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Energy Audit-A Case Study

Ankur Soni[1], Mukesh Pandey[2], Anurag Gour[3]

[1]*M.tech scholar,* [2]*Professor & Head,* [3]*Assistant Professor, School of Energy and Environmental Management, UTD, RGPV Bhopal, MP, India*

Abstract **-Energy audit is a process of checking the way energy is used and identify areas where wastage can be minimize if not totally eradicate. Energy audit consists of several tasks which can be carried out depending on the type of audit and the function of audited facility. It started with review the historical data of energy consumption which can be compiled from the electricity bills. These data is important in order to understand the patterns of energy used and their trend. After obtaining the information on energyconsumption, the next step is to set up an energy audit program. This program shou ld start with site survey in order to obtain information on present energy used.The energy utilization such as running hours of air-conditioning, lighting levels, locations of unnecessary air-conditioning and lighting due to unoccupied areas, temperature and humidity, chillers/pump scheduling and setting, efficiencies of equipment's and machine and the areas of high energy consumption and the possibility to reduce consumption should be record for further analysis.The energy audit discussed in this paper will only focused in the RGPV library building and university of teaching department. It is carried out in aim of analysing and identifying possible energy saving measures in the library, which can later be implem ented for energy efficiency program in RGPV.**

Keywords **– Energy Audit, Methods of auditing, Data collection, Recommendations, Payback period**

I. INTRODUCTION

An energy audit is an inspection, survey and analysis of energy flow for energy conservation in an industry, process to reduce the amount of energy input into the system without negatively affecting the output. Energy audit is a testing and analysis of how the enterprises another organizations use energy.According to national energy conservation laws and regulations for energy, consumption investigation and energy audit management. [1]

The energy auditing is one of the first task to be Promoted in the accomplishment of an effective energy cost control program.An energy audit consist of a detai-led examination of a how facility uses energy, what the facility pays for that energy, and a finally, a recommend ed program for changes in operating practices or energy consuming .

Equipment that will cost effectively saves bucks on energy bills.With new technology and alternative ener gy resources now available, this country could possibly reduce its energy consumption by 50%. If there were no barriers to implementation [2] but off course there are bar riers mostly economical.

Energy auditing is an official method of finding out the ECO's.It is the official surv ey/study of the energy consumption processing/supply aspects related with of industry or organization.Purpose of energy auditing is to recommend steps to be taken by management for improving the energy efficiency, reduce energy cost and saving the money on the energy bills.

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 inaction plan to reduce energy consumption".[3]

II. METHODS OF ENERGY AUDITING

a) Preliminary energy audit
b) Detailed energy audit.
c) General energy audit [4]

1. Preliminary energy audit

The preliminary audit alternatively called a simple audit, screening audit or walk-through audit, is the simplest and quickest type of audit. It involves minimal interviews with site operating personnel,a brief review of facility utility bills and other operating data, and a walk-through of the facility to become familiar with the building operation and identify areas of energy waste or in effi-ciency. Typically, only major problem areas will be uncovered during this type of audit.

2. Detailed energy audit

Detailed energy is also called comprehensive audit or investment grader audit. It expands on the general energy audit. It covers estimation of energy input for different processes, collection of past data on production levels and specific energy consumption.It is a comprehensive energy audit action plan to be followed effectively by the industry. In detail audit we define energy use and losses through a more detailed review and analysis of equipme nt, systems, operational characteristics, and on-site meas urements and testing.

3. General energy audit

The general audit alternatively called a mini-audit;site energy audit or complete site energy audit expands on the preliminary audit described above by collecting more det ailed information about facility operation and performi ng a more detailed evaluation of energy conservation measures identified.

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Utility bills are collected for a 12 to 36 month period to allow the auditor to evaluate the Faci lity's energy/demand rate structures and energy usage pro files.Additional metering of specific energy consum ing systems is often performed to supplement utility data. In-depth Interviews with facility operating personn el are conducted to provide a better understanding of major energy consuming systems as well as insight into variations in daily and annual energy consumption and demand .[4]

III. Case Study

The Purpose of RGPV survey is to determine general condition of Institution with respect to energy performance and the institutional and potential willingness to improve the institute's energy performance.This Energy audit aimed at detail idea about various end use energy consu mption activities and identifying enumerating and eval uating the possible energy saving opportunity.

