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Energy Audit: A Case Study of an Academic Building

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Abstract- The rapid diminution of fossil fuel resources on a worldwide basis now a days has necessitated an urgent search for alternative energy sources to cater to the present day energy demands. This paper analyzes the proper methodology to calculate the cumulative consumption of energy utilization in an academic building. The opportunities lie in the use of existing renewable energy technologies, greater efforts at energy efficiency and the distribution of these technologies and options. Energy Saving can be done by improved techniques and better instrumentation. It provides a comprehensive eco design of a smooth lighting & electrical system comprising appropriate electrical components which structurally improves the entire energy distribution system towards the destination of achieving energy efficiency.

Keywords— Energy Audit, Energy Consumption, Energy efficiency, Bill Saving, Payback Period, Energy Management.

I. INTRODUCTION

The purpose of the energy audit is to identify, quantify and line up cost saving measures relating to energy use. Now a days , due to the rapid increase of energy demand, Energy crisis becomes a major problem. For the rapid growth and development of technology, Energy is prime focused. The major aspects of any rising country is the proper utilization of energy. In order to meet the demand of ever increasing consumption, there is an increase in the need of energy. Over the last few years, subjects related to sustainable development and energy saving in our countries led to several research projects aiming to promote the amount of reduction of electrical energy utilized in educational buildings. Use of energy efficient equipment and conservation of energy can solve the main problem of Energy crisis [1]. Many different researchers made many case studies based on different techniques and energy audit schemes and gave their opinion on the Conservation of Energy. Biswajit Biswas, Sujoy Mukherjee, Aritra Ghosh [2] enlighten about the case study of energy conservation in campus lighting in an institution. Gousia Sultana, Harsha. H.U[3] made an approach about the electrical energy audit technology and implementation in institute. This paper concerns an assessment of energy consumption detect ambient daylight levels and to automatically adjust the artificial lighting output level to reach the desired illumination level that drastically reduces the electrical energy consumptions, which in turn reduce the cost of energy use. The study analysis has been performed on an Engineering College building namely Pailan College of Management & Technology Campus, Kolkata, West Bengal, India. (Fig1) The building comprises of four floor placed identically having more or less same electrical distribution system.

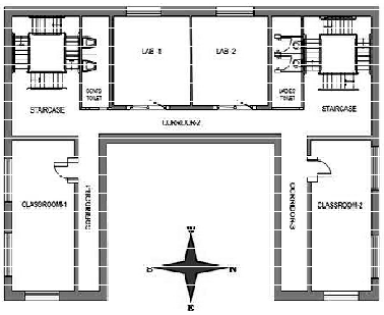

Fig.1 Floor plan of sample

II. ENERGY AUDIT AND ENERGY MANAGEMENT

1) Energy Audit

The inspection, survey and analysis of energy flow for energy conservation in an industry, is named as Energy audit. Energy audit is a process to reduce the amount of energy input into the system without negatively affecting the output. The testing and analysis of how the enterprises and other organizations use energy is called Energy audit.

Energy Management

The strategy using systems and procedures for adjusting and optimizing energy is called Energy Management, So as per the requirement, per unit output is reduced. Achieving and maintaining the requirement of load is the prime objective of energy management. As per the Energy Conservation Act, 2001, under Government of India, energy audit can be defined as "The verification, monitoring and analysis of use

of energy including submission of technical reports containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption."[4].

*2) **Energy Conservation***

Energy Conservation is the process of reduction of consumption of Energy without decreasing the quality and quantity of production.

III. ENERGY AUDIT METHODOLOGY

Energy audit is one of the useful tools for energy conservation for the achievement of energy efficiency. It comprises monitoring and analysis of various energy handling equipments and proper action plan to control the energy consumption in any building. Energy auditing for an institute can be achieve by accumulating data containing energy consumption followed by an quantitative analysis of those data to reduce the misuse of energy. Following methodology adopted for energy audit which comprises of :

1. Data Collection – In primary data collection phase, thorough data collection was performed using different approach such as observation and measurements. The steps for the entire data collection procedure are consist of :

a) Connected Electrical Load Measurement.

b) Electricity bill study for previous One-year (January'2018 to December' 2018)

c) Demand Measurement in seasonal basis.

