A
Dissertation
Report On

Energy Audit and Energy Management

Submitted in partial fulfillment of the requirements for the degree

BACHELOR OF ENGINEERING

By

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Under the guidance of

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A Dissertation
Report On

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We would like to extend our sincere thanks to all of them.

CERTIFICATE

This is to certify that the report entitled “Energy Audit and Its Management” submitted by VAIBHAV BENKE, NITIN BHOSALE, ROHAN CHAVAN, DHAWAL GAWADE in partial fulfillment of the requirement for the award of Bachelor of engineering in “ELECTRICAL ENGINEERING” is an authentic work carried under my supervision and guidance.

Date:

DECLARATION

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principle so academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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CHAPTER 1

1.1 ENERGY MANAGEMENT AND AUDIT

1.1.1 Definition & Objectives of Energy Management

"The strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems"

The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and:

- To minimize energy costs / waste without affecting production & quality
- To minimize environmental effects.

1.1.2 Energy Audit: Types and Methodology

Energy Audit is the key to a systematic approach for decision-making in the area of energy man- agreement. It attempts to balance the total energy inputs with its use and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management program.

As per the Energy Conservation Act, 2001, Energy Audit is defined as "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption".

1.2 Need of Energy Audit

In any industry, the three top operating expenses are often found to be energy (both electrical and thermal), labor and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes 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.

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programs which are vital for production and utility activities. Such an audit program will help to keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify

energy conservation technologies, retrofit for energy conservation equipment etc.

In general, Energy Audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.

The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a " bench-mark" (Reference point) for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

1.2.1 Types of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry
- Depth to which final audit is needed, and
- Potential and magnitude of cost reduction desired

Thus, Energy Audit can be classified into the following two types.

- Preliminary Energy Audit
- Targeted Energy Audit
- Detailed Energy Audit

1.2.2 Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to:

- Establish energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely (and the easiest areas for attention
- Identify immediate (especially no-/low-cost) improvements/savings
- Set a 'reference point'
- Identify areas for more detailed study/measurement
- Preliminary energy audit uses existing, or easily obtained data

1.2.1 Detailed Energy Audit Methodology

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems.

This type of audit offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

Detailed energy auditing is carried out in three phases: Phase I, II and III.

Phase I - Pre-Audit99 Phase

Phase II - Audit Phase

Phase III - Post Audit Phase

A Guide for Conducting Energy Audit at a Glance

Industry-to-industry, the methodology of Energy Audits needs to be flexible.

A comprehensive ten-step methodology for conduct of Energy Audit at field level is pre-sented below. Energy Manager and Energy Auditor may follow these steps to start with and add/change as per their needs and industry types.

<u>Ten Steps Methodology for Detailed Energy Audit:</u>

STEP NO.	PLAN OF ACTION	PURPOSE / RESULTS
Step 1	Plan and organize Walk through audit Informal interview with energy manager, production/plant manager	Resource planning, Establish/organize an Energy audit team Organize Instruments &time frame Macro Data collection (suitable to type of industry.) Familiarization of process/plant activities First hand observation & Assessment of current level operation and practices

Step 2	Conduct of brief meeting/awareness program with all divisional heads and persons concerned (2-3 hrs.)	Building up cooperation Issue questionnaire for each department Orientation, awareness creation
Step 3	Primary data gathering, Process Flow Diagram & Energy Utility Diagram	Historic data analysis, Baseline collection Prepare process flow charts All service utilities system diagram (Example: Single line power distribution diagram, water, compressed air & stream distribution.) Design, operating data and schedule of operation Annual Energy Bill and Energy consumption pattern (refer manual, log sheet, name plate, interview)
Step 4	Conduct Survey and monitoring	Measurements: Motor survey, Insulation and Lightning survey with portable instruments for collection of more and accurate data. Confirm and compare operating data with design data.
Step 5	Conduct of detailed trials/experiments for selected energy guzzlers	Trials/Experiments: 24 hours power monitoring (MD, PF, Boiler/Efficiency trials for (4-8 hours) Furnace Efficiency trials Equipment's Performance experiments etc.

