

Electrical Energy Audit a Case Study

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Abstract : In this paper, the importance of energy auditing and process of energy auditing are presented in detail. A sincere attempt has been made to conduct the Energy Audit at Nandi Institute of Technology & Management Sciences, Bangalore, to estimate the Energy consumed in a day, week and month. Identification of areas of energy wastage and estimation of energy saving potential in the Canteen, all Departments and Institute Central Facilities has been made by walk-through energy Audit. Also, detailed analysis of data collected is done by suggesting cost-effective measures to improve the efficiency of energy use. Estimation of implementation costs and payback periods for each recommended action has been made. The results & vital information generated through these activities are documented. The Energy Auditing for a day is the index of the consumption which normalizes the situation of Energy crisis by providing the conservation schemes.

Keywords: Energy audit, Energy Consumption, Energy management, Estimation, energy conservation

I. Introduction

An energy audit is a study of a plant or facility to determine how and where energy is used and to identify methods for energy savings. There is now a universal recognition of the fact that new technologies and much greater use of some that already exist provide the most hopeful prospects for the future. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the dissemination of these technologies and options.

This energy audit of the Nandi Institute of Technology and Management Sciences (NIT&MS) has been carried out and reported in this paper. We have compiled a list of possible actions to conserve and efficiently utilize our scarce resources and identified their savings potential. The next step would be to prioritize their implementation. I look forward with optimism that the institute authorities, staff and students shall ensure the maximum execution of the recommendations and the success of this work.

Nandi Institute of Technology & Management Sciences (NIT&MS) one of the pioneer private Engineering College in Karnataka was established in the year 2007 initially with three AICTE approved Degree Engineering course and one AICTE approved Management course. At present the college is running Five UG Courses and one Management course.

Before planning this project the various papers related to the Energy Audit available in the IEEE archives were studied. Most of the papers [1, 2] related to such studies made in different industries like, mechanical and heavy engineering. To the best of our knowledge no paper could be located on the energy auditing of educational institutions. However, the following paper was identified.

Dr. K. Umesha [3] has mentioned that the Energy auditing has been conducted at the Technical Institute Campus. In this paper the Energy Auditing has been dealt as the index of the consumption which normalizes the situation of Energy crisis by providing the conservation schemes. This has been done to minimize the unwanted power shutdown either incidentally or by load shedding. Here author has defined Energy auditing is one of the tools through which balancing of demand and supply is determined. The recommendations reduce around 15-20% of the energy and 25-30% of cost reduction.

In the paper [6] Equipment wise analysis has been performed in order to identify the electrical equipment's, within same application area, which consume more power as compared to others. During equipment wise analysis of the overall campus, the equipment's with power consumption less than 1% of total power consumption of the campus were ignored so as to make the analysis results simple and easy to observe.

A) Problem Formulation:

The total Electricity bill for the year 2012 is Rs. 1, 94,101 and power consumption for this year is 25047kWh. Subsequently, the institution is planning to start civil engineering in the year 2014 and the mechanical labs of heavy machines are being installed in the year 2013. The mechanical branch has just been started in the year 2012 but the total energy taken from KEB is only 49 units which will be insufficient for further usage including mechanical and civil department. In order to manage the power requirements, there is an absolute necessity to save the energy consumption. In order to achieve the required savings in power the different steps need to be taken. The details of all the components and factors involved need to examine.

B) Objective of this Project:

The main objective is to investigate the energy consumption of full campus by energy auditing. This energy audit assumes significance due to the fact that the NIT&MS electricity bill had crossed Rs. 1.90lakh during 2012 financial year. It was aimed at obtaining a detailed data about the various end use energy consumption activities and identifying, enumerating and evaluating the possible energy savings opportunities. The target is to achieve savings in the electrical energy consumption to the extent of 20% to 60%. The audit was also aimed at to learn or to get a feel of the practical problems and difficulties in carrying out energy audits.

II. Methodology Adopted

The methodology adopted for this audit was a three step process comprising of:

1. Data Collection – In preliminary data collection phase, exhaustive data collection was made using different methods such as observation, interviewing key persons, and measurements.