2. Data Analysis - Detailed analysis of collected data was done which included Electrical Load survey for calculation of overall electrical consumption and demand monitoring using electrical bill analysis (January'2018 to December' 2018).

b) Study of power utilization in different season throughout the year for the noble approach of daylight implementation and demand monitoring.

IV. SYSTEM DESIGN

The proposed system is described in the block diagram given below

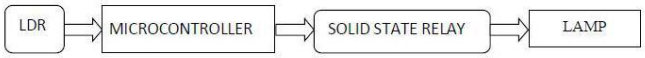

Fig. 2 Block Diagram representation of the System

Here the Light Depended Resistor (LDR) measures the amount of light availability in the room. The measured value is sent to the micro controller which further compare with the preset value and a signal will send to the master switch for further operation. Depending on the light intensity, the lamp can be turned on or off according to a preset of the signal. The entire process for light energy monitoring can easily be described with the help of a process flowchart as under.

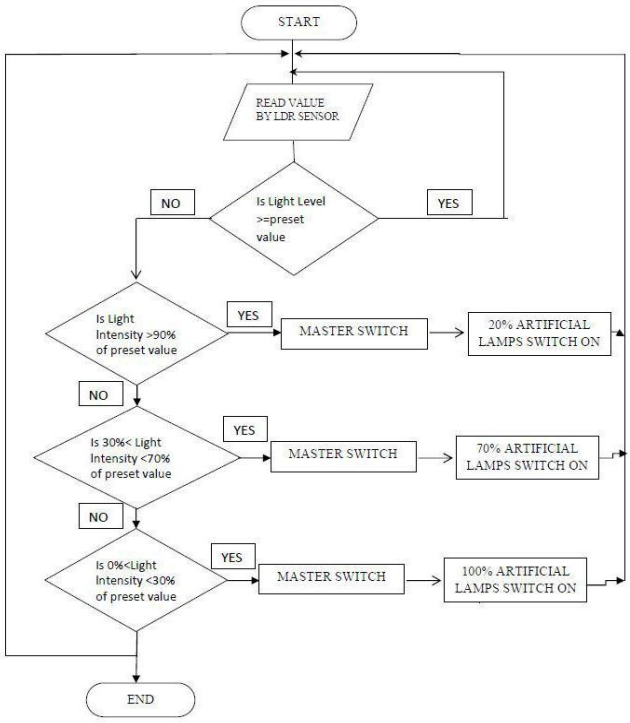

Fig.2 Flow Chart of proposed system

V. ANALYSIS OF POWER CONSUMPTION

Table 1: Last one year electrical bill analysis (2018)

SL.NO	Year	Month	KVAH	KWH	KVA	Max demend (KVA)	P.F	LF%	EC_Tariff (paisa)	DC_Tariff (paisa)	Total charge(Rs)
1	2018	JANUARY	11985	8435	39	255	0.7038	5.5952	655	317	187726
2		FEBRUARY	14915	11385	73	255	0.7633	7.1679	655	317	211561
3		MARCH	24100	21035	184	255	0.8728	13.1264	655/659	317	289358
4		APRIL	32525	29195	226	255	0.8976	16.1047	734	320	364233
5		MAY	31795	28710	256	256	0.903	16.6934	734	320	349210
6		JUNE	28665	25280	188	255	0.8819	14.6369	734	320	338305
7		JULY	26614	23033	176	255	0.8654	12.4248	734/732	320	320489
8		AUGUST	42091	38007	266	266	0.903	18.8377	732	320	448275
9		SEPTEMBER	32992	29758	267	267	0.902	17.1619	732	320	379612
10		OCTOBER	28638	25388	210	255	0.8865	15.598	732/730	320	338013
11		NOVEMBER	25277	21945	105	255	0.8682	13.3233	730	320	309275
12		DECEMBER	12470	9300	64	255	0.7458	6.5728	730	320	207049

By studying the bill of academic block we made the above table which shows the KWH ratings of a year. Analyzing this table energy consumption is evaluated. By analyzing monthly power consumption see that the power consumption is high from the month of April till September. We also analyze the KVAH, KVA and maximum demand monthly(KVA) . By bill study we can also calculate the total charges in Rs. per month.