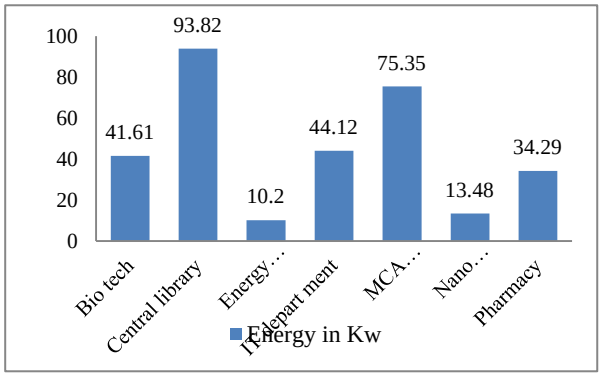

Fig.1 Department wise Energy consumption

1) Energy audit survey of Bio technology

Table. 1
Total Connected Load Of Bio Technology

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	27	1890	15.12
Tube Light T12	40	120	4800	38.4
CFL	18	19	342	2.73
2 BY 2 CFL	36	3	108	0.864
Printer	250	5	1250	10
Xerox	250	1	250	168
AC	1500	14	21000	8
System LCD CRT	250 350	37 11	9250 3850	74 30.8

2) Energy audit survey of Central Library

Table. 2
Total Connected Load Of Central Library

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	275	19250	154
Tube Light T12	40	1136	45440	363.52
CFL	18	15	270	2.73
2 By 2 CFL	36	10	360	2.88
Printer	250	2	500	2
Xerox	250	2	500	2
Halogen	500	15	7500	2
AC	1500	5	7500	60
System LCD	250	80	20000	160

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3) Energy audit survey of Energy Department

Table. 3
Total Connected Load Of Energy Department

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	15	1050	8.4
Tube Light T12	40	83	3320	26.56
CFL	18	2	36	0.28
Printer	250	2	500	2
Xerox	250	1	250	1
2 By 2 CFL	36	4	3000	1.15
System LCD CRT	250 350	4 3	1000 1050	8 8.4

4) Energy audit survey of Information technology

Table. 4
Total Connected Load Of Information Technology

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	29	2030	16.24
Tube Light T12	40	42	1680	13.44
CFL	18	81	1458	11.66
2 By 2 CFL	36	96	3456	27.64
Printer	250	2	500	1
Xerox	250	2	500	1
AC	1500	5	7500	60
System LCD	250	108	27000	216

5) Energy audit survey MCA department

Table. 5
Total Connected Load MCA Department

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	25	1750	14
Tube Light T12	40	20	800	6.4
CFL	18	108	1944	15.55
2 BY 2 CFL	36	49	3456	14.11
Printer	250	4	1000	2
AC	1500	6	9000	72
Xerox	250	2	500	1
System LCD CRT	250 350	223 1	55750 350	446 2.8
Tube Light T12	40	20	800	6.4

6) Energy audit survey of Nano technology

Table. 6
Total Connected Load Of Nano Technology

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy Consumption per month (kWh)
Fan	70	15	1050	8.4
Tube Light T12	40	18	720	5.76
CFL	18	31	558	4.4
2 BY 2 CFL	36	32	1152	9.2
Printer	250	4	1000	2
AC	1500	4	6000	48
System LCD	250	12	3000	24

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7) Energy audit survey of Pharmacy department

Table. 7
Total Connected Load Pharmacy Department

Load	Rating of the Equipment (W)	Number of equipment	Connected Load (W)	Energy consumption per month (kWh)
Fan	70	43	3010	24.08
Tube Light T12	40	103	4120	32.96
CFL	18	18	324	2.59
AC	1500	11	16500	132
Printer	250	10	2500	10
Xerox	250	3	750	3
System LCD	250	39	9750	78
System CRT	350	3	1050	8.4

IV. ELECTRICITY BILLS DATA COLLECTION

For energy auditing of RGPV it is necessary to analysis of consumption of electrical energy of previous year. The electricity bill data of RGPV is collected from Dec 2012 to Nov 2013.The collected data is visualized through graph then only wastage of energy consumption can be easily identify for making recommendation to high authority. The collected bill data of RGPV is taken from record of department. The graph for units consumed by RGPV during collected period given below.

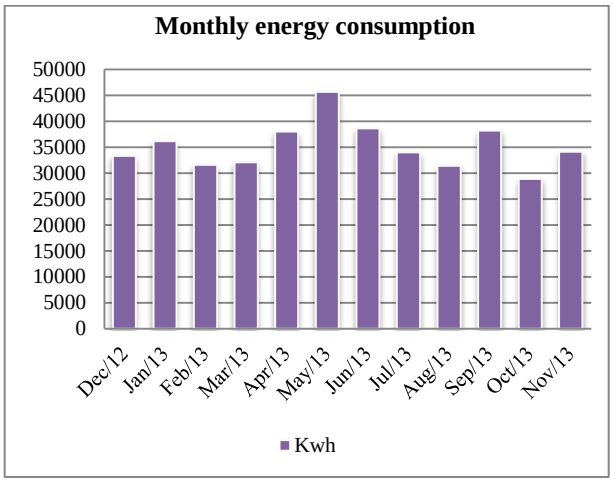

Fig 2. Units Pattern Characteristics

V. ENERGY SAVING CALCULATION

1. Energy saving by replacing T12 tube light to T5 tube light

Total no. of T12 tube light =1522
Total power consumption = 1522 x40W
= 60880 W
=60.88 kW
Total energy consumption= power consumption x operating hrs. =60.88 kW x 8 hrs.
=487.04 kWh
Energy cost / day (1kWh=Rs5.15) =5.15 x487.04
= Rs.2508.25/-
Total annual energy cost = Energy cost / day x no. of days =Rs.2508.25x288days

