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Energy Auditing on University Teaching Department and Central library of Rajeev Gandhi Technical Institute Bhopal

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Abstract: **Energy auditing has been conducted to Rajeev Gandhi Technical Institute to estimate the energy cons umed in day, week & monthly. The Energy auditing for day is index of consumption with normalizes the situation of energy crisis by providing the conservation scheme. This paper describe the process of energy audit approach es to determine worthiness of investment on energy saving measure & proposed the ways on how to improve energy uses.The discussion includes purposed new design sche me order to increase energy efficiency and achieve opti mum energy saving, for sake energy conservation and minimised downtime.Energy audit is a process of checki ng the way energy is used and identify areas where wast age can be minimize if not totally eradicate.Energy audit consists of several tasks which can be carried out depen di ng on the type of audit and the function of audited facility. It started with review the historical data of energy consu mption which can be compiled from the electricity bills. These data is important in order to understand the patter ns of energy used and their trend. After obtaining the info rmation on energy consumption, the next step is to set up an energy audit program. This program should start with site survey in order to obtain information on present ene rgy used.**

Keywords: Energy audit, Methods of auditing, Data collection, Recommendations, Payback period.

I. INTRODUCTION

The Energy audit is a process of examine an energy account, checking way energy used an identified area were wastage can be minimised.[1]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 ne gatively affecting the output.

The energy audit is a testing analysis how the enterprises other organisation use energy Acco- rding to national energy conservation law and regula tions for energy,consumption investigation and ene rgy audit management.[2]

Audit activities in general order include:

- Identification of all energy systems.
- Evaluation of conditions of the systems.
- Analysis of impact of improvement to those systems.
- Preparation of energy audit report.

Need for energy audit

In an organisation like Engineering college, top operating expenses is often found to be electrical energy .In most assessment of manageability of cost

saving in above component, would invariably emerge at top priority, and thus energy audit.

Energy constitutes a strategic area for cost reduction. A well done energy audit will always help owners to understand more about the ways energy used in their energy used in their organisations, and help to identify areas waste can occur and where scope can improvement exists.

The energy audit gives positive orientation to energy cost reduction, preventive maintenance and quality control programme which are vital for produc tion and utility activities.Such an audit programme will help to keep focus on variation that occur in ene rgy cost,availability and reliability of supply of ener gy, help to decide on appropriate energy mix, identify energy conversion technologies, retrofit for energy conservation equipment etc.

In journal energy audit is translation of conservation ideas and hopes into reality, by lending technically feasible solution with economic and other organisational considerations with specific time and frame. [3]

II. METHODS OF ENERGY AUDITING

Energy audit can be carried by different ways.Depen ding on time span invested auditing can be classified as [4]:

1) Preliminary energy audit
2) Detailed energy audit.
3) General energy audit

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 mini mal 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 fami liar with the building operation and identify glaring areas of energy waste or in efficiency.Typically, only major problem areas will be uncovered during this ty pe 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 produc tion levels and specific energy consumption. It is a comprehensive energy audit action plan to be follo wed effectively by the industry.In detail audit we define energy use and losses through a more detailed review and analysis of equipment, systems, operati onal characteristics, and on-site measurements and testing.

3) General energy audit

The general audit alternatively called a mini-audit; site energy audit or complete site energy audit expa- nds on the preliminary audit described above by collecting more detailed information about facility operation and performing a more detailed evaluation of energy conservation measures identified.Utility bills are collected for a 12 to 36 month period to allow the auditor to evaluate the Facility's energy /demand rate structures and energy usage profiles. Additional metering of Specific energy-consuming systems is often performed to supplement utility data. In-depth Interviews with facility operating personnel are conducted to provide a better understanding of major energy consuming systems as well as insight into variations in daily and annual energy consu mption and demand. [4]

III. CASE STUDY

The purpose of RGTU survey is to determine general condition of institution with respect to energy perfo- rmance and the institutional and potential willingness to improve the institute's energy performance.This energy audit aimed at detailed idea about various end use energy consumption activities and identifying enumerating and evaluating the possible energy savi ngs opportunity.By adopting energy audit method ology the measurement are taken from different loca tion of facilities. The energy utilities are found in for m of energy and cost shown in Table 1.

TABLE 1: Details of Energy consumption in Overall Institution:

Loads	Energy consumption kWh	Cost per Month
Light	537.44	6642
Fan	240.24	29688
Air conditioner	304	37574
System	122.3	120930
Xerox	24	2966
Printer	29	3584
Water cooler	64	7910

Note* Cost will be depending on tariff which is fixed by distributers.

In this paper have investigates the energy consump tion in both pre-audit and post audit.Initially collect all the information about energy facility and its meas urements are taken based on the specific energy cons umption instantaneously,to made bar charts and sug gested Energy conservation for which areas needed then constituted a framework on the recommendation of each facility.