Demand measurement:
The power consumption in winter and summer is shown below by table 2 and 3:

Table 2: Power consumption in Winter

Sl. No	Time	Feeder 1 Current (Amps)			Feeder 2 Current (Amps)			Feeder 3 Current (Amps)			Total Current (Amps)		
		R	Y	B	R	Y	B	R	Y	B	R	Y	B
1	10:00	30	25	26.1	29.2	28.4	20.6	No AC Load			59.2	53.4	46.7
2	11:00	32	28.7	24.3	29.6	28.9	23.6				61.6	57.6	47.9
3	12:00	35.5	36.9	25.2	32.9	32.6	25.2				68.4	69.5	50.4
4	1:00	34.8	36.2	26.4	31.8	34.8	25				66.6	71	51.4
5	2:00	35.9	35.9	25.4	33.8	36.1	24.3				69.7	72	49.7
6	3:00	36.4	35.8	24.9	34.9	37.1	24.2				71.3	72.9	49.1
7	4:00	32.5	29.3	23.6	32.2	29.2	22.5				64.7	58.5	46.1
8	5:00	30.1	29.1	22.6	31.5	28.4	21				61.6	57.5	43.6

Table 3: Power consumption in Summer

Sl. No	Time	Feeder 1 Current (Amps)			Feeder 2 Current (Amps)			Feeder 3 Current (Amps)			Total Current (Amps)		
		R	Y	B	R	Y	B	R	Y	B	R	Y	B
1	10:00	30	25	26.1	29.2	28.4	20.6	No AC Load			59.2	53.4	46.7
2	11:00	32	28.7	24.3	29.6	28.9	23.6				61.6	57.6	47.9
3	12:00	35.5	36.9	25.2	32.9	32.6	25.2				68.4	69.5	50.4
4	1:00	34.8	36.2	26.4	31.8	34.8	25				66.6	71	51.4
5	2:00	35.9	35.9	25.4	33.8	36.1	24.3				69.7	72	49.7
6	3:00	36.4	35.8	24.9	34.9	37.1	24.2				71.3	72.9	49.1
7	4:00	32.5	29.3	23.6	32.2	29.2	22.5				64.7	58.5	46.1
8	5:00	30.1	29.1	22.6	31.5	28.4	21				61.6	57.5	43.6

VI. RESULTS AND DISCUSSION

The above tables show the average power consumption in winter and summer time from which we can perceive the high time when the power consumed maximum. From the analysis of energy consumption different plot related to different parameters has been plotted which are shown below:

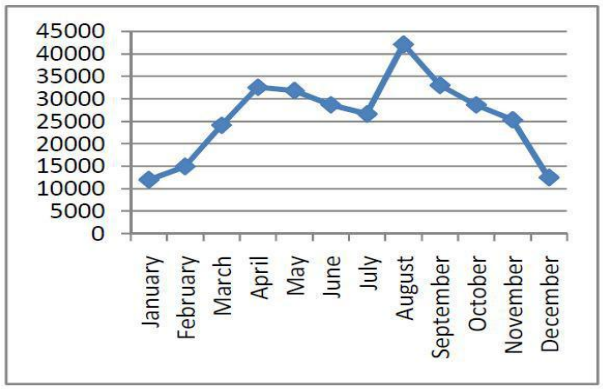

Fig3. : Annual Consumption of KVAH (Last one year)

By studying the above plot, one can easily notice that in the month of August the KVAH rating is higher in comparison with other months.