Following steps were taken for data collection:

- Visited each department, centre, laboratories, library, canteen, auditorium and other entities of the institution.
- Information about the general electrical appliances was collected by observation and interviewing.
- Obtained Site drawing of available building lay-out and Electricity distribution.
- Collection of Electricity bill from the in-charge personnel.
- The power consumption of appliances was measured using power analyser in some cases (such as fans) while in other cases, rated power was used (CFL for example).
- Information collected on redundant / non-operational energy systems
- The details of usage of the appliances were collected by interviewing key persons e.g. Electrician, caretaker (in case of departments) etc.
- Approximations and generalizations were done at places with lack of information.

2. Data Analysis - Detailed analysis of data collected was done. Energy consumption per month in kWh is calculated based on each department and block-wise.

The analysis of data is done in following way:

- Power Flow diagram
- Evaluation of collected data department wise analysis, block wise analysis and location wise analysis.
- Reasons for the Variance between connected load and actual consumption was evaluated.
- The database prepared was further studied and the results have been graphically represented.

This helped to identify the areas with maximum energy saving potential.

3. Recommendation – On the basis of results of data analysis and observations, some steps for reducing power consumption were taken. The recommended measures will not affect the present working conditions and at the same time substantial energy savings will arise.

Following were the steps involved in this process:

- The capital cost involved in replacing an appliance and/or process was estimated.
- The energy saving by the move was calculated in terms of price of energy per year.
- These two costs were compared to calculate the capital cost recovery time which is defined as the total time by which the saving in energy bill balances the capital cost involved.
- If capital cost recovery time is less than the product life, the move can be supported.

Some other recommendations were also made which are based on lighting intensity, computer usage, fans and motion sensors.

III. NIT&MS Energy Scenario

Nandi Institute of Technology started in the year 2007 and has taken the Electricity Installation of 49KW Power from Karnataka Electricity Board in the year 2007. Fixed Energy Charges for the 49 units is 1715 rupees and Energy Charges are Rs.5.70 paise per unit. The monthly recorded peak demand for the year 2012 is given in Figure.3.1.