Since the facility information is collected from different areas and made detail statistics provid- ed about consumption of energy in percentage, and there is no investment in measures. (Shown in Fig 1)

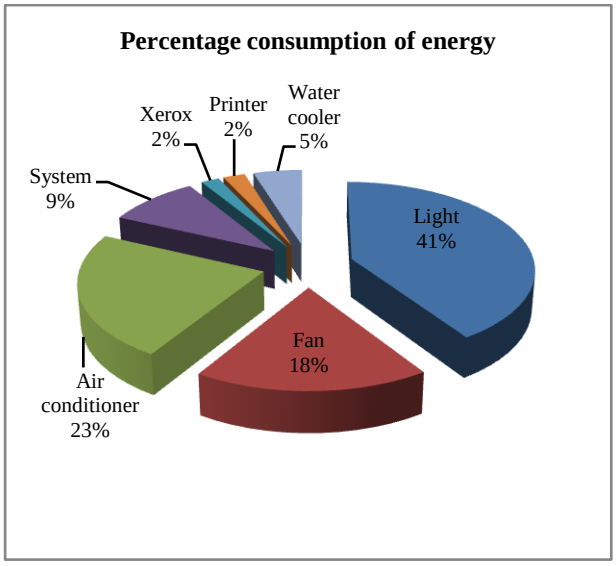

Fig.1 Distribution of connected load by end use in institution

It used to identifying the reasons and range energy consumption of each department as shown in fig.2. The Central Library was consumed more energy. Because of the most number of fans, Tube light and system (computer) loads operating were longer.

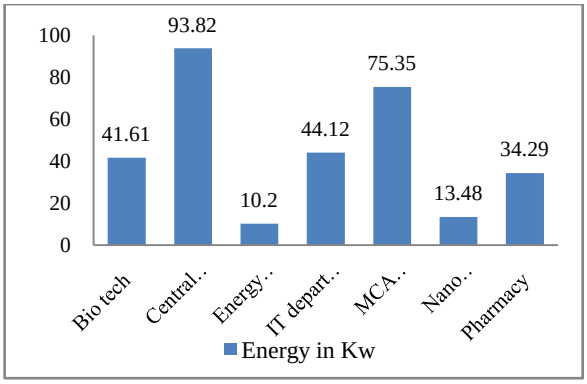

Fig.2 Department wise energy consumption

In this case study mainly focused on large consum- ption energy facilities or loads are concerned here for analyses which are followed the recommendations. There is1)Air conditioning system, 2)Lighting system.

1. Lighting system

The fig.1 shows that more energy consume by lighting system that is 41% of entire institution ene rgy consumption.The different types of lamps are using at various locations.So mainly focused on red uce the energy consumptions in lighting system usage pattern.The rate of energy consumption of air-cond itioning system was 537.44kWh/month.After implem ent overall energy consumption would be 356.4kWh saved per month.

2. Air -conditioning system

The Air-conditioning system is the second largest Power consumer in institution that is 23% which is shown in fig.1.The better energy conservation is to be followed by recommendation.After followed recom mendations the improved result as shown in fig.4.

IV. ELECTRICITY BILLS DATA COLLECTION

For energy auditing of RGTU it is necessary to anal ysis of consumption of electrical energy of previous year.The electricity bill data of RGTU is collected from Dec 2012 to Nov 2013.The collected data is vis ualized through graph then only wastage of energy consumption can be easily identify for making reco- mmendation 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.

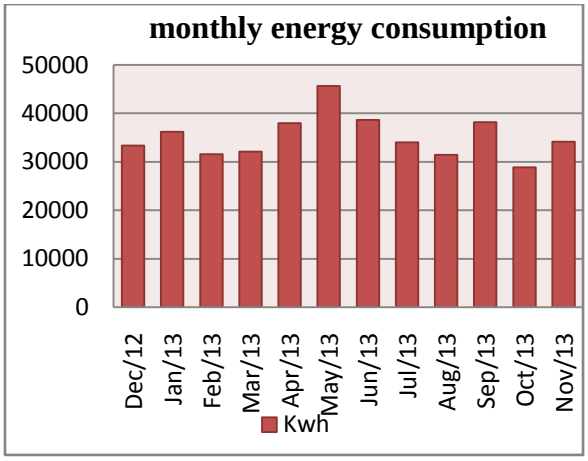

Fig.3 Units pattern characteristics

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
Energy cost / day (1kWh=Rs5.15) =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 savings = (Rs.722377-505440)
= Rs. 2,16,937

Cost of T5 tube light =Rs.120

Total cost of installation =120x1522
=Rs.1,82,640
Payback period = (182640/216937)
= 0.841 years
The additional cost incurred towards the replacement will be paid in 8 months time period.

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 (1kWh=Rs5.15) =5.15 x39.2
= Rs.201.8/-
Total annual energy cost = Energy cost / day x no. of days
=Rs.201.8x288days
=Rs.58,141/-
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.
=15.28 kWh
Energy cost / day (1kWh=Rs5.15) =5.15 x15.28
= Rs.78.6/-
Total annual energy cost = Energy cost / day x no. of days
=Rs.79x288days
=Rs.22,636 /-

Annual cost saving = (Rs.58141-22752)
=Rs.35,389/-

Cost of Led =Rs.490
Total cost of installation =490x274
= Rs.1,34,260/-

Payback period = (134260/35389)
=3.79 years
The additional cost incurred towards the replacement will be paid in 3year 7months time period.

