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Research Paper

Design of an energy efficient campus-based on energy audit report

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Abstract

Due to rapid urbanization and industrialization there is fast depletion of fossil fuels. Renewable energy resources contribute a considerable part in the Grid these days yet there is a mismatch between generation and consumption. The consumption of electrical energy is more than the electrical energy generated. It has become mandatory for us to conserve electrical energy in order to save the fuel reserves for our future generation. In this paper it is explained how an energy efficient institution can be made with the help of periodic Energy Audit

Keywords: *Annual Savings; Energy Auditing; Tariff.*

1. Introduction

The power sector has grown considerably in the past few years yet there is energy crisis existing in these days. This is because the technology has become a part of people's life and the utilization of electrical energy has been maximized. The demand grows at a faster rate than generation rate. If the energy crisis is not taken as a serious issue and the solutions are not framed, then it might end up in indeterminable blackouts which indirectly affect the economic growth of the country. The main reason for energy crisis is that there is no proper utilization of electrical energy and an ample amount of power gets wasted. The main reason for the wastage of electrical power is the usage of less efficient machines which consumes a lot of power than the rated power and lack of proper maintenance of the equipment. In this paper the remedial measures to make a building an energy efficient one by doing energy audit and implementation of the remedial measures has been discussed.

2. Energy audit

Energy Audit is the procedure of detailing the existing energy consumption of a building. It involves process inspection, survey and analysis of energy flow in a building. After analysis part is over, the factor for high energy consumption and the possible sites for energy wastages are identified and remedial measures are proposed. There are certain procedures that need to be followed for doing an energy audit and they are as follows:

Data collection: The first and foremost step in Energy Auditing is data collection (i.e.) the total number of loads that are connected to the utility and their duration of operation etc.

Analysis of the data collected: The load data collected is analysed for possible areas of conservation and power wastages.

Remedial Measures suggestion: The remedial measures suggested should be economical and should be easily available. The suggestion should undergo cost analysis and should be cross checked with the current energy consumption so that the payback of the conservative technique is less.

Workflow: In this paper, energy audit is being done for an institution where initially the entire load connected to the utility of the institution is being collected. Then the load is segregated as shown with their duration of operations. The flowchart of the process is as shown:

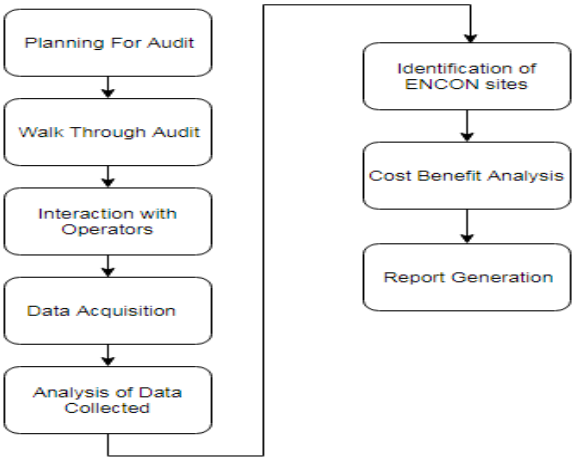


Fig. 1: Work Flow.

Chennai Institute of TechnologyA renowned and esteemed institution which has aconstructional area of 14 acres with student count more than 2000, molded by endowed faculties and dedicatednon-teaching staffs, which aims to provide quality technical education with adequateindustrial exposure.

3. Findings based on data acquisition

The total ballast light loads of the institution collected after survey was found to be about 31.82 kW. After gathering information about the duration of the operation per dayper month and the total estimated kWh is found to be about 5791.24 kWh. The tariff for commercial load is Rs.8 per unit. The total cost accounted by the lighting load is about Rs.46329.92.

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The total fan load connected to the utility is about 61.3 kW. The duration of operation per day per month as estimated by theoperators is about 11156.6 kWh. The operational cost of the fan load accounts in the monthly bill for about Rs.89, 252.80. The nextmajor loads of the institution are the air conditioner and the water cooling units. There are about 14 water cooling units which consume about 28 kW. They remain operative for 7 hours approximately. So the estimated kWh consumption is about 5096 kWh. The estimated cost of operating a cooling unit is aboutRs.40, 768. The air conditioning unit is the major source of load which is connected to the utility. The total air conditioning units installed in the institution consume about 368.1 kW. The total duration ofoperation of the ac units differs from season to season. For example, during summer, the AC units remain operative most part of the day. While in the winter, they are mostly inactive. The estimatedaverage operation of the air conditioning unit per month is about 47, 853 kWh. The overall average operational cost of the air conditioning unit per month is about Rs.3, 82,824.

