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Energy Auditing and Assessment for Smart Building

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Abstract*: This paper identifies basic electrical infrastructure error in a building by the method of energy auditing done in a 15-Story Building as a reference. As per the NMEEE (National Mission for Enhanced Energy Efficiency) document, annual consumption of 89,823 KWh is predicted to reach by 2030. Energy Conservation Building Code has set minimum energy standards for a commercial building having a connected load of 100 KW or contract demand of 120 KVA and above. To obtain those standards a close inspection of the building was performed. Energy consumption growth rate in commercial buildings (8%) is more than that of Residential sector (5%), therefore in order to construct a smart building and have sustainable energy consumption the 15-story building was monitored closely for around five months. This was done in order to suggest new methods to reduce the overall power consumption and provide various techniques which could be employed to increase the efficiency of the building. To find out the power consumption of the 15-Story Building the total number of electrical and electronic appliances in the Smart Building were counted and penned down. Find out the total consumption by the electrical and electronic appliances in a given time period. Find out if the current power consumption is out of bounds. Develop new and practical methods which are to be employed to reduce the overall power consumption of the Smart Building. Compare the overall power consumption taken up if the new methods are to be implemented to the previously calculated power consumption.

Index Terms*: Energy Auditing, Smart Building, ECBC (Energy Conservation Building Code), NMEEE.

I. INTRODUCTION

Energy auditing is a crucial procedure for analysis of proper power consumption at a sustainable rate and development for a building or a country. It's a powerful tool for energy management, for the analyzation of energy consumption and to secure perfect energy saving options in buildings. Basically, there are several types of loads. The building may have a small load or can have larger loads. In a building, we have got an inductive, resistive and capacitive load. An Incandescent lamp is inductive in nature. Similarly, motor starters are capacitive load and a fan has resistive loads. Every load has a different power consumption. And after studying these loads we can modify the electrical loads, keeping in mind the cost of installation and cost of energy consumed with units of recovery. For the purpose of energy consumption in a building was closely monitored, loads are counted, the energy bill was analyzed.

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II. BUILDING AND LOAD

It is a 15-story rectangular building which is used for education purpose. It is a reinforced concrete system, build at an elevation from ground level. This building has the well set up of solar panel and windmills to harvest the highly efficient wind and solar energy of a city like Chennai with average wind 9.8miles/hour. The electrical load system of this building is primarily distributed in two basic structure. Lab System Classroom Lab system has periodic energy consumption only during lab hours which are in around five hours per day while in the classroom the energy consumption is throughout eight hours in continuation. There are various loads in there, in major which includes Lights, Fans, Air Conditioning, Electrical instruments in the lab, Computer systems, etc. Load system of the Building structure is given in the table. In pi-chart, it shows the power consumption by all loads.

TABLE I

APPLIANCES	TOTAL NUMBER	POWER CONSUMPTION (WATTS)	TOTAL POWER CONSUMPTION(WATTS)
FAN	**749**	**80**	**59920**
TUBE LIGHT	**2197**	**28**	**62276**
WIFI ROUTER	**119**	**12.5**	**1487.5**
SMALL TUBE LIGHT	**381**	**15**	**5715**
CCTV CAMERA	**204**	**40**	**8160**

DESKTOP	1629	150-200	325800
PROJECTOR	94	300	28200
PRINTER	18	30-50 300-500	9000
FIRE ALARM	670	0.4	260
WATER ALARM	1210	0.4	484
TELEVISION	5	100	500
SPEAKER	21	13	273

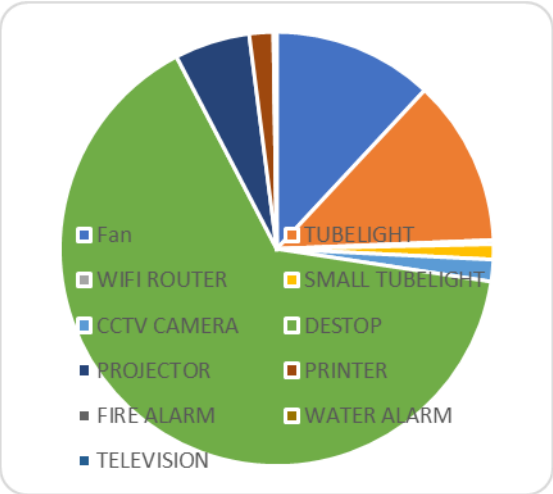

Fig. 1: Load Distribution

III. . ENERGY ANALYZER FLUKE-434-II

The Fluke 434-II is intended for clients who need to get to the arrangement of the power quality issue as fast as could be allowed with the goal that they can limit costly personal time. The estimation procedure and show of information are advanced to get to the most critical data as fast as could be expected under the circumstances. Numerous parameters are estimated all the while and showed in organizations that rapidly portray generally speaking force quality wellbeing while at the same time giving you the definite data you have to settle on better upkeep choices. Information can be immediately gotten to as straightforward advanced qualities, pattern charts that give you quick knowledge into changes after some time, waveforms, and phasor graphs or broke down and composed into unthinkable organization, for example, the occasion information where the extent, span and time stepping empower fast connection to the issues you are encountering in your office.