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 (1kWh=Rs5.15) =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 (1kWh=Rs5.15) =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.356256-305280)
=Rs.50,976

Cost of Energy efficient fan = Rs.1200
Total cost of installation =1200x429
=Rs.5,14,800

Payback period = (514800/50976)
=10 years
The additional cost incurred towards the replacement will be paid in 10 year time period.

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 (1kWh=Rs5.15) =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 (1kWh=Rs5.15) =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.74753-53395)
=Rs.21,358/-

Cost of LCD computer =Rs.5000
Total cost of installation =RS.5000x18
= Rs.90,000

Payback period = (90000/21358)
=4.21 years

The additional cost incurred towards the replacement will be paid in 4year 2months time period.

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 (1kWh=Rs5.15) =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 (1kWh=Rs5.15) =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.450892-338169)
=Rs.1,12,723/-

Cost of split Ac = Rs.20,000
Total cost of installation =Rs.20,000 x 19
=Rs.380000

Payback period = (380000/112723)
=3.37 years
The additional cost incurred towards the replacement will be paid in 3year3 months time period.

VI. RECOMMONDATIONS

By following recommendation are suggested by Energy conservation opportunities with short term pay back. [5, 6&7]

1. Air conditioning system

- Prefer air split Air-conditioning system.
- Do not over cool-maintain ideal temperature 22^0C to 24^0C.
- Installation of energy saver for each AC
- Insulate wall & ceiling.
- Routine maintenance for air filters& cooling pins to make proper operation at regular interval.
- Use air curtains 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 climate conditions.
- Use pedestal fan instead of air-conditioners during non laboratory hours.

2. Lighting

- Switch off lights when absent from your work area for more than 30 minutes inclu ding 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 LED lamps instead of incandescent bulbs.
- Promote electronic chokes for florescent lamps instead of EMT chokes.

3. Computer 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 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.
- Advice on PC energy saving features like advanced LED monitor.
- 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.

4. Xerox machines (photocopiers),Printers

- 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.

TABLE.2. Energy Savings Is Achieved By Follow-Up the Recommendations.

Load	Before follow up recommendation		After follow up recommendation		%savings
	Energy consumed in kWh	Cost per month	Energy consumed in kWh	Cost per month	
Light	526.26	65041.2	356.16	44006	32
AC	304	37574	228	28180	25
System CRT	50.4	6229	36	4449	28
Fan	240.24	29688	205.92	25440	14
Total	1120.9	138532	826.08	102075	24

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 ene rgy utility cost.From the figure.4 the energy improve ment is notified that the comparison of energy consu mption before and after follow-up the recommenda- tions shown in table.2.Some major facilities is conc- erned here, the details of savings after implemented the recommendations (follow-up) are the Lighting 32%, Air conditioning system 25% ,Computer 28% ,fan 14%. Therefore the 24 % of overall energy wou ld be saved in the entire college campus.

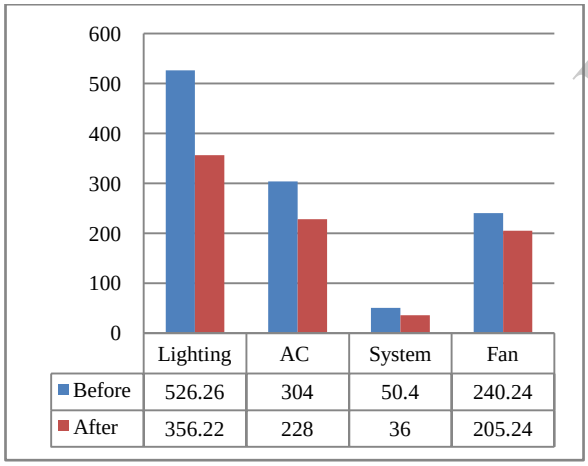

Fig.3. Result of Energy saving after Audit

VIII. CONCLUSION

The analysis and calculation of electrical energy cons ervation of Rajeev Gandhi Technical Institute campus carried out there are many changes on lightning system such as replacing CFL to LED light these may red uce energy consumption 2% to 3% per year and repla cing 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/-.

Acknowledgment

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Annexure – I

Typical Summary of Energy Expenses Based On Monthly and Annual Utility Bills

Mode of energy savings	Cost to be saved in Rupees	Investment in Rupees	Payback period
Replacing T12 tube light to T5 tube light	2,16,937	1,82,640	8 month
Replacing CFL light to LED light	35,389	1,34,260	3year 7month
Replacing Normal fan to energy efficient fan	50,976	5,14,800	10 year
Replacing CRT monitor with LCD monitor	21,358	90,000	4 year 2month
Replacing Window Ac to Split Ac	1,12,723	3,80,000	3year 3months