Step 6	Analysis of energy use	Energy and Material balance & energy loss/waste analysis
Step 7	Identification and development of Energy Conservation (ENCON) opportunities	Identification & Consolidation ENCON measures Conceive, develop, and refine ideas Review the previous ideas suggested by unit personal Review the previous ideas suggested by energy audit if any Use brainstorming and value analysis techniques Contact vendors for new/efficient technology
Step 8	Cost benefit analysis	Assess technical feasibility, economic viability and prioritization of ENCON Options for implementation Select the most promising projects Prioritize by low, medium, long term measures
Step 9	Reporting and presentation to the top management	Documentation, Report Presentation to the top management.
Step 10	Implementation and Follow-up	Assist and Implement ENCON recommendation measures and Monitor the performance Action plan, schedule for implementation Follow-up and periodic review

CHAPTER 2

2.1 INTRODUCTION: -

What is Energy Audit?

Energy Audit is a periodic examination of an energy system to ensure that energy is being used as efficient as possible.

Aim: - To reduce the College Energy Bill

- Our college has four Sections Diploma, Architecture, Engineering and Pharmacy.
- We have collected and gone through previous Energy Bills.

We have done Walkthrough Audit in our college. In this we have collected the data regarding type & number of loads connected in each room and the time consumed by connected loads. This data has been mentioned in an excel format in the next page.

- The rating of loads is also mentioned in collected data.
- We have done the phase test in whole college in a group of people by using Tester.
- All the collected data is written in excel sheet with each block detailed separately.

2.2 Excel sheet data of entire campus

ENGINEERING BUILDING							
Ground Floor							
Room no.	No. of Fans	No. of TubeLights	No. of AC	Projectors	Filters	No. Of Computers	T.V.
B-101(A)	3	5-Striped 2-Double	1	0	0	1	0
B-102(B)	15	24 -Striped	0	0	0	0	0
Washroom	0	3-Striped	0	0	1	0	0
B-101(B)	3	4-Striped	0	0	0	0	0
B-103	12	26-Striped 2-Small	1	1	0	0	0
B-104	9	11-Striped 2-Small	1	0	0	1+2 Printers	0
B-105	5	6-Striped 2-Small	1	0	0	0	0
B-106	6	8-Striped	0	0	0	0	0
Washroom	0	3-Striped 3-Sphere	0	0	1	0	0
B-107	6	8-Striped	0	0	0	0	0
B-108	3	4-Striped	0	0	0	0	0
B-109	12	18-Striped 2 Small	1	0	0	0	0
B-110(A)	4	8-Striped	0	0	0	0	0
B-110(B)	7	10-Big 4-Small	2_3	0	0	0	0
B-111	6	16-striped	0	0	0	1	0
B-112	6	8-Striped	0	0	0	0	0
B-113	9	8-Double 17-Small	1	0	0	12	0
B-114							
B-115	5	8-Striped	0	0	0	1	0
Lobby	2	7-Double 12-Round	0	0	0	0	4 L.C.D.
First Floor							
B-201	7	7-Striped	0	1	0	0	0
B-202	7	7-Striped	0	1	0	0	0
B-203	7	7-Striped	0	1	0	0	0
Washroom	0	3-Striped	0	0	1	0	0
B-204	6	12-Striped 2-Small	1	0	0	1	0
B-205	6	14-Striped 2-Small	1	0	0	0	0
B-206	6	11-striped	0	1	0	0	0
Connected	4	4-Striped	0	0	0	0	0
B-206©	6	9-Striped	0	0	0	0	0
B-207	3	4-Striped	1	0	0	1	0
Project Lab	6	8-Striped	2	1	0	30	0
Washroom	0	3-Striped 2-Sphere	0	0	1	0	0
B-208	6	8-Striped	0	1	0	0	0
B-209	8	6-Double 6-Small	3	1	0	61	0
B-210	9	15-Striped	0	1	0	0	0
B-211	8	20-striped	0	1	0	0	0
B-212	6	16-Striped	0	1	0	0	0
B-213	7	7-Striped	0	1	0	0	0
B-214	7	7-Striped	0	1	0	0	0
B-215	7	7-Striped	0	1	0	0	0
B-216	6	10-Striped	0	0	0	1	0
Exam Cell	14	14-Round 2-Small	6	0	0	11+3 Printer	0
		6-Double 4-Stripped					