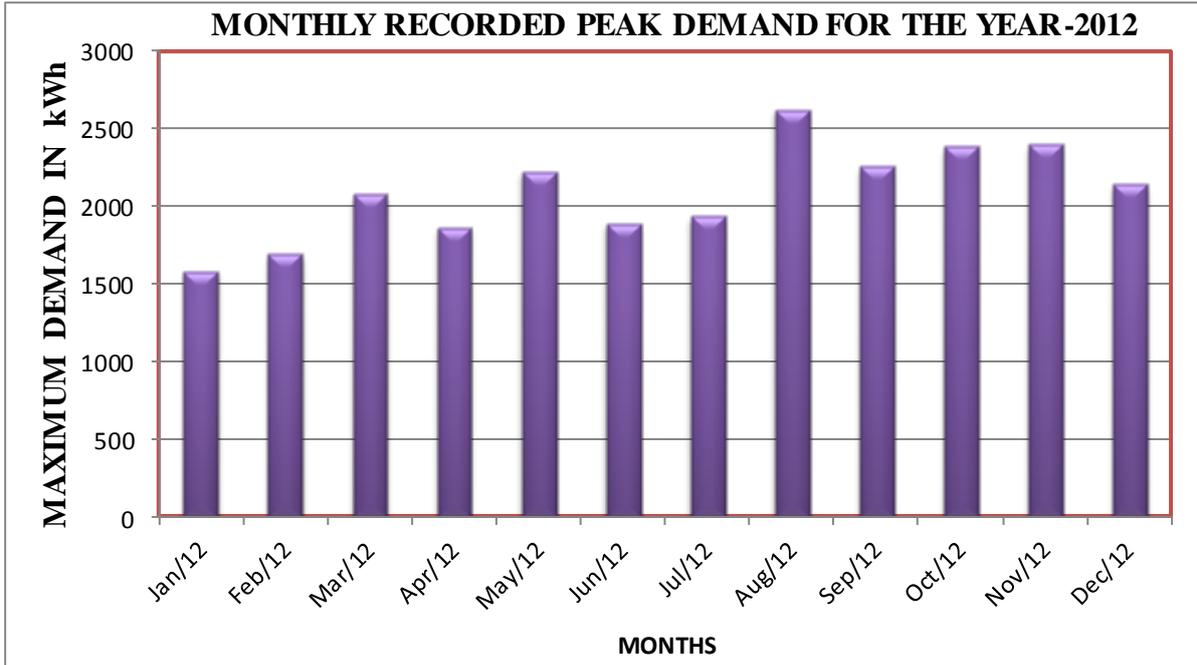


Figure.3.1. Recorded monthly peak demands at NIT&MS during the year 2012

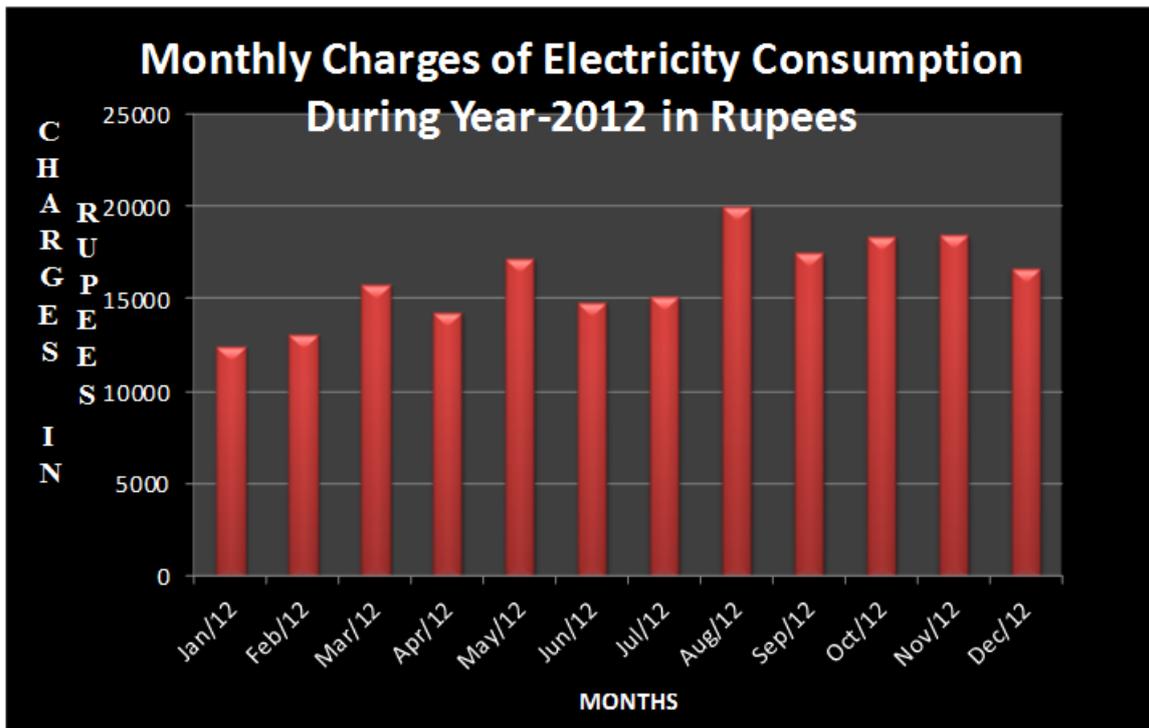


Figure.3.2. NIT&MS energy bill for the year 2012

IV. Energy Audit

1.1 Total average Electrical Energy consumption per month due to appliances of NIT&MS Campus

The sum of the total electrical energy consumption per month by each block of NIT&MS campus is given below:

$$(938.742+576.57+ 975.88+316.83+144.6+550.298 + 339.922) = \mathbf{3842.842kWh}$$

Total Connected Load for different Usage in kWh								
	Light	Fan	Lab computer	Lab Equipment	Xerox Machine	Printer	AC & LCD projector	Fridge & water pump motor
Ground Floor	94.27	140.52	493.2	-	15.6	49.14	92.16	76.8
First Floor	36.93	225.36	291.6	-	-	22.68	-	-
Second Floor	24.32	209.88	636.46	88.92	-	15.12	1.16	-
Third Floor	0.32	165.96	18	124.99	-	7.56	-	-
Block-2	20.16	32.64	47.04	-	37.2	7.56	-	-
Block-3	67.67	46.08	18	410.98	-	7.56	-	-
Block-4	189.4	7.2	-	-	-	-	-	143.2
Total energy Consumption	433.1	827.64	1504.4	624.89	52.8	109.62	93.32	220.0
percentage energy consumption	11.27	21.53	39.14	16.26	1.37	2.85	2.42	5.72

Table.4.1 Total Connected Load for different Usage in kWh

1.2 Load Distribution Chart

The Figure.4.1 below gives the clear picture of percentage of electrical power consumption between different loads or appliances present in NIT&MS Campus. The measure of highest power consumption is obtained from personal computers used in laboratories, office and library. The next highest power consumption is by the Fan load and Light loads respectively installed in the NIT&MS campus.