=Rs.7,22,377 /-

Total no. of T5 tube light =1522
Total power consumption = 1522 x28W
= 42616 W
=42.61kW
Total energy consumption= power consumption x operating hrs. =42.61 kW x 8 hrs.
=340.88kWh

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Energy cost / day =5.15 x340.88
= Rs.1755/-
Total annual energy cost = Energy cost / day x no. of days =Rs.1755x288days

=Rs.5,05, 440/-

Annual cost saving =Rs.2,16,937

Cost of T5 tube light =Rs.120

Total cost of replacement =120x1522
=Rs.1,82,640

Payback period = 8 month

2. Energy saving by replacing CFL to LED

Total no. of CFL =274
Total power consumption = 274 x18W
= 4932W
=4.9kW
Total energy consumption= power consumption x operating hrs. = 4.9 kW x 8 hrs.
= 39.2 kWh
Energy cost / day =5.15 x39.2
= Rs.206/-
Total annual energy cost = Energy cost / day x no. of days =Rs.201.8x288days
=Rs.58,118 /-

Total no. of LED =274
Total power consumption = 274 x7W
= 1918 W
=1.91kW
Total energy consumption= power consumption x operating hrs. =1.91kWx 8 hrs.
=15.34 kWh
Energy cost / day =5.15 x15.34
= Rs.79/-
Total annual energy cost = Energy cost / day x no. of days =Rs.79x288days
=Rs.22,752 /-
Annual cost saving =Rs.35,366/-
Cost of Led =Rs.490
Total cost of replacement =490x274
= Rs.1,34,260
Payback period = 3 year 7month

3. Energy saving by replacing normal fan to energy efficient fan

Total no. of Fan =429
Total power consumption = 429 x70W
= 30030W
=30.03kW
Total energy consumption= power consumption x operating hrs. =30.03 x 8 kWh
=240.24 kWh
Energy cost / day =5.15 x240.24
= Rs.1237/-
Total annual energy cost = Energy cost / day x no. of days =Rs.1237x288days
=Rs.3,56,256 /-
Total no. of Energy efficient fan = 429
Total power consumption = 429 x60
= 25740W
=25.74kW
Total energy consumption= power consumption x operating hrs =25.74kWx 8 hrs.
=205.92 kWh
Energy cost / day =5.15 x205.92
= Rs.1060/-
Total annual energy cost = Energy cost / day x no. of days =Rs.1060x288days
=Rs.3,05,280 /-
Annual cost saving =Rs.50976
Cost of Energy efficient fan = Rs.1200
Total cost of replacement =1200x429
=Rs.5,14,800
Payback period = 10 year

4. Energy saving by replacing CRT computer to LCD computer

Total no. of CRT computer =18
Total power consumption = 18 x350W
= 6300 W
=6.3kW
Total energy consumption= power consumption x operating hrs. =6.3kW x 8 hrs.
=50.4 kWh
Energy cost / day =5.15 x50.4
= Rs.259.56/-
Total annual energy cost = Energy cost / day x no. of days =Rs.259.56x288days
=Rs.74,753/-
Total no. of LCD computer =18
Total power consumption = 18 x250W
= 4500 W
=4.5kW
Total energy consumption= power consumption x operating hrs. =4.5kWx 8 hrs.
=36 kWh
Energy cost / day =5.15 x36
= Rs.185.4/-

Total annual energy cost = Energy cost / day x no. of days =Rs.185.4x288days
=Rs.53,395 /-
Annual cost saving =Rs.21358/-

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Cost of LCD computer =Rs.5000
Total cost of replacement =RS.5000x18
= Rs.90,000
Payback period = 4 year 2month

5. Energy saving by replacing Window Ac to Split Ac

Total no. of window Ac =19
Total power consumption = 19 x2000W
= 38000 W
=38kW
Total energy consumption= power consumption x operating hrs. = 38kW x 8hrs
= 304kWh
Energy cost / day =5.15 x304
= Rs.1565.6/-
Total annual energy cost = Energy cost / day x no. of days =Rs.1565.6x288days
=Rs.4,50,892 /-
Total no. of split Ac =19
Total power consumption = 19x1500W
= 28.5kW