Second Floor								
B-301	7	7-Striped	0	1	0	0	0
B-302	7	7-Striped	0	1	0	0	0
B-303	8	10-Striped 2-Small	1	0	0	0	0
B-304	4	10-Big 2-Small	0	0	0	12	0
Washroom	0	4-Striped	0	0	1	0	0
B-305	6	12-Striped 2-Small	0	0	0	0	0
Electronics Lab	8	11-Striped	0	0	0	0	0
B-306	6	7-striped	0	1	0	0	0
B-307							
Washroom	0	6-Big round 3-Striped	0	0	1	0	0
B-309	6	6-Striped			0		0
B-310	9	11-Striped 1-Small	1	0	0	1	0
B-311	6	6-Big 5-Small	4	1	0	21	0
B-312	6	16-Striped	0	0	0	1	0
B-313	12	11-Small 8-Big	4	1	0	14	0
B-314	7	7-Striped	0	1	0	0	0
B-315	7	7-Striped	0	1	0	0	0
B-316	7	7-Striped	0	1	0	0	0
B-317	6	14 Big 5-Small	3	1	0	23	0
B-318	16	16-Striped 1 Small	1	0	0	1	0
Third Floor							
B-401	8	13+1	4	1	0	0	0
B-402	6	12+1	0	0	0	0	0
B-403	8	13-Striped 11-Round	5	0	0	0	0
B-404					0	0	0
B-405	7	9-Striped	0	1	0	0	0
B-406					0	0	0
B-407	7	9-Striped	0	1	0	0	0
B-408					0	0	0
B-409	7	9-Striped	0	0	0	0	0
Washroom	0	5-Striped 2-Big Round	0	0	1	0	0
Washroom	0	3-Striped 2-Big	0	0	0	0	0
B-413	8	12-Mini 4-Small Circle	5	1	0	24	0
		9-Small 1-Big Double					
B-414	4	13-Mini 9-Small CFL	3	1	0	24	0
		1-Big Double					
B-415	8	13-Big Double 2-Small	4	1	0	24	0
B-416	7	8-Small 3-Round	3	1	0	24	0
B-417	8	10-Small 3-Round	4	1	0	24	0
B-418	14	0-Small 10-Round bulb	6	1	0	27	0
		5-Big Double					
B-419	6	12-Small 1-Big Double	3	1	0	24	0
B-420							
B-421	8	14-Round 6-Small	5	1	0	20	0
		3-Big Double					
B-422	3	7-Big Double	1	0	0	4+1 Printer	0

Architecture Building						
Ground Floor						
Room no	Tubelight	FAN	AC	PC	Machine	
					Projector	Filter
Basement	83 T/L	71 ceiling	5		6 speakers	
(Masjid)	2 CFL	16 table			1 indicator	
Lobby	14 + 16(Enterance)					
(Gnd Floor)						
Studio Space	39					
(rn 005)						
RN 003	39					
RN 002	9	8		1		
RN 001	9	8		1		
RN 006	12	6				
1st Floor						
Room no	Tubelight	FAN	AC	PC	Machine	
					Projector	Filter
Stationary Store	10	2				
Studio Space	39	23				
Staff Room	6	3	1	8	1 Printer	
(Faculty-105)						
W/C	12				1 Filter	
Boys/ Girls						
102 and 101	14	12	3	8	1 induction cooker	
Lobby	15					
Auditorium	36	29				
2nd Floor						
Room no	Tubelight	FAN	AC	PC	Machine	
					Projector	Filter
Studio Space	45	26				
Discussion Room	5	3				
W/C	12				1 Filter	
Boys/Girls						
Faculty Room	32	6	2			
Lobby	31					
Lecture Hall	36	29		1		
Auditorium	36	29				
3rd Floor						
Room no	Tubelight	FAN	AC	PC	Machine	
					Projector	Filter
Design Cell	6	3				
Studio Space	54	41		10		
Lecture Hall	6	3				
Auditorium	36	29				
Lobby	48					
W/C	12				1 Filter	
Boys/Girls						

