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# Energy audit a case study of K. J. Somaiya College of Arts, Commerce and Science, Kopargaon, MS, India

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**ABSTRACT**

Climate Change & Global warming, ever increasing energy prices, acute energy shortage, forever widening and supply gap, hence energy efficiency and conservation measures have gained importance in the recent years. This paper involved an energy auditing with a view to enhance the existing energy efficiency level in the K.J. Somaiya College, Kopargaon. Energy auditing is a systematic study of existing energy consumption pattern. We know that electricity is unique source of energy to run college activities.
During the energy audit, a complete survey of power consumption in the College was carried out. Audit was conducted for lighting, fans, computers, Air conditioners, single phase, three phase water pump and the laboratory equipment and their power consumption pattern was determined. The present energy consumption pattern of institute was identified and suitable energy conservation measures were suggested for minimizing the power consumption in the college. Energy conserved is energy produced. This audit not only conserves energy but also produces energy.

**Keywords:** Energy audit, Energy Consumption, instruments, energy conservation

## 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 Zhang Jian *et al* [1-2]. 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.The energy audit of the K.J.Somaiya College 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. Before planning this audit, the various papers related to the Energy Audit available in the IEEE archives were studied [3-4]. Most of the papers [5- 6] 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. M.Bala Raghav *et al* [7] have 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. There commendations reduce around 15-20% of the energy and 25-30% of cost reduction. In the paper 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.

**Scope of Energy Audit:**

The work of energy audit has the objective of finding opportunities of energy conservation, saving and to recommend action plan with calculation of investment option and energy saving. The scope of energy audit is,

1. To study and audit MSEDCL bill.
2. Study of lighting system and its measurement.
3. Harmonic measurement and its study.
4. Splitting of air conditioner.
5. Identification of energy saving opportunity and energy conservation.
6. Load study and submission of technical report.

## METHODOLOGY

The audit involves visiting physical position of load and carry out inventory of load. Due measurement of electrical load of equipment and circuit is carried out. Energy bill received from MSEDCL is audited and studied for KWH requirement and how efficiently energy is used. Energy conservation and saving opportunities are identified during round and measurement for implementation.

**System Studied During Energy Audit:**

1. MSEDCL monthly electricity is studied and audited.
2. Lighting system in campus is studied and illumination is measured.
3. Motor pump set measurement and study.
4. UPS load measurement (harmonic measurement at UPS input and main feeder after MSEDCL meter).
5. Study of energy utilization requirement.
6. Split air conditioner operation.
7. Energy saving opportunities is identified.

The identified saving opportunities are summarized for review and implementation,

**Table 1:** Replacement of existing inductive choke with electronic choke of T-12 as well as T-12 bar with T-8 bar of fluorescent

| Existing item to be replaced | Number of items | Saving KWH | Saving in electricity bill per year | Total cost of T8 bar, electronic choke | Pay-back period |
|---|---|---|---|---|---|
| T-12 tube light | 65 | 741 | 7158 | 2925 | 5 month |
| Inductive choke | 81 | 2539 | 24527 | 14175 | 7 month |

**Table 2:** Energy saving by overhauling of bore well motor

| Motor rating HP | KW rating | Measured drawing power in KW | % overloading of motor | Wastage of power per year in KW | Wastage amount per year |
|---|---|---|---|---|---|
| 3 | 2.25 | 5.29 | 200 | 9120 | 88099 |

**Table 3:** Replacement of CRT with energy efficient LCD monitor

| Total CRT monitor | Watt of each CRT monitor | Total power in watt | Watt of each LCD monitor | Total power in watt | Saving in electricity KWH | Saving of bill per year | Pay-back period in year |
|---|---|---|---|---|---|---|---|
| 25 | 200 | 5000 | 55 | 1375 | 8265 | 79840 | 2.66 |