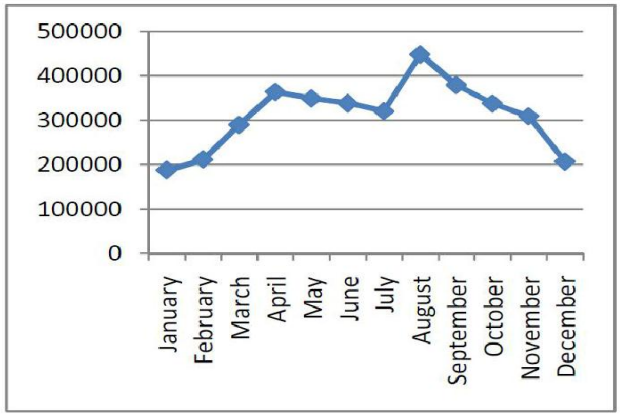

Fig 4: Annual consumption of Electricity bill

When we plot the amount of electricity bills we studied that the amount is high in the month of August due to high consumption of power which can also be realised by the KWH consumption plot shown below

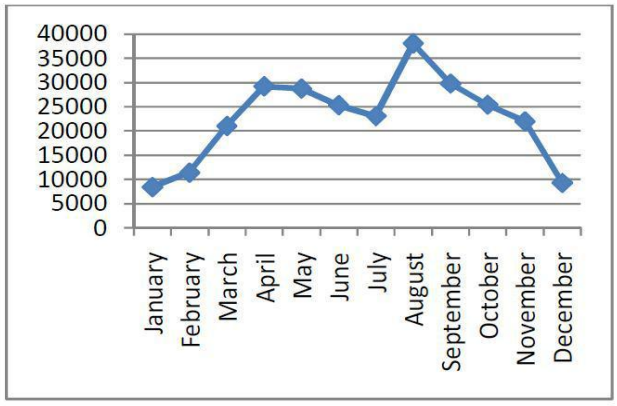

Fig 5: Annual consumption of KWH

It has also been studied that though the contract demand for the sample building is 300kVA, the average consumption of demand.

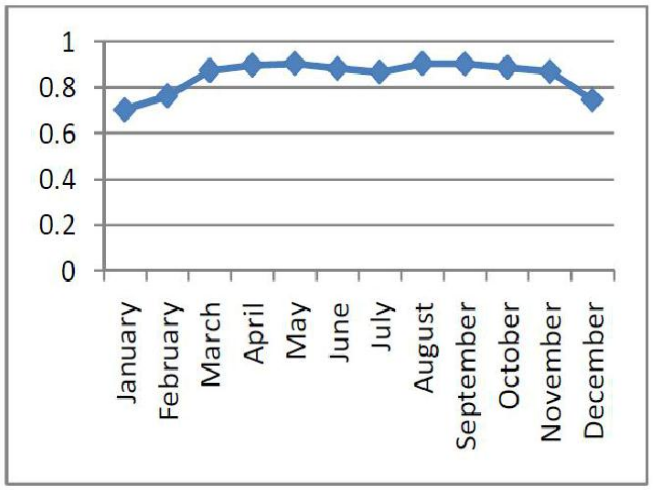

Fig 6: Plot of PF (Last one year)

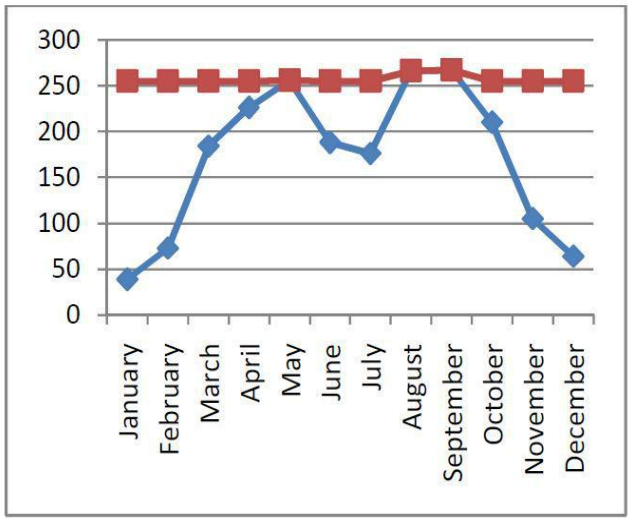

Fig 7: Plot of KVA & MD

In this plot the KVA ratings and the maximum demand curve is shown. The maximum demand is almost same throughout the year except the month August and September where the demand became little bit higher. The KVA rating is going from low to high till the month May and then it become little bit low in the month of June and July and then the KVA rating became high till September, after September it turn to low. The percentage of LF is higher in May and August. Its nature is kind of similar to the nature of KVA ratings curve.