PHARMACY BUILDING							
Ground floor							
Room no	Fans	Tubelight	Machines	AC	Projector	Filter	PC
A 105 EM Lab	8	6B					
A 103 Pharmacy lab	9	16S					
Store dept	2	7S					
Store dept	1	2B					
Boys restroom		5B				1	
Canteen	34	23W/7NW				1	
A 108 workshop	28	22	2-1ph, 3-3ph				1
Lobby	3	24CFL					
1st Floor							
Room no	FAN	tubelight	machine	AC	projector	filter	PC
A 201 faculty	8	8B/6S		2-1.5 tonne			1
A 202	8	10					
A 203	8	11					
A 204	8	10					
A 205 Chemistry lab	11	9S	4 machines				
A 206	9	11					
A 207 Tutorial	4	30S 26/4					
A 208	9	11					
CO lab1	4	30S	2 printer	2 2 tonne			20
CO lab2	4	30S		2 2 tonne			17
A 210	11	11					
Seminar hall							
A 209 server hall							
Lobby	2	9B/24 CFL					
Director office	2	4 CFL/4 LED					1
2nd Floor							
Room no	FAN	tubelight	machine	AC	projector	filter	PC
A 302	11	2B/15S	5 machines				
A 302 II	1	6S 4/2				1 door	
DP lab	11	9B	1 oven				
A 304	11	11S	1 oven			1 pure it	
A 305	9	11					
A306	9	12					
Dean	7	4	3 printer	2			3
Lobby	2	9B/24 CFL					
3rd Floor							
Room NO	Fans	Tubelight	Machine	AC	Projector	Filter	PC
A 403	17	60		3			
A 404	17	60		2			
A 406	6	12					
Clinic	3	5					3
Library	46	42					5

CHAPTER 3

3.1 INTRODUCTION

In the previous chapter, we carried out a walk-through audit which includes collection of primary data, formation of a process flow diagram and energy utility diagram. A detailed survey and monitoring was done to analyze the use of energy. In this chapter, identification and development of energy conservation opportunities and cost benefit analysis will be done.

3.2 Identification of energy conservation factors and areas

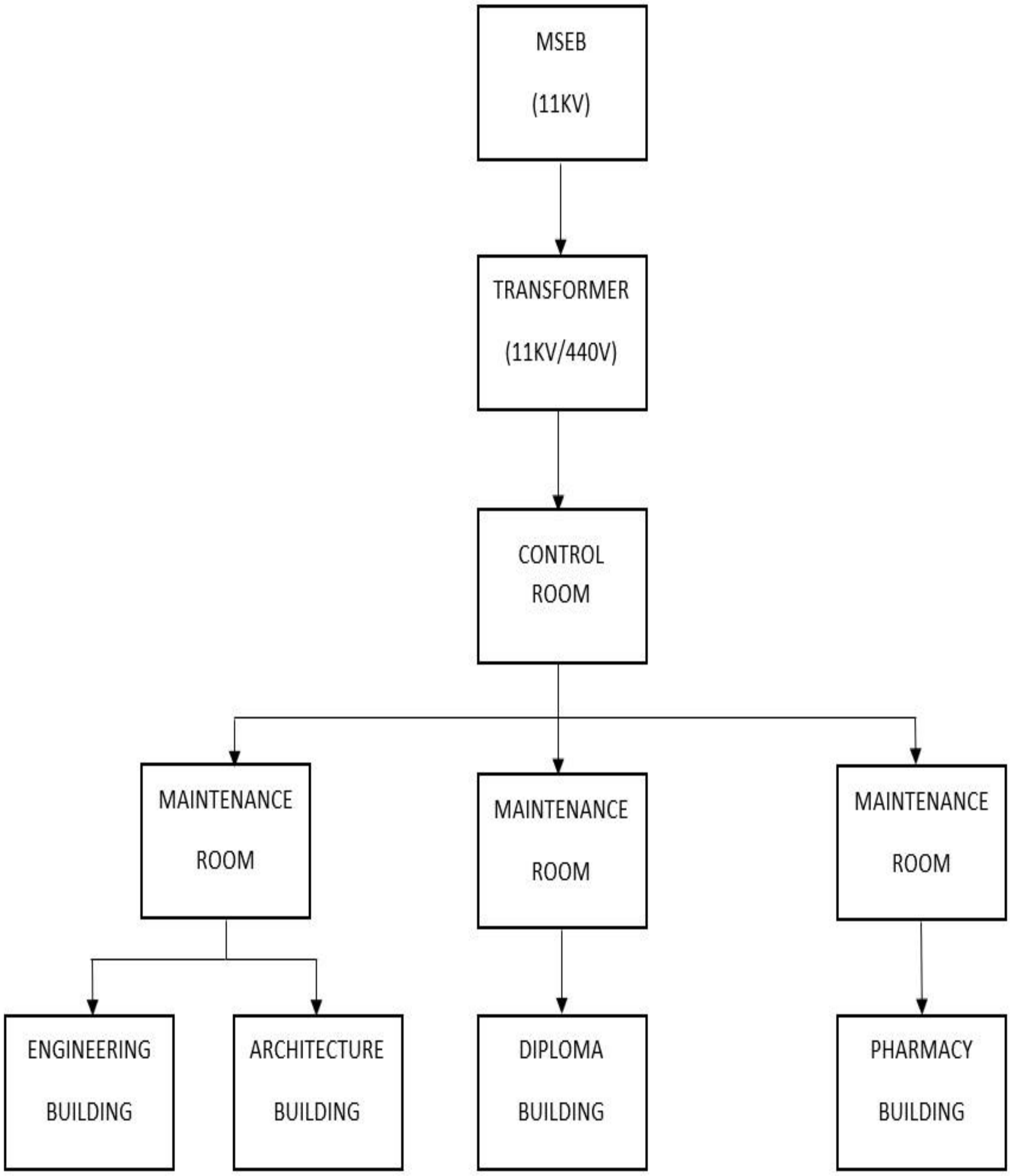
Steps can be taken for conserving energy if we know the correct factors and areas to be studied and details of fuel used.