The pumps used to pump water from the sump also contribute to a considerable part in energy consumption. There are about five 7.5 HP motor pumps available in the institution, out of whichmost of the pumps are operated for a period of 12 hours to meet the water requirements of the institution. The next most important load which is connected to the utility is computer. There are about 1091 computers available in the institution out of which 571 remains operative most of the time during the working hours of the institution and remaining 520 computers are operated occasionally. The average energy consumption of a computer is about 260 – 300 W. There are more than 200 laptops connected to utility which is a variable count. The average power consumption of a laptop charger lies between60 - 90 W.

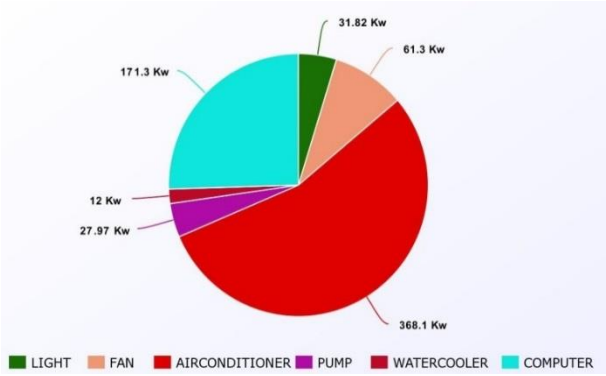


Fig. 3.1: Total Load Connected.

3.1. Recommendations

Lighting Load:Replacement with LED tube lights: All the lights used in most of the study rooms in the institution are T8 fluorescent tube light. If they are being replaced with T8 LED Tube Lights, then the power consumption can bereduced to a considerable level. An example of theannual saving is as shown
Cost of one T8 LED light which consumes 20 W is Rs. 425.
Total number of tube lights need to be replaced is 885.
Total investment to be made for the equipment is given as

885 * 425 = Rs. 3, 76,125

The total monthly saving if a LED tube light which consumes about 20W is as shown

885 * 20 = 17.7 kW

17.7 * 26*7 = 3221.4 kWh

(Considering 26 working days and 7 operational hours)
Total monthly bill estimated is Rs. 25,771.20
The total monthly saving is estimated to be

Rs. 46, 329.92 – Rs. 25, 771.20 = Rs. 20,558.72

The total annual savings estimated as shown
Total annual cost /kWh consumption of the institution is

37,170 kWh * 8 = Rs. 2, 97, 360

The total annual saving is estimated as

Rs. 5, 34,576 – Rs. 2, 97,360 = Rs. 2, 37, 216

Thus electricity bill is reduced to considerable amount if the following reimbursement is done.
Total payback period is calculated as shown

3, 76,125 / 2, 37, 216 = 1.6

This implies that the return of investment is just in 1.6 years.

- The cleaning of the tube lights over a period of time is required as dust particles offer hindrance to illumination by tube lights and reduce the lux of the tube light etc.

Fan load:
Replacement with Energy Efficient Fan: The currently used fan can be replaced by energy efficient fan which consumes only 50 W while the traditional one consumes about 75 W. The example for annual savings has been shown below
Cost of a 5 star rated fan is Rs. 2130
Total number of fans to be replaced is 817

Total investment to be made = 817*2130 = Rs. 17, 40,210

The total monthly saving if smart fan which consumes about 50W is being replaced is as shown

817*50 = 40.85 kW

40.85*26*7 = 7434.7 kWh

(Considering 26 working days and 7 operational hours)
Total monthly bill estimated is Rs. 59, 477.60
The total monthly saving is estimated to be

89, 252.80 – 59, 477.60 = Rs. 29, 775.20

The total annual savings estimated as shown:
Total annual cost /kWh consumption of the institution is

85785 kWh * 8 = Rs. 6, 86,280

The total annual saving is estimated as

Rs. 10, 29,840 – Rs. 6, 86,280 = Rs. 3, 43,560

Total payback period is calculated as shown

17, 40,210 / 3, 43,560= 5.1

This implies that the return of investment is just in 5.1 years.

- The cleaning of the fans is necessary because dust accumulation reduce the efficiency of the fan.
- Needless operation of the fans should be avoided.

Water Cooling Units: The water cooling units can be operated for less duration and number of water cooling units can be reduced to one or two and rest can be operated as normal water supplying unit.
Air conditioning units: Most of the air conditioning units are 2 stars rated. It has been 5 years since their installation. They can be replaced with 5 star rated AC units since they consume less energy. An example calculation is as shown.
Cost of one 5 star 2 ton AC consuming 1.7 kW is Rs. 45, 400.
Total number of AC units need to be replaced is 54.

