of HVDC system fault analysis using wavelet transforms.