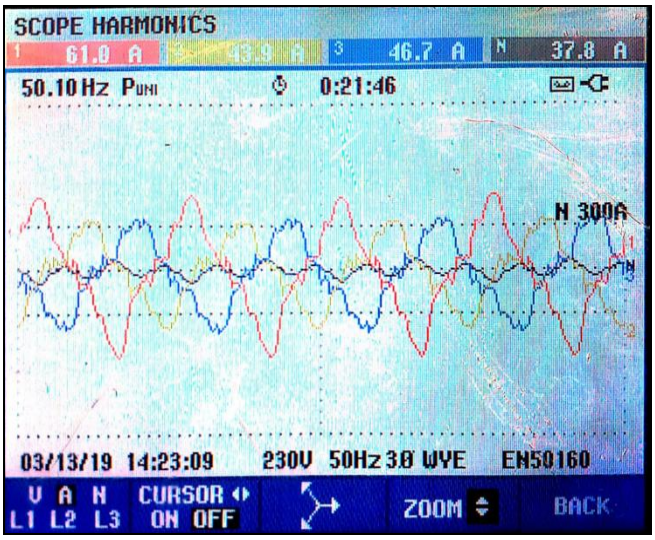

Fig.2: Harmonic system of the building

By the help of energy analyzer, readings were obtained for two halves, i.e., before noon and afternoon. The following points can be noted by the obtained readings: It was a well-planned building.at 50Hz, harmonics is totally fine. Around 50.9 Hz harmonics is a bit distorted, but it won't affect energy consumption. The harmonic graph is totally fine. There is an error of 0.01%. Electrical systems won't be affected at all but electronics systems may be affected. Nowadays, there are not much less efficient gadgets available, thus, the electronics part may be neglected. The red phase is extremely high and the blue phase is extremely low, thus a phase difference may be created. But yellow phase and neutral phases are at the center, it manages the phases differences. Phase distortion may affect the running of motors, but as the building is well planned, the other part of the yellow and neutral phase circuit manages it. The transient voltage and current reading are taken from it was perfectly fine.

