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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NEW PANVEL

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CERTIFICATE

This is to certify that the report entitled "Energy Audit and Its Management" submitted by SHOAIB MOMIN, FAIQUE BAGDADI, AASIF BEVOOR, SHAHNAWAZ KHAN 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.

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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:

- 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".

Energy audit is an effective tool in defining and pursuing comprehensive energy management programmes. It has positive approach aiming at continuous improvement in energy utilisation in contrast to financial audit which stresses to maintain regularity. Energy audit provides answer to the question – what to do, where to start, at what cost and for what benefits?

Energy audit helps in energy cost optimization, pollution control, safety aspects and suggests the methods to improve the operating and maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipment, in- strumentations and technology.

1.2 Need for 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 identifyingtheareaswherewastecanoccurandwherescopeforimprovementexists.

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.

It aims at:

i. Assessing present pattern of energy consumption in different cost centers of operations.

ii. Relating energy inputs and production output.

iii. Identifying potential areas of thermal and electrical energy economy.

iv. Highlighting wastage in major areas.

v. Fixing of energy saving potential targets for individual cost centers.

vi. Implementation of measures of energy conservation and realization of savings.

The overall objectives of the Energy Audit are accomplished by:

i. Identifying areas of improvement and formulation of energy conservation measures requiring no investment or marginal investment through system improvements and optimization of operations.

ii. Identifying areas requiring major investment by incorporation of modern energy efficient equipment and up-gradation of existing equipment.

THE ELECTRICITY ACT 2003 :

Before Electricity Act, 2003, the Indian Electricity sector was guided by The Indian Electricity Act, 1910 and The Electricity (Supply) Act, 1948 and the Electricity Regulatory Commission Act, 1998. The generation, distribution and transmission were carried out mainly by the State Electricity Boards in various States. Due to politico-economic situation, the cross-subsidies reached at an unsustainable level. For the purpose of distancing state governments from tariff determination, The Electricity Regulatory Commissions Act was enacted in 1998. So as to reform electricity sector further by participation of private sector and to bring in competition, Electricity Act was enacted in 2003.

With effect from 2 June 2003 India has adopted a new legislation called the Electricity Act 2003, to replace some age-old existing legislation operating in the country. The new act consolidates the position for existing laws and aims to provide for measures conducive to the development of electricity industry in the country. The act has attempted to address certain issues that have slowed down the reform process in the country and consequently has generated new hopes for the electricity industry. This paper reviews the Electricity Act 2003, to highlight how the new features are different from the existing legal provisions and whether these measures have economic rationale.

An act to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity for taking measures conducive to development of electricity industry, promoting competition therein, protecting interest of consumers and supply of electricity to all areas, rationalisation of electricity tariff, ensuring transparent policies regarding subsidies, promotion of efficient and environmentally benign policies, constitution of Central Electricity Authority Regulatory Commissions and establishments of Appellate Tribunal for matters therewith or incident thereto.

1.2.1 Type 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.
- Potential and magnitude of cost reduction desired

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

i) Preliminary Energy Audit

ii) Targeted Energy Audit

iii) Detailed Energy Audit

1.2.2 Preliminary Energy Audit Methodology:

Preliminary audit is carried out in the limited time say within 10 days and it highlights the energy cost and wastages in the major equipment's and processes. It also gives the major energy supplies and demanding accounting. The questionnaire containing the industrial details of energy consumption process carried out, energy need to unit product; load data etc. must be completed before the pre-audit visit.

The pre-audit visit is done, by the audit team/audit consultant, in the plant area with the attention focused on the energy inputs, spots of wastage and available energy conservation opportunities. The items for waste recycling opportunities are identified. The data regarding energy inputs and outputs are collected for use during preliminary audit.

During the visit, discussions with line supervisors and line technicians and joint brainstorming may be necessary to acquire creative ideas and to know the practical difficulties in carrying out the proposed Energy Conservation Measures (ECMs).

`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

1.2.3 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 - Pre-Audit 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.

Ten Steps Methodology for Detailed Energy Audit:

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)	• Buildingupcooperation • Issue questionnairefor 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 & Management Presentation to the Top	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.