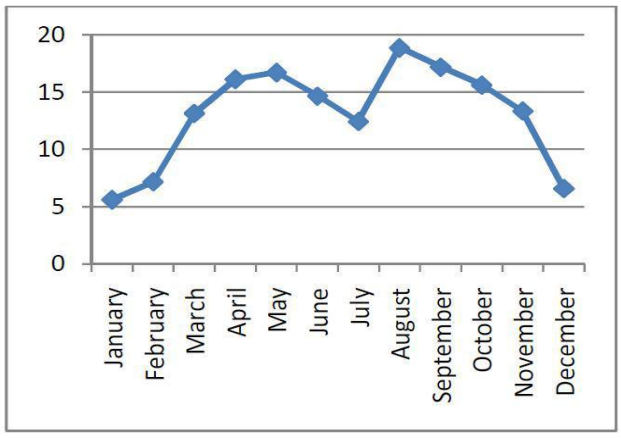

Fig 8: Plot of Percentage Load Factor

The transformer rating in our academic building is given below for ready reference

- **Transformer Rating:- 500KVA,11000/440V, 50Hz**
- **Supply Voltage:- 11kV**
- **Contract Demand:- 300 KVA**
- **Tariff Code:- E(C-EI)**

It has been observed that although the contract demand is 300kVA, monthly consumption of energy is in the range of 260kVA.

Table 4 shows analytical results of Monthly demand (kVA), Max Demand & Cost paid for Demand.

Jan'18	Feb'18	Mar'18	Apr'18	May'18	Jun'18	Jul'18	Aug'18	Sep'18	Oct'18	Nov'18	Dec'18
39	73	184	226	256	188	176	266	267	210	105	64
255	255	255	255	256	255	255	266	267	255	255	255
80835	80835	80835	81600	81920	81600	81600	85120	85440	81600	81600	81600

Contract Demand (kVA).	300 kVA
Normal Demand (kVA)	255 kVA (85% of Contract Demand).
Normal Demand rate	317 or 320 (Rs/KVA/month)

From the above table it has been observed that the total yearly (Jan' 18 to Dec' 18) cost for Normal Demand is Rs. **984585.00** .

The above study illustrate that there is considerable potential for improved energy savings from power management strategies. For optimum energy management different approaches has been proposed, which can reduce the cost for energy consumption as well as energy monitoring.

A proposed scheme is also illustrated which is shown in Table 5.

Jan'18	Feb'18	Mar'18	Apr'18	May'18	Jun'18	Jul'18	Aug'18	Sep'18	Oct'18	Nov'18	Dec'18
39	73	184	226	256	188	176	266	267	210	105	64
212.5	212.5	212.5	212.5	256	212.5	212.5	266	267	212.5	212.5	212.5
67362.5	67362.5	67362.5	68000	81920	68000	68000	85120	85440	68000	68000	68000

Proposed Contract Demand (kVA).	250 kVA
Normal Demand (kVA)	212 kVA (85% of Contract Demand).
Normal Demand rate	317 or 320 (Rs/KVA/month)
Yearly (Jan' 18 to Dec' 18) cost for Normal Demand (Proposed Scheme	Rs 862568/-

Using proposed data it has been analyses that cost for energy consumption can be rapidly reduced. With the help of proposed scheme the yearly (Jan' 18 to Dec' 18) energy consumption bill for Normal Demand is reduced to Rs. 862568.00 which indicates a Yearly Saving of Rs 122017.50

VII. CONCLUSION AND FUTURE SCOPE

The energy conservation helps in reducing the energy consumption and provides the savings. By adopting proper measures as on the basis of suggestion in the report, some steps containing proposal for reducing power consumption without affecting the comfort and satisfaction were recommended along with their cost.

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