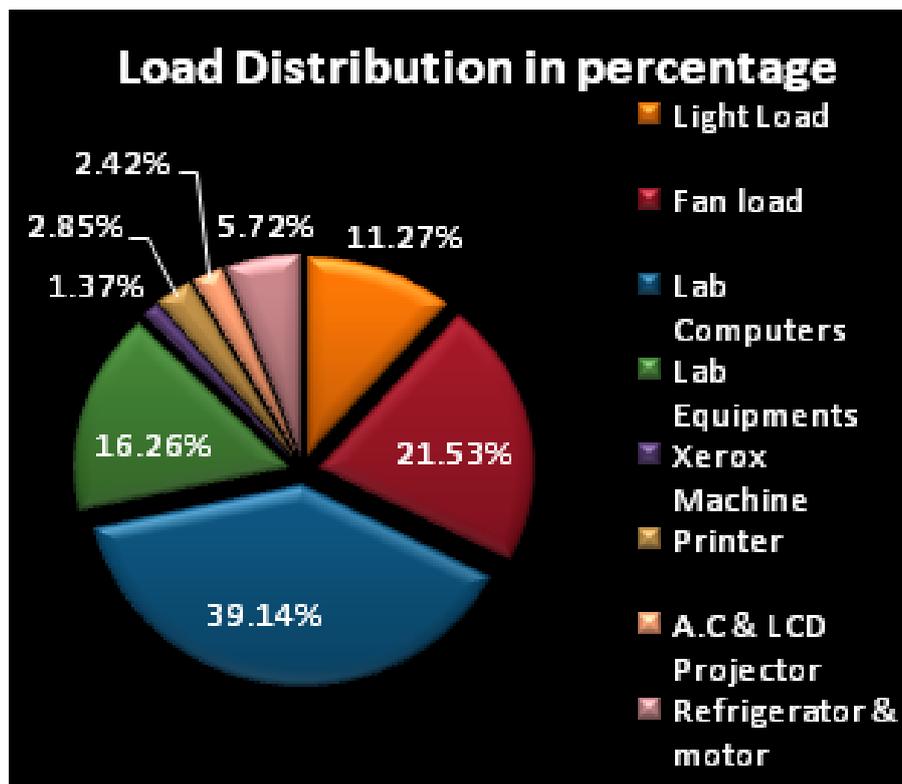


Fig.4.1. Load Distribution Chart

1.3 Variance between connected load and actual consumption

As seen from the results given above, there is an appreciable difference between the actual connected load and the actual power consumption. The various reasons and connected factors there to be given below:

- i. A location of the institute is in the interior rural belt, where the KPTCL power supply shut downs are very frequent. Sometimes these shut downs are extended over many days especially during monsoon seasons or due to some extensive repair works.
- ii. During such periods of shut down the back-up power from the diesel generator, installed in the campus, is utilized for running academic related essential requirements.

- iii. Many a time during such shut downs the power is utilized from the various UPS batteries installed at various locations which are charged from KPTCL power supply.
- iv. During night time shut downs generators are normally not operated, except in certain exigency cases.
- v. Thus KPTCL power supply actual consumption is drastically reduced because of interruption in regular power supply as stated above.
- vi. vi)The Total shortage of KPTCL power supply is only partially supplemented by power back-up's from diesel generator. This way the variation is further enhanced.

From above it is evident that there will definitely be a variation between the load capacity and KPTCL power supply. In this study this variation works out to **(3842.842kWh–2620kWh = 1222.842kWh)**. Thus the percentage of electrical power utilized from KPTCL is **68.17%**.