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

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.

3.1 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 Methods to be adopted for energy conservation

3.2.1 Zero Cost Method

This is an efficient method and works on zero cost basis. This can be adopted by each and everyone 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.

3.2.2 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.

3.2.3 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.

Various Energy Efficiency Measures are:

There are some practices that aren't just good, they're the best. And the ideas below are based on best practices from leading ENERGY STAR partners who know how to trim their energy waste with nothing more invested than time and elbow grease. But remember … low-hanging fruit grows back quickly. Have a plan for how to monitor and maintain savings to avoid snapback.

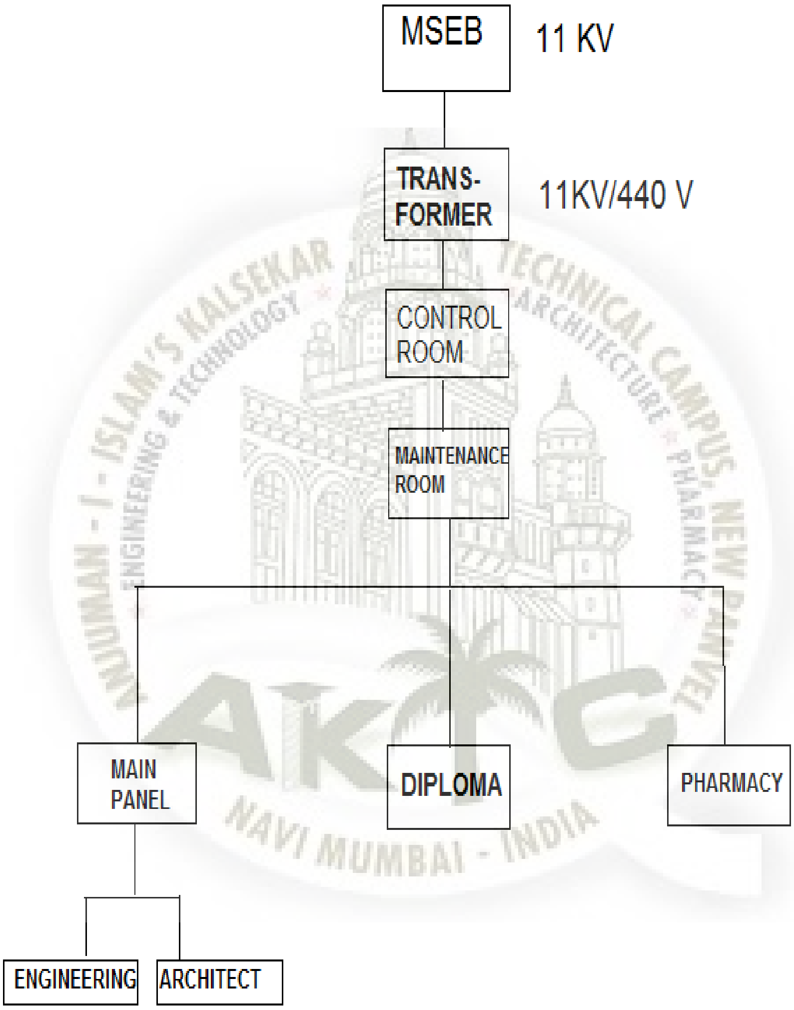
Find best practices for:

- Operations and maintenance
- Lighting
- Office equipment
- Heating and cooling
- Communication and education
- Outside help

DETAILED AUDIT

3.1 Detailed Audit of AIKTC

3.1.1 Single line diagram



3.2 Power factor Improvement:

3.2.1 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 <cosφ< 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’.

