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Energy Auditing And Reactive Power Optimisation

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Abstract -*Nowadays, people are more concerned about energy efficiency, energy consumption and conservations in buildings. Energy Audit is considered as one of the comprehensive methods in checking the energy usage and wastage in buildings .Energy efficiency can be achieved by controlling maximum demand and reducing energy losses by improving the power factor of the total system. This project aims a comprehensive load study of our college .From the preliminary study ,the maximum demand 170 percentage of committed contract demand each month .Much more ,from past few years new buildings ,new loads has been installed ,which either points the importance of consideration of the contract demand or implementation of drastic energy reduction measures .As the former is much more adaptable ,a complete Energy Audit has to be done in order to find the scope of saving. After analysis of monthly bill ,it is seen that power factor on average is .92,which can be improved closed to unity as inductive loads are less. Rating of the capacitor panel to be installed has been found out which is to installed in the L.T side.*

Entire load systems were reviewed thoroughly on the basis of cost savings, investments and payback period of profit. The scope of demand management was evaluated with the help of TOD meter readings of two consecutive days .On the whole, a clear understanding was made on the areas to be concentrated to reduce the energy cost. An indoor substation that can account for future expansion has been designed .A real time monitoring system is proposed.

Key Words:**Energy audit, energy conservation, payback period, and consumption and substation design**.

1.INTRODUCTION

The growing energy demand and supply gap is one of the reasons for hike in price of fossil fuels. The increasing use of fossil fuels has caused air pollution leading to global warming. These sources of energy are not replenishable and thus the focus is shifting towards energy conservation and use of renewable energy. It is estimated that around 50 percentage of global energy consumption is due to buildings. Energy consumption in buildings varies according to climate, geography, building type and location. India ranks fifth as a global energy consumer. By 2035, India will become import-dependent. India's energy production would increase by 112 percentages, while consumption would rise by 132percentage. Indian government has initiated many policies and regulatory measures to ensure energy security but a large number of issues still remain and they require significant attention. Incorporation of energy efficiency measures in existing and new buildings will help India to achieve a reliable energy future.

Energy Audit can be classified into i) Preliminary Audit ii) Detailed Audit. Preliminary energy audit is relatively quick exercise; it estimates the scope for saving using the existing or easily obtained data and helps identify the areas for more de-tailed study. The detailed energy audit is carried out in three phases: Phase I - Pre Audit Phase, Phase II - Audit Phase, Phase III - Post Audit Phase. In this present study, the methodology used for detailed energy audit was adopted. This paper high lights energy saving potentials and feasibility of achieving the same in the existing public office building in India.

2.BUILDING AND UTILITY DATA ANALYSIS

Mar Athanasius College of Engineering, founded in 1961, has a well formed infrastructure, including academic buildings, workshops, canteen, library, hostels etc. Many of the blocks were built to cop up with the increased necessities over the years. With our initialstudies we couldsee tremendousdifference between the buildings that were built years ago and that of now. As we talk much on Green buildings, Energy efficient buildings, actually in many cases we fail to analyse buildings before their construction in that way.

A comprehensive study is required to identify the possible energy conservation opportunities. Through this project work, we attempt to present a base line energy audit of our college which is to be worked out further using qualified professionals.

2.2Energy Consumption Profile

Our College is being supplied by Single Electrical connection falling under HT- II(A) General Category. The Electricity is being supplied by KSEB Pvt. Ltd. Diesel is utilized for DG Sets of 180 kVA which is coupled with incoming lines. The connection is provided with a 11kV supply having contract demand of 120kVA. The average monthly energy consumption comes around 37675 units. More over the average monthly maximum demand comes around 218kVA with an average power factor of 0.91.

2.3 Bill Analysis

Electricity bills of college over an year were collected and went for an detailed analysis. The details including Energy consumption, Maximum demand, Power factor, Purchase cost, Unit cost and Load factor were analysed and tabulated as in table. 1. It is clear that the electrical energy use increases during the summer months when the outdoor temperatures are high. Moreover during academic breaks the consumption is low which is attributed by office equipments and lightings.The first step in the building energy audit process is to collect all available information about the energy systems and the energy use pattern of the building for certain period of time. The energy consumption of the facility during the period 2015-16 has increased due to introduction of new buildings which accounts for new loads. The average monthly energy consumption comes around 37000 units. The purchase cost of each unit counts Rs 5. Obviously there is hike in energy consumption during summers. This information was collected before the field survey.