These can be:

- Energy generation
- Energy distribution
- Energy used by process
- Fuel substitution
- Use of types of cable for connection
- Color coding used for connection in distribution panels
- Connection of phase and neutral wires in electrical switchboards.

3.2 DETAILED AUDIT

3.2.1 Single line diagram



3.3.2 Power factor improvement

❖ Need for power factor improvement

- Power factor is cosine of the phase difference between source voltage and current.
- It refers to the fraction of total power (apparent power) which is utilized to do the useful work called active power.
- Real power is given by P = VIcosφ. To transfer a given amount of power at certain voltage, the electrical current is inversely proportional to cosφ. Hence higher the pf lower will be the current flowing. A small current flow requires less cross-sectional area of conductor and thus it saves conductor and money.
- From above relation we saw having poor power factor increases the current flowing in conductor and thus copper loss increases.
- Further large voltage drop occurs in alternator, electrical transformer and transmission and distribution lines which gives very poor voltage regulation.
- Further the KVA rating of machines is also reduced by having higher power factor as, Hence, the size and cost of machine also reduced. So, electrical power factor should be maintained close to unity.
- This factor ($-1 < \cos\varphi < 1$) represents the fraction of total power that is used to do the useful work.
- A fraction of this total electrical power which actually does our useful work is called as active power. It is denoted as 'P'.
- The other fraction of power is called reactive power. This does no useful work, but it is required for the active work to be done. It is denoted by 'Q'.

❖ Methods of Power Factor Improvement

Capacitors:

- Improving power factor means reducing the phase difference between voltage and current.
- Since majority of loads are of inductive nature, they require some amount of reactive power for them to function.

This reactive power is provided by the capacitor or bank of capacitors installed parallel to the load. They act as a source of local reactive power and thus less reactive power flows through the line. Basically, they reduce the phase difference between the voltage and current.

Too large capacitors might make the internal power supply loop go unstable, which would create large voltage deviations across the capacitor and potentially burn it due to too large capacitor heating caused by its non-zero parasitic resistance called "ESR".

❖ Benefits of improving power factor include:

1) Lower utility fees:

a) Reducing peak KW billing demand:

- Inductive loads, which require reactive power, caused your low power factor. This increase in required reactive power (KVAR) causes an increase in required apparent power (KVA), which is what the utility is supplying. So, a facility's low power factor causes the utility to have to increase its generation and transmission capacity in order to handle this extra demand.
- By lowering your power factor, you use less KVAR. This results in less KW, which equates to a dollar savings from the utility.

b) Eliminating the power factor penalty:

- Utilities usually charge customers an additional fee when their power factor is less than 0.95. (In fact, some utilities are not obligated to deliver electricity to their customer at any time the customer's power factor falls below 0.85.) Thus, you can avoid this additional fee by increasing your power factor.

2) Increased system capacity and reduced system losses in your electrical system:

- By adding capacitors (KVAR generators) to the system, the power factor is improved, and the KW capacity of the system is increased.
- For example, a 1,000 KVA transformer with an 80% power factor provides 800 KW (600 KVAR) of power to the main bus.
- By increasing the power factor to 90%, more KW can be supplied for the same amount of KVA.
- 1000 KVA = (900 KW)2 + (? KVAR)2KVAR = 436
- The KW capacity of the system increases to 900 KW and the utility supplies only 436 KVAR.

- Uncorrected power factor causes power system losses in your distribution system.
- By improving your power factor, these losses can be reduced. With the current rise in the cost of energy, increased facility efficiency is very desirable. And with lower system losses, you are also able to add additional load to your system.