3.2.2 Methods of Power Factor Improvement

1. STATIC Capacitors:

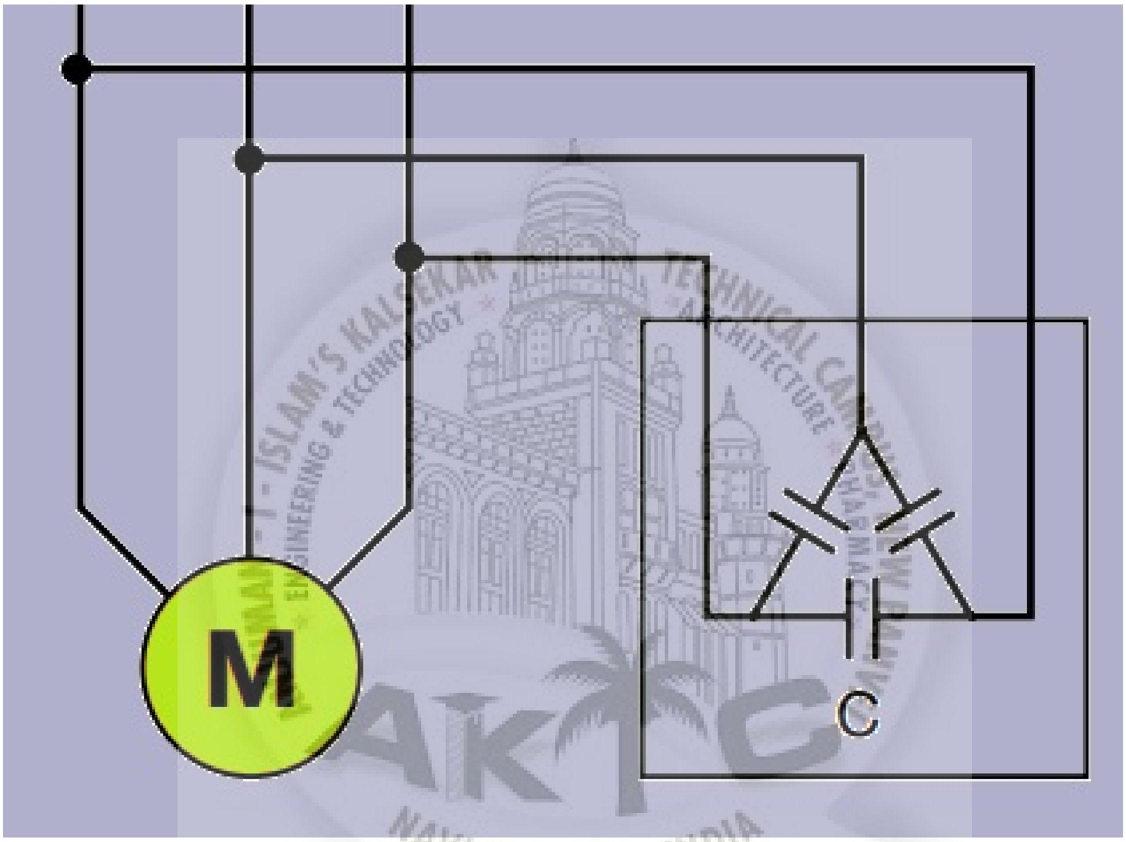
- Improving power factor means reducing the phase difference between voltage and current.
- Since majority of loads are of inductive nature, they require some amount of reactive power for them to function.

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 reduces 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".

STATIC CAPACITOR:



Advantages:

- Capacitor bank offers several advantages over other methods of power factor improvement.
- Losses are low in static capacitors
- There is no moving part, therefore need low maintenance
- It can work in normal conditions (i.e. ordinary atmospheric conditions)
- Do not require a foundation for installation
- They are lightweight so it is can be easy to installed