**Table 4:** Electrically Connected load Study

| Types of load | Administrative building | | Ladies hostel | | Science building | | Total | | Total load | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Watt | No. | Watt | No. | Watt | No. | Watt | Watt | % |
| FTL | | | | | | | | | | |
| 36 watt | 97 | 3492 | 14 | 504 | 39 | 1404 | 150 | 5400 | | |
| 40 watt | 41 | 1640 | 5 | 200 | 19 | 760 | 65 | 2600 | | |
| Total | | | | | | | | | 8000 | 14.30 |
| Choke | | | | | | | | | | |
| Electronic | 81 | | 14 | | 39 | | 134 | 00 | | |
| Magnetic | 57 | | 05 | | 19 | | 81 | 00 | | |
| Ceiling fan | 74 | 4440 | 17 | 102 | 30 | 1800 | 121 | 7260 | 7710 | 13.78 |
| Exhaust fan | | | | | 10 | 450 | 10 | 450 | | |
| CFL Lamp | 17 | 246 | 67 | 1704 | | | 84 | 1950 | 1950 | 3.48 |
| PC | | | | | | | | | | |
| CRT | 24 | 6000 | 1 | 250 | | | 25 | 6250 | | |
| LCD | 36 | 2880 | | | 45 | 3600 | 81 | 6480 | | |
| Total | | | | | | | | 12730 | 12730 | 22.75 |
| Fridge | 1 | 175 | 3 | 425 | | | 4 | 600 | | |
| Water Cooler | 1 | 300 | 1 | 300 | | | 2 | 600 | | |
| TV | 1 | 120 | 1 | 300 | | | 2 | 420 | | |
| Mixer | 1 | 650 | 1 | 750 | | | 2 | 1400 | | |
| Total | | | | | | | | 3020 | 3020 | 5.40 |
| AC | 5 | 5495 | | | 1 | 1200 | 6 | 6695 | 6695 | 11.96 |
| Hot plate | | | | | 1 | 1500 | 1 | 1500 | | |
| Oven | | | | | 2 | 3000 | 2 | 3000 | | |
| Auto clave | | | | | 1 | 1500 | 1 | 1500 | | |
| Incubator | | | | | 1 | 1500 | 1 | 1500 | | |
| Geyser | 1 | 2000 | | | | | 1 | 2000 | | |
| Total | 1 | 2000 | | | 5 | 7500 | 6 | 9500 | 9500 | 16.98 |
| Water Pump | | | | | | | | | | |
| 3-phase | 3 | 5250 | | | | | | 5250 | | |
| 1-phase | 1 | 1100 | | | | | | 1100 | | |
| Total | 4 | 6350 | | | | | | 6350 | 6350 | 11.35 |
| | | | | | | | | | 55955 | 100.00 |

**Table 5:** Graphical Presentation of Load Mix

| Sr. No | Types of Load | Total Load | |
|---|---|---|---|
| | | % | Watt |
| 1 | FTL | 14.30 | 8000 |
| 2 | Ceiling & Exhaust Fan | 13.78 | 7710 |
| 3 | CFL Lamp | 3.48 | 1950 |
| 4 | PC | 22.75 | 12730 |
| 5 | Other | 5.40 | 3020 |
| 6 | AC | 11.96 | 6695 |
| 7 | Heating Load | 16.98 | 9500 |
| 8 | Water Pump | 11.35 | 6350 |
| | | 100.00 | 55955 |

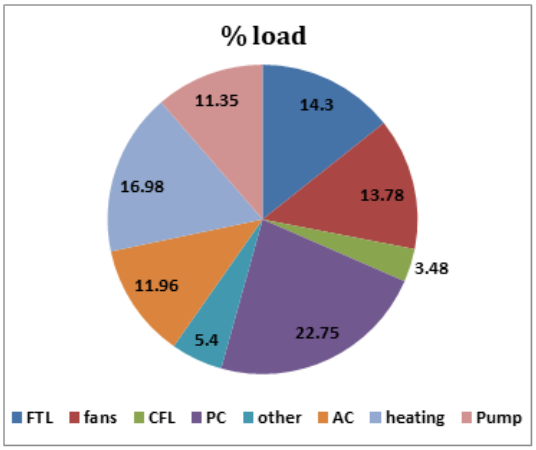


**Table 6:** UPS Load Measurement

| Location | Capacity | Battery | | | Input power measurement | | | | % Load |
|---|---|---|---|---|---|---|---|---|---|
| | | NO. | AH | Volt | KW | KVAR | KVA | P.F. | |
| BCA Lab | 7.5KVA, 1-phase | 16 | 190 | 12 | 1.9 | 2.15 | 2.97 | 0.64 | 37 |
| Computer Lab | | 20 | 100 | 12 | 3.39 | 3.43 | 4.82 | 0.7 | 64 |
| BCS Lab | | 16 | 100 | 12 | 2.47 | 2.6 | 3.59 | 0.68 | 49 |