3) Increased voltage level in your electrical system and cooler, more efficient motors:

As mentioned above, uncorrected power factor causes power system losses in your distribution system. As power losses increase, you may experience voltage drops. Excessive voltage drops can cause overheating and premature failure of motors and other inductive equipment. So, by raising your power factor, you will minimize these voltage drops along feeder cables and avoid related problems. Your motors will run cooler and be more efficient, with a slight increase in capacity and starting torque.

❖ Calculation of required capacitor:

Suppose Actual P.F is 0.8, Required P.F is 0.98 and Total Load is 516KVA.

Power factor = KWh / KVAR

kW = kVA x Power Factor

= 516 x 0.8 = 412.8

Required capacitor = kW x Multiplying Factor

= (0.8 x 516) x Multiplying Factor

= 412.8 x 0.547 (See Table to find Value according to P.F 0.8 to P.F of 0.98)

= 225.80 KVAR

❖ Use of capacitor in APFC panel:

- The capacitor should be provided with suitable designed inrush current limiting inductor coils or special capacitor duty contactors. Annexure d point no d-7.1 of IS 13340-1993
- Once the capacitor is switched off it should not be switched on again within 60 seconds so that the capacitor is completely discharged. The switching time in the relay provided in the APFC panel should be set for 60 seconds for individual steps to discharge. Clause No-7.1 of IS 13340-1993
- If the capacitor is switched manually or if you are switching capacitors connected in parallel with each other than "ON" delay timer (60sec) should be provided and in case of parallel operation once again point No 1 should be taken care. Clause No-7.1 of IS 13340-1993
- The capacitor mounted in the panel should have min gap of 25-30 mm between the capacitor and 50 mm around the capacitor to the panel enclosure.

In case of banking a min gap of 25mm between the phase to phase and 19mm between the phases to earth should be maintained. Ensure that the banking bus bar is rated for 1.8 times rated current of bank.

- The panel should have provision for cross ventilation, the louver / fan can be provided in the care Annexure d point No d-3.1 IS 13340-1993

For use of reactor and filter in the panel fan should be provided for cooling.

- Short circuit protection device (HRC fuse / MCCB) should not exceed 1.8 x rated current of capacitor.
- In case of detuned filter banks MCCB is recommended for short circuit protection.

3.4 Electrical Safety & Energy Audit Report of Kurla campus

Under AIKTC's Social Responsibility and as guided/ directed by Mr. Burhan Harris (Hon. Ex. Chairman, BINM, AI) and Dr. Abdul Razzak Honnutagi (Director, AIKTC, New Panvel), we visited the school of Anjuman-I-Islam's, Kurla campus Mumbai on 4th and 5th of January 2018 for systematically carrying out Electrical Safety and Energy Audit work.

Prof. Rizwan Farade (Asst. Prof. Electrical Engineering Department) and Prof. Gulrez Bodhle (Asst. Prof. Electrical Engineering Department) assisted us in auditing.

After conducting a said audit of the building, the following observations along with appropriate measures are suggested for implementation:

1.Fire extinguishers are to be provided in all buildings. Main power room should have a CO_2 extinguisher.

2. Main power room:

a) Load distribution in three phases is to be adjusted to be equal.

b) Burnt wiring to be replaced.

c) Wires are not insulated properly.

d) Energy meters and fuses are left open. They are not covered with an insulation material.

e) Power room to have a rubber mat on the floor.

f) Loose hanging wires used for different connections are to be laid and secured properly.

3. Many old fans and light fittings are to be replaced with new energy efficient fittings. All connections are to be secured using plugs and nut bolt.

4. First aid boxes are to be provided at different locations.

5. No cost measures**:** Switch off electrical appliances when not needed

6. High-cost long-term payback period plan: Solar on grid power generation to reduce electricity charges substantially.

7.Main panel board must replace with new one, with modern protective devices and means for improvement in power factor.

8.Old switchboards at various locations need to be replaced.

9.Many fans are operated by a single regulator; each fan should have an individual regulator to avoid extra loss.

10.Most of the tube lights and fans are not working properly.

11.Some of the wires in corridor are left open.

12.Electrician to be provided with proper test equipment, at least multimeter and clamp current tester.

3.5 Faults observed while performing detailed audit:

1.The terminal of MCB and busbar contact got heated up and turned black due to difference of material used.

2. If the load increases above 30% of total load, the CT senses this rise which turns on the relay and eventually turns on the APFC panel.