Table1:

Energy Consumption Details 2014-15

Month &Year	RMD			Energy consumption (KSEB)	Average power Factor	Purchase Cost	Unit Cost
	Normal	Peak	Off peak	kWh		Rs.	Rs./kWh
OCT'14	212.28	89.22	65.44	30772	0.91	158188	5.140649
DEC	156.27	88.4	76.18	36872	0.91	189244.1	5.132461
JAN'15	201.12	59.22	69.25	27324	0.91	140148.7	5.129141
FEB	184.07	93.51	82.86	31830	0.91	163763.7	5.144947
MAR	273.34	148.24	80.78	45210	0.93	235606.8	5.211386
APR	278.76	102.1	86.65	51724	0.93	266779.5	5.157751
MAY	182.65	105.72	66.1	34342	0.93	176004.6	5.125055
JUN	104.15	79.02	67.57	30502	0.94	155827.3	5.108756
JUL	286.92	85.42	70.52	31562	0.9	162600.8	5.151789
AUG	236.6	78.42	72.42	35542	0.9	183031.4	5.14972
SEP	242.92	90.34	74.58	34604	0.91	179447.7	5.185749
OCT	254.96	100.46	74.02	43858	0.92	228189.3	5.202912
NOV	239.76	86.8	72.3	46606	0.92	242469	5.202528
DEC	196.47	87.09	62.95	40084	0.93	208936.8	5.212474
JAN'16	154.06	83.04	66.89	33806	0.92	175197	5.182423
FEB	226.64	86.18	53.47	35610	0.91	185423.2	5.207055
MAR	282.3	109.46	78.28	50242	0.93	261851.9	5.211812
Average	**218.4276**	**92.50824**	**71.78**	**37675.88235**	**0.918235**	**194865.3**	**5.168036**

2.3 Load Factor

The load factor is a tool for analyzing the electrical power demand. It can be measured according to the time period considered, daily, monthly, yearly etc. Higher Load Factor measure system stability, while lowload factorindicates that there are fluctuations in power demand requiring a larger supply over certain periods. A good load factor implies a more constant rate of electrical usage. The uneven and fluctuating low load factor is due to variable load demand of the utility. Only during normal zone, bulk of energy is consumed. During 9.00 am to 4.00 pm, demand is high due to the working of labs, workshops, classrooms, seminar halls and more. While night time, early morning accounts a low demand because energy consumption is limited to hostels only.

3.ENERGY AUDIT

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It quantifies energy usage according to its discrete functions.

Industrial energy audit is an effective tool in designing and pursuing comprehensive energy management program.Moreover, several large industrial and commercial buildings have established internal energy management programs based on energy audits to reduce waste in energy use or to comply with the specifications of some regulations and standards. Some on the other hand take advantage of available financial incentives typically offered by utilities or state agencies to perform energy audits and implement

energy conservation measures. This audit is the most comprehensive but also time-consuming energy audit type.

Specifically, the detailed energy audit includes the use of instruments to measure energy use for the whole building or for some energy systems within the building (for instance, by end uses: lighting systems, office equipment, fans, air conditioners, etc.). We tried to make detailed data set of all the equipment running all over the college based on their consumption. All the blocks were categorised on the basis of their individual demand. The techniques available to perform measurements for an energy audit are diverse. During the onsite visit, handheld Power Quality analyser and clamp-on instruments were used to determine the variation of some building parameters such as the harmonics level, and electrical energy use etc. When long term measurements are needed, sensors are typically used and connected to a data-acquisition system so measured data can be stored and be accessible remotely.

3.1 Energy Saving Opportunities

These are some of the methods we quoted in order to reduce the energy consumption as well as for a healthy electrical system.