**Table 7:** Water Pump Load measurement

| Location | Capacity in HP | Input Power Measurement | | | | | | % Loading |
|---|---|---|---|---|---|---|---|---|
| | | KW | KVAR | KVA | P.F. | Volts | Amp | |
| Indoor game hall | 2 | 1.48 | 0.56 | 1.58 | 0.64 | 226 | 7 | 84 |
| Indoor game hall | 2 | 5.29 | 6.14 | 8.73 | 0.6 | 221.7 | 11.3 | 200 |
| | | | | | | 230.7 | 11.4 | |
| | | | | | | 234.3 | 15.3 | |
| Near gate | 3 | 0.29 | 1.84 | 1.86 | 0.15 | 225.4 | 2.7 | No lead |
| | | | | | | 237 | 2.7 | |
| | | | | | | 231.6 | 2.7 | |

**Table 8:** Voltage Harmonic Measurement and Limit as Per IEEE 519-1992 Standard

| Location | Harmonic | Harmonic order | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| UPS-2 Com. Lab | Input voltage | 212 | 0.3 | 19.4 | 0.1 | 14.8 | 0.3 | 6.7 | 0.2 | 2.2 |
| | % THD | 11.7 | 11.8 | 12 | 11.4 | 12 | 11.9 | 12.4 | 1 | 11.7 |
| UPS-3 BCA Lab | Input Voltage | 228 | 0.6 | 12.4 | 0.1 | 13.2 | 0.1 | 1.6 | 0.2 | 5.9 |
| | % THD | 8.9 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 | 8.7 |
| Permissible limit | % THD | | | | | 5 | | | | |

**Table 1** shows that, when T12 tube and inductive choke are replaced by T8 tube and electronic choke the total saving of power in KW is 3280 and total saving of electricity bill per year is Rs.31685. from **table 2** it is observed that wastage of power per year is 9120 KW and wastage of amount per year is Rs.88099. Therefore servicing of 3 HP motor after three month is suggested. **Table 3** shows that when CRT monitor are replaced with LCD monitor, total power saving is about 8265 KWH and amount saving per year is Rs.79840 having pay-back period 2.66 per year. Physical chemistry laboratory with IR spectrometer and UV visible spectrophotometer are placed under controlled temperature with AC in cabinet. This cabinet was studied in point of energy consumption as AC is working 24 hours. It is observed that there is continuous cooling load of ambient air on AC due to lack of insulation to cabinet and leaking of cooled air from slit below doors. This is leading to wastage of energy at about 10%. So it is strongly recommended to insulate and seal inside space from outside to save energy and its cost. In other chemistry laboratory gas burners are used to heat up chemicals. The flames of burners are totally exposed to atmospheric air, so heat is carried out by flowing air around it and useful heat is wasted. So the stem of burner with flame shall be covered with cabinet to save loss of heat and LPG gas.

**Lighting Study and Measurement in Laboratory/ Classroom:**

It is suggested that natural light shall be used optimum and only additional light requirement shall be met with electricity to conserve and save energy. Illumination level is measured with Lux meter and found that overall illumination level is below standard which is to be required and maintain within 300-500 lux in laboratory and class rooms.

From **table-8,** it is observed that voltage harmonic are more than permissible limit, i.e. permissible limit is % THD = 5. The current harmonics are also beyond permissible limit. So it is suggested that harmonic mitigation technique is required at input of UPS to avoid over loading and excess drawn of power.

**Recommendations:**

1) Chairman cabin and administrative office is recommended to provide key tag switch to avoid unwanted operation and wastage of electricity.
2) T12 tube light and magnetic choke is recommended to replace with energy efficient T5 and electronic choke to conserve energy.
3) Submersible pump set is recommended to overhaul after three month to avoid wastage of energy due to poor performance.
4) Motor pump set is recommended to provide power capacitor.
5) It is strongly recommended to insulate and seal inside space of IR spectrophotometer and UV visible spectrophotometer cabin from outside to arrest loss of reconditioned air.
6) Air conditioner shall be operated between temperature range of 23-25$^0$C to maintain lower cooling load on compressor to save energy.
7) Submersible motor found overload which need urgent repairing.
8) Voltage and current harmonic measured are beyond permissible limit which needs harmonic mitigation treatment.
9) CRT monitor of PCS are recommended to replace with energy efficient LCD monitors to conserve energy.
10) Solar energy application is recommended for battery charging of UPS.

## 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 campus of K.J. Somaiya College. It highlights the amount of energy savings, thereby reducing the energy crisis considerably. After doing energy audit of institute the electrical energy saving per year is 20466KWH and total cost saving of electrical bill per year is Rs -199633.

**Conflicts of interest:** The authors stated that no conflicts of interest.

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