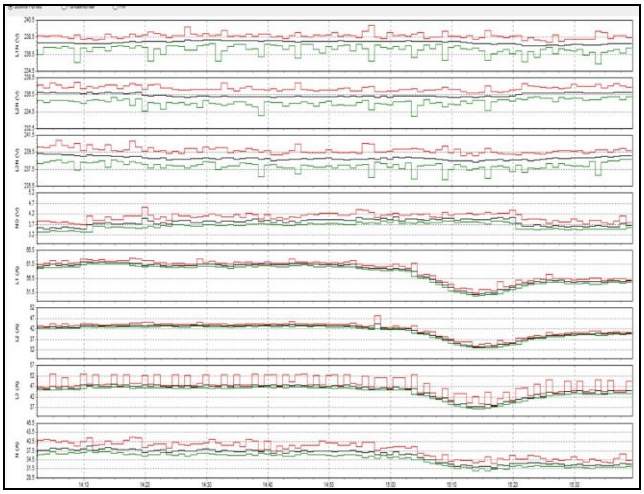

Fig 3: Current/Voltage Graph

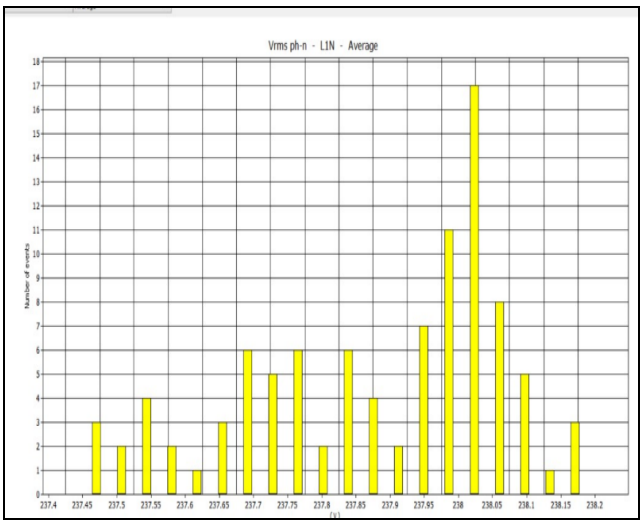

Fig. 4: Vrms For Peak Hour

IV. LIGHTS

In the building, most of the lights used are T5 tube lights in the building. Most T5 tube lights cost between Rs 350-650 (negotiate if you are charged more), 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. As deducted by our calculations the total power consumption of the tube lights of a 15 floors building is approximately equal to 533 Units. There is a total of 8 working months in a year, 2 months dedicated to exams and 2 months holidays. We, therefore, take the total number of weeks the tube lights are being kept on is 45. The total power consumed in 45 weeks can be given by: = Total number of days the light is being kept on*total power consumption in a day

= 315*533

= 1,67,895 UNITS

Cost of 1 UNIT as per Kanchipuram District is Rs 6.35.

Therefore, the total consumption cost of 45 weeks is given by:

= 1,67,895*6.35

= Rs 10,66,133.25 = Rs 1066K

Let us assume that the total time period of the led strips being one of a Smart be 8 hours.

Room Size (in sq. meters)	Fan Size (in mm)
<7	900
07-10	1050
10-12	1200
12-14	1400
greater than 14 sq. meters or Use 2 or more fans	>1400

There is a total of 8 working months in a year, 2 months dedicated to exams and 2 months holidays.

Power consumed by a foot of the led strip in an hour = 7.28 Watts/hour

Power consumed by 1175 led strips = 1175*7.28 = 8554 Watts/hour

Power consumed by 1175 led strips in 8 hours = 8554*8 = 68,432 Watts Therefore, total units = 68432/1000 = 68 UNITS We, therefore, take the total number of weeks the led strips are being kept on is 45. The total power consumed in 315 days can be given by : = Total number of days the light is being kept on*total power consumption in a day

= 315*68

= 21,420 UNITS

V. FANS AND SWITCHING SYSTEM

There are basically two types of fans system. One is ceiling fan while the other one is a pedestal fan. Both have almost the same power consumption of 80-100watt per hour. These fans consist of a considerable amount of power consumption. By using angle specification and blade length we can restrict energy wastage and can secure proper air circular for a given area. Switching system can be of two types. Multiple regulations from one switch and single regulation from a single switch. In the building, the switching system used is five fans per switch which increase energy wastage when there is need of only one fan at a time. For the purpose of energy auditing, a calculative analysis is done for an hour wastage of energy and then compared with the cost of installation of the switch. Power distribution for a system 4000 W consumed for 8 hrs Units consumed 25.4 Rs Charged 1260 units 7948 Rs charged A switching cost around 20 Rs. So, for installation, we need 14,980 Rs. For a classroom, therefore, 100Rs < 7,948 Rs

VI. AIR CONDITIONER SYSTEM

For air conditioning of rooms, two types of air conditioning system are used. One is window split AC and another one is central ac duct system. The Duct system is used in the majority. And it very important for a 15-floor building for proper air circulation and ventilation. The Central AC has better ventilation then the Window split AC. But the cost of installation and maintenance of Central AC exceeds the installation of window split AC. This systems refrigeration cycle should be increased in order to achieve higher efficiency. Along with it, the condenser should be properly periodically cleaned and the ducts should be managed. For room temperature and volume flow following management circuit are to be followed: Room temperature management circuit:

- temperature detector
- setpoint price claims adjustor
- temperature-controller

Volume flow management circuit:

- differential pressure electrical device
- volume flow controller
- mechanism

VII. CONCLUSION

In spite of the fact that building is very much arranged, there can be adjustments in it. Afterall nothing can be penny percent flawless. By the proposed changes, once cash is spent, yet on long haul premise, much vitality is saved. We are supplanting T5 tube lights by Drove strips. The multi-switch framework is changed to ordinary, 'one by one switch' as in this way energy wastage could be reduced. New fans installation should be done as per proper specifications for energy conservation. Duct system's condenser should be cleaned periodically and for new installation multiple outlets central AC should be chosen. Unnecessary, switch on of WiFi router should be avoided, in big University, commercial building. The router should be turned off during non-working hours. A regular energy auditing should be conducted to all commercial, big capacity building for proper sustainable development and new installations should be perceived and well planned.

When not in use, switches should be turned off of any electrical appliances. And the best way of energy conservation in a building is the IoT based system. More use of sensor switching should be included. Furthermore, solar powered or wind vitality framework for additional heap bearing framework, rather than Diesel generator, should be used.

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