V. Recommendations For Better Energy Efficiency

Recommended Measure	Energy Savings /year in KWh	Savings in Rs. /year	Capital Investment in Rs.	Pay-back Period (years)
Replacing conventional choke of all FTL's by Electronic choke.	1209.6	6894.72	26,250	3.8
Use of motion sensors in corridors and toilets	1168	6657.6	1500	0.22
Avoiding Using photocopier Machine In The Sleepy Mode when not in use	57.6	328.32	Nil	Nil
Replacing all FTL's by LED lights of equal similarities	2563.2	14532	53400	3.67
Replacing all Laser Printers by Ink-jet Printers	2695.68	15,365	88,912	5.78
Replacing CRT monitors of PC's with LCD monitors	2741.76	15628	72,000	4.6
	10435.84kWh	59405.6 Rupees	2,42,062 Rupees	

Table.5.1 Recommended Measures

Implementation of all the above measures can bring about a total saving of around Rs. 45021.42 per year that is 23.19 % of the present electricity bill. The total investment is Rs. 188,662 for various appliances. The pay-back period for each appliance varies as shown in the Figure.5.2. The numbers on X-axis refers to the appliances.

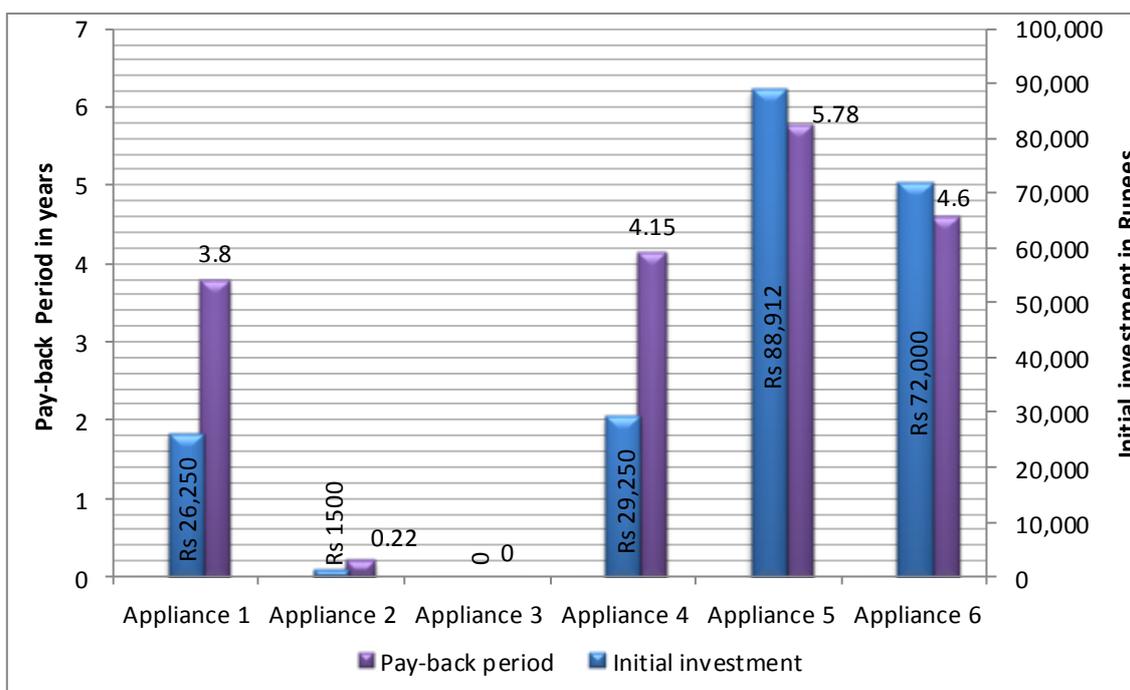


Fig.5.1. pay-back period for different appliances

VI. Conclusion

Energy audit is an effective tool in identifying and perusing a comprehensive energy management program. A careful audit of any type will give the organization a plan with which it can effectively manage the organization energy system at minimum energy cost.

In this paper, a detailed study has been made to reduce the electrical energy consumption in the complete campus of Nandi Institute of Technology & Management Sciences. It highlights the amount of energy savings that can be obtained in an educational Institution, thereby energy crisis can be reduced considerably.

The Following facts have emerged after the detailed energy auditing of said building

1. Energy saving per year is 10435.84 kWh
2. Total Cost reduction per year is 59405.67 rupees
3. Pay-back Period of various appliances.

The Proposed paper gives strong warning to the consumer not only in terms of the energy bills, but also the energy crisis in the near future to all sectors of people. By implementing the recommendations suggested in this project, there will be a reduction of around 41.66 % of the energy and 30.6 % of cost reduction. The total investment required for implementing the recommendations would be to the extent of Rs 2, 42,062 and The Pay-Back period for various appliances have also been calculated. Energy Auditing is a continuous process and organizations should carryout auditing periodically.

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