3.When load increases above a limit value in the auditorium, the capacitor banks of auditorium must turn on. But due to the occurrence of fault in the CT or relay the capacitor bank of maintenance room turns on instead of turning on the capacitor of auditorium.

4.The phase wire should be connected on the right side in the socket. While performing detailed audit of electrical department's staffroom we found that the phase wire is connected on left side, which may damage the equipment if unbalanced load condition occurred.

5.If we connect excessive capacitor bank, then

- Voltage level increases
- Transient instability occurred
- Power factor reduced

6.Some panel are not secured properly. An earthing wire should be connected to the MCB panel to avoid linking of flux with the panel.

7.Dust is accumulated in the main panel, which increases the losses and conduction may take place. It also leads to heating up of the main panel

8.Maintenance should be done at regular interval to avoid such problems.

3.6 Equipments used while performing Audit:

1. Infrared Thermometer

An **infrared thermometer** is a thermometer which infers temperature from a portion of the thermal radiation sometimes called black-body radiation emitted by the object being measured. They are sometimes called **laser thermometers** as a laser is used to help aim the thermometer, or **non-contact thermometers** or **temperature guns**, to describe the device's ability to measure temperature from a distance. By knowing the amount of infrared energy emitted by the object and its emissivity, the object's temperature can often be determined within a certain range of its actual temperature. Infrared thermometers are a subset of devices known as "thermal radiation thermometers".

Sometimes, especially near ambient temperatures, readings may be subject to error due to the reflection of radiation from a hotter body even the person holding the instrument rather than radiated by the object being measured, and to an incorrect assumed emissivity.

The design essentially consists of a lens to focus the infrared thermal radiation on to a detector, which converts the radiant power to an electrical signal that can be displayed in units of temperature after being compensated for ambient temperature. This permits temperature measurement from a distance without contact with the object to be measured. A non-contact infrared thermometer is useful for measuring temperature under circumstances where thermocouples or other probe-type sensors cannot be used or do not produce accurate data for a variety of reasons.

2. Clamp meter

An electrical meter with integral AC current clamp is known as a clamp meter, clamp-on ammeter or tong tester.

A clamp meter measures the vector sum of the currents flowing in all the conductors passing through the probe, which depends on the phase relationship of the currents. Only one conductor is normally passed through the probe. In particular if the clamp is closed around a two-conductor cable carrying power to equipment, the same current flows down one conductor and up the other; the meter correctly reads a net current of zero. As electrical cables for equipment have both insulated conductors (and possibly an earth wire) bonded together, clamp meters are often used with what is essentially a short extension cord with the two conductors separated, so that the clamp can be placed around only one conductor of this extension.

Clamp meters are used by electricians, sometimes with the clamp incorporated into a general-purpose multimeter. It is simple to measure very high currents (hundreds of amperes) with the appropriate current transformer. Accurate measurement of low currents (a few milliamperes) with a current transformer clamp is more difficult. The range of any given meter can be extended by passing the conductor through the jaw multiple times. For example, a 0–200 A meter can be turned into a 0–20 A meter by winding the conductor 10 times around the jaw's core.

CHAPTER 4

4.1 Methods to be adopted for energy conservation

4.1.1 Zero Cost method

This is an efficient method and works on zero cost basis. This can be adopted by each and every one as a primary method to save energy. This method involves switching off the lights and fans which are not in use. The use of ACs should be limited only during summer time. This can save energy in much simpler way without wasting any money.

4.1.2 Low Cost method

Low cost method involves substitution methods for equipment which can be replaced or can be upgraded. This can be use of high quality capacitors which can store energy more efficiently. Use of led tubes instead of using high wattage lighting. Use of energy savers for ACs which consume more power than they should consume ideally. These changes can save energy.

4.1.3 High Cost method

High cost method involves installation of solar panels and use solar energy for consumption. Solar panel electricity systems, also known as photovoltaic (PV), capture the sun's energy using photovoltaic cells. These cells don't need direct sunlight to work – they can still generate some electricity on a cloudy day. The cells convert the sunlight into electricity, which can be used to run household appliances and lighting. Hence, use of solar panels can be beneficial as we can have our own generation technique which will eventually cutoff our electricity bills. Installation of such system requires a huge amount of investment at the start depending on the amount of energy required for consumption. The returns of the initial installment can be obtained after some months or even years. Once the cost has been recovered, we can earn or in other words it will become economical.