Total investment to be made for the equipment is given as

54 * 45, 400 = Rs. 24, 51,600

The total monthly saving if a 5 star Air conditioning Unit which consumes about 1.7 kW is as shown

54 * 1.7 = 91.8 kW

91.8 *26 * 5 = 11, 934 kWh

(Considering 26 working days and 7 operational hours)
Total monthly bill estimated is Rs. 95, 472
The total monthly saving is estimated to be

Rs. 1, 23,552 – Rs. 95, 472 = Rs. 28,080

The total annual savings estimated as shown
Total annual cost /kWh consumption of the institution is

1, 37,700 kWh * 8 = Rs. 11, 01,600

The total annual saving is estimated as

Rs. 14, 25,600 – Rs. 11, 01,600 = Rs. 3, 24,000

Total payback period is calculated as shown

24, 51,600 / 3, 24,000 = 7.6

The total investment can be taken back in 7 years and six months. The calculation shown is for 2 ton split units alone.

- Replacement of all units is not feasible because it is not economical.
- Replacement of the units which has crossed its estimated over life cycle is recommended.
- Cleaning of air filters at regular interval of times so that there is no hindrance in air flow of the cooling unit.
- Checking of the insulations of the conducting ducts is essentials so that cooling loss can be minimized.
- Sites of cooling loss should be detected by inspection and proper sealing of the sites (i.e.) doors and windows should be done.

Table 3.2: Annual and Monthly Savings in Electricity Bill

BILLING TYPE	TYPE OF LOAD		
	Light	Fan	AC(2 TON)
Monthly Bill before alteration	Rs.46,329.92	Rs.89,252.80	Rs.1,23,552
Monthly Bill after alteration	Rs.25,771.20	Rs.59,477.60	Rs.95,472
Savings in Monthly Bill	Rs.20,558.72	Rs.29,775.20	Rs.28,080
Annual Bill before alteration	Rs.5,34,576	Rs.10,29,840	Rs.14,25,600
Annual Bill After alteration	Rs.2,97,360	Rs.6,86,280	Rs.11,01,600
Savings in Annual Bill	Rs.2,37,216	Rs.3,43,560	Rs.3,24,000

Tab 3.2 Annual and Monthly Savings in Electricity Bill
Electricity Bill analysis is the first and foremost step in energy auditing. Five months electricity bill is taken into consideration. The bill cost is as shown in the bar graph and if the following reimbursement is to be implemented then savings in the bill can be made as highlighted in the graph. [12]

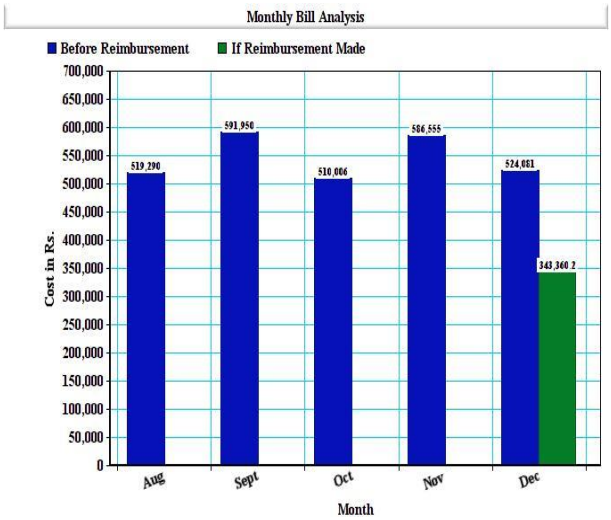


Fig. 3.2: Monthly Electricity Bill.

Pumps: These are essential loads and their operating time can be only be reduced by effective water management. Careful utilization of water should be insisted. Leakages in pipes and Taps are to be corrected.
Computer loads:The computers should be switched on and off whenever it's necessary only. It should not be kept in idle condition. Laptops should not remain in plugged in condition while it is put to use. It should be plugged in to the utility only when the battery backup is 10% and it should be plugged out when battery is fully charged.

4. Summarization

This is an initiative taken by the management to make the institution an energy efficient campus and from the audit the total load that is connected to the utility has been calculated. From the load calculated, the possible potential sites of energy conservation have been notified and remedial measures have been recommended. If the recommended measures are being implemented, then there will be considerable reduction in the electricity bill.

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