1. Increase the present CD of 120kVA to 220 kVA to eliminate the penalty imposed for excess MD.

2. Rescheduling of LAB timetables to reduce the maximum demand.

3. Replacement of present 36W/40W fluorescent lamps with T5 FL or T5 LED.

4. Replacement of present 15W CFL Bulbs with 2.5 W Philips LED Bulb.

5. Use energy efficient motors as a replacement for the present ordinary motor when it is due for replacement.

6. Use of Energy Efficient Air Conditioners.

7. Replacement of Old Window type AC's.

8. Use of more Solar Panel's wherever the installation is feasible.

9. Installation of kVAr panel for automatic power factor correction.

10. Installation of separate meters for each outgoing feeders.

11. Avoid the usage of lights during daytime where sufficient natural light is available.

12. Provide adequate awareness on energy conservation.

13. Proposal for a Centralized UPS System.

14. Centralized drinking water system, incorporated with solar hot water system.

3.2 Design Consideration For New Building As Per ECBC

1. Design and construction of all buildings having a connected load of 100kW and greater or contract demand of 120kVa and greater or having conditioned area of 500 sq. m and greater and is intended to be used for commercial purposes must comply with Kerala State Energy Conservation Building Code after its notification. This requirement is applicable to all buildings complexes such as offices, hotels, shopping complexes, private hospitals, godowns and other building that are not primarily used for manufacturing process.

2. The building falling under the purview of Kerala State Energy Conservation Building Code should conduct energyaudit by Bureau of Energy Efficiency accredited energy auditor in such interval as notified by BEE or EMC from time to time.

3. The energy audit details must be reported to EMC in such form and manner and intervals as notified by the EMC from time to time.

4. Based on the energy audit report, EMC has to issue report to the Chief Electrical Inspector and the same can be verified by the CEI during the periodical inspection and compliance may be reported back to EMC.

5. All the educational institutions in the State must participate in energy efficiency and conservation programmes designed for educational institutions as per the guidelines notified time to time by Government of Kerala.

6. Before construction, planning should be done on the basis of Building Envelope, Heating, ventilation, Air conditioning, Service water heating and pumping, Lighting, Electrical Power system and their mandatory requirements as per ECBC guidelines should be met.

4.REACTIVE POWER AND POWER FACTOR

All inductive machines and device that operate on AC power convert electrical energy from the power system generators in to mechanical work and heat. This energy is measured by kWh meter and is referred to as "active" or "wattful energy". I order to perform this conversion , magnetic fields have to be established in the machines, and these fields are associated with another form of energy to be supplied from the power system known as "reactive" or "wattless power". This reason for this that inductive circuit cyclically absorbs energy from the system and re-injects that energy in to system twice in every power-frequency cycle.

An exactly similar phenomenon occurs with shunt capacitive element in a power system, such as cable capacitance or banks of power capacitors, etc. In this case energy is stored electrostatically. The cyclic charging and discharging of capacitive circuit reacts on the generators of the system in the same manner as that described above for inductive circuit, but the current flow to and from the capacitive circuit inexact phase opposition to that of the inductive circuit. This feature is the basis of power factor schemes employed.

4.1 Methods Of Improving Power Factor

There are different methods that are employed to improve power factor, including Compensation at LV,Fixed Capacitors, Automatic Capacitor bank. For our college we need a 100kVAr capacitor bank for power factor correction.

4.1.1Automatic Capacitor Banks

This kind of equipment provides automatic control of compensation, maintaining the power factor around close limits of selected level. Such equipment is applied at points in an installation where the active power and reactive power variation is relatively large. A bank of capacitors is divided in to number of sections, each of which is controlled by a contractor. Closure of a capacitor switches its section in to parallel operation with other sections already in use. The size of the bank therefore can be increased or decreased in steps, by the closuring and opening of controlling contactors.

The capacitor bank is installed to the bus bars of the main LV distribution board for the installation, and remains in service during the period of normal load. The global type compensation reduces the tariff penalties, reduces the apparent power kVA, relieves the supply transformer which is then able to accept more load if necessary.

5.CONCLUSION

An energy audit of commercial building encompasses a wide variety of tasks and requires expertise in a number of areas to determine the best energy conservation measures suitable for an existing facility. We tried to perform a general but systematic approach to performing energy audits. If followed carefully, the approach helps to facilitate the process of analyzing a seemingly endless array of alternatives and complex interrelationships between building and energy system components. In any industry, one of top operating expenses are often found to be energy. It can be observed that scope of potential cost savings are high in case of energy, thus energy management function constitute a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists.

After Energy Auditing we were able to find that existing system was not efficient. There is huge hike in demand during summers, and some semester. From TOD meter we noted the MD, kVAr, kVAh, kVArh, pf, frequency, currents and voltages in different zones were analyzed. We have suggested a automatic power factor correctionusing capacitor bank of rating 100kVAr. Forecasting the future energy consumption, we have designed.

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