4.1 Future Scope

4.1.1 Photovoltaic system:

A photovoltaic system, also PV system or solar power system, is a power system designed to supply usable solar power by means of photovoltaics. It consists of an arrangement of several components, including solar panels to absorb and convert sunlight into electricity, a solar inverter to change the electric current from DC to AC, as well as mounting, cabling, and other electrical accessories to set up a working system. It may also use a solar tracking system to improve the system's overall performance and include an integrated battery solution, as prices for storage devices are expected to decline. Strictly speaking, a solar array only encompasses the ensemble of solar panels, the visible part of the PV system, and does not include all the other hardware, often summarized as balance of system (BOS). Moreover, PV systems convert light directly into electricity and shouldn't be confused with other technologies, such as concentrated solar power or solar thermal, used for heating and cooling.

PV systems range from small, rooftop-mounted or building-integrated systems with capacities from a few to several tens of kilowatts, to large utility-scale power stations of hundreds of megawatts. Nowadays, most PV systems are grid-connected, while off-grid or stand-alone systems only account for a small portion of the market.

Operating silently and without any moving parts or environmental emissions, PV systems have developed from being niche market applications into a mature technology used for mainstream electricity generation. A rooftop system recoups the invested energy for its manufacturing and installation within 0.7 to 2 years and produces about 95 percent of net clean renewable energy over a 30-year service lifetime

A photovoltaic system for residential, commercial, or industrial energy supply consists of the solar array and several components often summarized as the balance of system (BOS). This term is synonymous with "Balance of plant" q.v. BOS-components include power-conditioning equipment and structures for mounting, typically one or more DC to AC power converters, also known as inverters, an energy storage device, a racking system that supports the solar array, electrical wiring and interconnections, and mounting for other components.

Advantages of Photovoltaic System:

- PV panels provide clean – green energy. During electricity generation with PV panels there is no harmful greenhouse gas emissions thus solar PV is environmentally friendly.
- Solar energy is energy supplied by nature – it is thus free and abundant!
- Solar energy can be made available almost anywhere there is sunlight
- Solar energy is especially appropriate for smart energy networks with distributed power generation – DPG is indeed the next generation power network structure!
- Solar Panels cost is currently on a fast-reducing track and is expected to continue reducing for the next years – consequently solar PV panels has indeed a highly promising future both for economical viability and environmental sustainability.
- Photovoltaic panels, through photoelectric phenomenon, produce electricity in a direct electricity generation way
- Operating and maintenance costs for PV panels are low, almost negligible, compared to costs of other renewable energy systems
- PV panels have no mechanically moving parts, except in cases of –sun-tracking mechanical bases; consequently, they have far less breakages or require less maintenance than other renewable energy systems (e.g. wind turbines)
- PV panels are totally silent, producing no noise at all; consequently, they are a perfect solution for urban areas and for residential applications (see solar panels for homes)
- Because solar energy coincides with energy needs for cooling PV panels can provide an effective solution to energy demand peaks – especially in hot summer months where energy demand is high.
- Though solar energy panels' prices have seen a drastic reduction in the past years, and are still falling, nonetheless, solar photovoltaic panels are one of major renewable energy systems that are promoted through government subsidy funding (FITs, tax credits etc.); thus, financial incentive for PV panels make solar energy panels an attractive investment alternative.

Residential solar panels are easy to install on rooftops or on the ground without any interference to residential lifestyle.

CHAPTER 5

5.1 Conclusion

Our project topic is energy audit & its management. Energy audit is the key to saving energy in your organization. the importance of energy audit is to save energy and reduce bill of organization. Demand of energy is increasing day by day and now it is very importance to manage energy. It is the time to reduce our dependence on the fossil fuels that are becoming increasingly limited in supply.

Energy audit comprises of three types preliminary energy audit, targeted energy audit and detailed energy audit. In preliminary energy audit, we have collected the data of types of connected load.

From data we concluded that our college has less inductive load which is at the ground floor in mechanical, electrical and civil practical lab. We have also collected the bill and analyzed it. Phase, ground and earthing wire should be connected properly in socket. Phase should be on right side in socket & neutral should be on left side. We checked all the socket by using tester. In detailed audit, we observed some faults like phase reversal, panels are not insulated properly. Capacitor bank in auditorium is not working because CT fails to detect the over current, less maintenance done of panels. we did the energy audit basically to reduce the electricity bill and to save energy. We were almost successful in collecting data but if we could have started in our early 3rd year we could have got the chance of implementation. Our junior batch can take from here and go further and help in conservation of energy.

5.2 References: -

Links:

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