Total energy consumption= power consumption x operating hrs. =28.5 x 8 kWh
= 228kWh
Energy cost / day =5.15 x228
= Rs.1174.2/-
Total annual energy cost = Energy cost / day x no. of days =Rs.1174.2x288days
=Rs.3,38,169 / -
Annual cost saving =Rs.1,12,723/-
Cost of split Ac = Rs.20,000
Total cost of replacement =Rs.20,000 x 19
=Rs.380000
Payback period = 3year 3month

VI. RECOMMONDATIONS

1) T5 Tube light are considered to be higher efficiency performance and consuming up to 28 wattss.T5 tube light have much longer life .The average life of T5 tube light 10,000 hrs. Cost of T5 tube lights cost between Rs 350-650 which is expensive as compared to a regular tube light. But their payback (by savings in electricity) happens in 6 months to 1 year if it is used daily in the evening for 4-6 hours at least. And they last for about 3 years. So it provides 2 years of savings if replaced for regular tube light. Also the initial cost is high because T5 tube light needs a different kind of frame as compared to T8 tube lights. But once installed, replacement tube (just the tube) costs much less (about Rs 100-150)
2) LED Bulbs are small, very efficient solid Bulbs LED technology is advancing rapidly, with many new bulb style.LED bulbs up to 10 times as long as CFL .LED bulbs use only 2-17 watts of electricity (1/3 to 1/30th of CFL). Although LED are initially expensive ,the cost is recouped over time.[5]
3) LCD monitors typically require about 30% of the power required for a CRT monitor with the same screen area. In addition, the amount of heat gener ated by an LCD monitor is considerably less than a CRT monitor, resulting in a lower load on air-condi tioning.Building cooling needs may be decreased by up to 20%.

Table. 8
Energy Savings Is Achieved By Follow-Up The Recommendations

Load	Before follow-up Recommendations		After follow-up Recommendations		% saving
	Energy consumed in kWh	Cost per Month	Energy consumed in kWh	Cost per Month	
Tube light	487.04	60198	340.88	42120	30
AC	304	37574	228	28180	25
System	50.4	6229	36	20256	28
Fan	240.24	29688	205.92	25440	14
CFL	39.2	4944	15.34	1918	61
Total	**1120.88**	**139533**	**826.14**	**117914**	**25**

VII. 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.3 the energy improvement is notified that the comparison of energy consumption be-fore and after follow-up the recommendations shown in table.8.Some major facilities is concerned here, the details of savings after implemented the recommendatio ns (follow-up) are the Tube light 30%, Air conditioning system 25%,Computer28%,fan14%,CFL 62%.There fore the 25 % of overall energy would be saved in the entire college campus.

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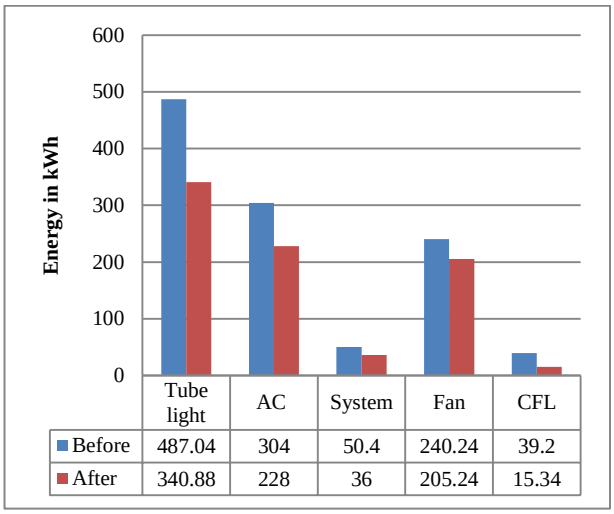

Fig.3. Result of Energy saving after Audit

VIII. CONCLUSION

The analysis and calculation of electrical energy conse- rvation of Rajeev Gandhi Prodhyogiki Vishwavidhalaya campus carried out there are many changes on lightning system such as replacing CFL to LED light these may reduce energy consumption 2% to 3% per year and replacing T12 tube light to T5 tube light these may gives cost saved Rs.216937/- per year. The total cost to be save after energy audit is Rs.4,37,383/-.

REFERENCES

[1] Zhang Jian, Zhang Yuchen, Chen Song, Gong Suzhou; "How to Reduce Energy Consumption by Energy Audits and Energy Management" Issue Date: July31 2011- Aug.2011 on page(s): 1 - 5 Date of Current Version: 12 September 2011.

[2] Barney L Capehar and Mark B. Spillter "Energy Auditing",

[3] www.bee-india.nic.in

[4] http://www.energymanagertraining.com/audit_guide/energy%20audit%20methodology.pdf

[5] Eartheasy.com/live_led_bulbs_comparision