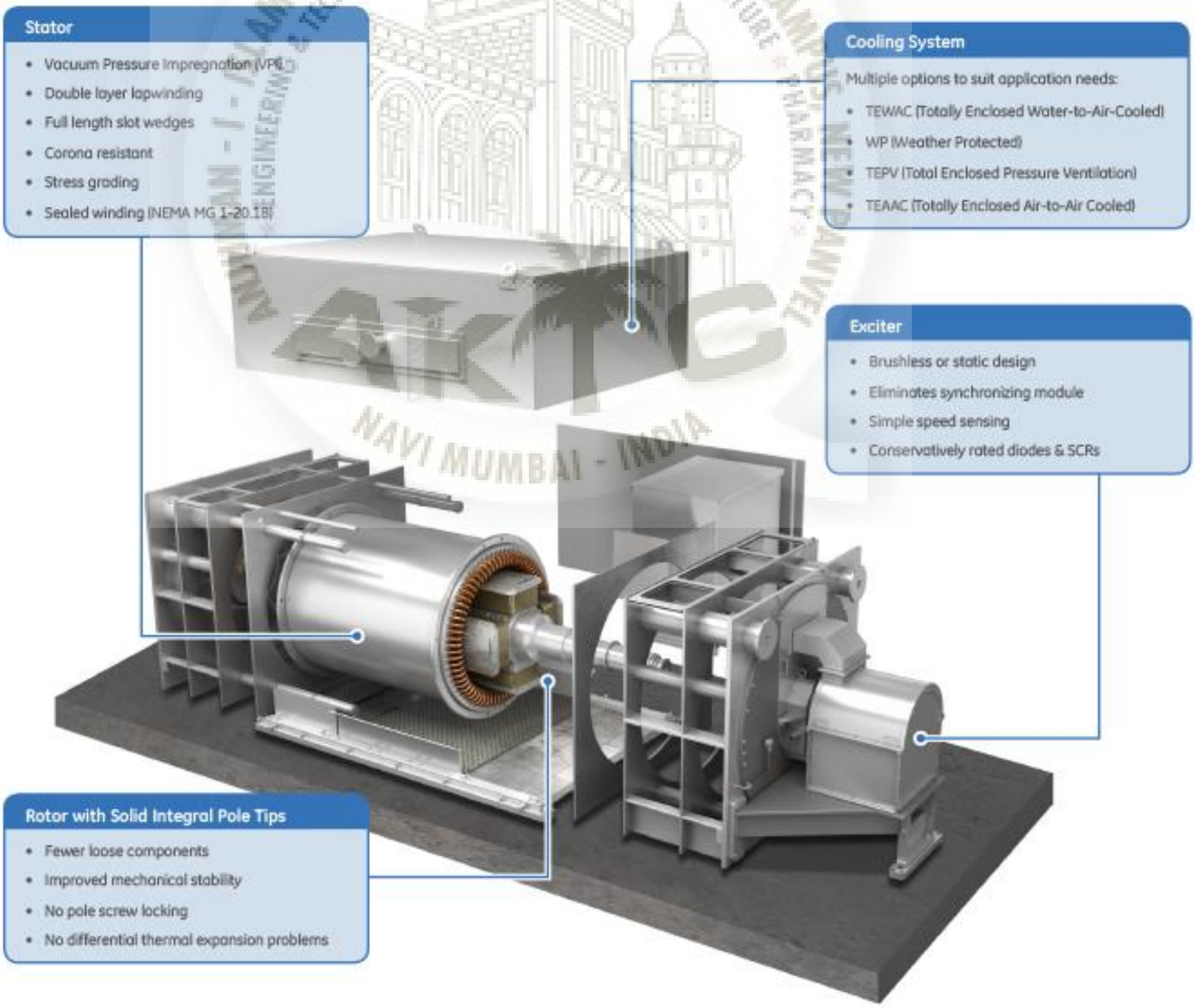
Disadvantages:

- The age of static capacitor bank is less (8 – 10 years)
- With changing load, we have to ON or OFF the capacitor bank, which causes switching surges on the system
- If the rated voltage increases, then it causes damage it
- Once the capacitors spoiled, then repairing is costly

2. Synchronous Condenser:

They are 3 phase synchronous motor with no load attached to its shaft. The synchronous motor has the characteristics of operating under any power factor leading, lagging or unity depending upon the excitation. For inductive loads, synchronous condenser is connected towards load side and is overexcited. This makes it behave like a capacitor. It draws the lagging current from the supply or supplies the reactive power.

The synchronous condenser has many advantages since it requires low maintenance, can run for up to years and is not affected by harmonics. However, its disadvantages include the high maintenance, cost and noise. It also requires an additional equipment to start the motor as it has no self-starting torque.



Advantages:

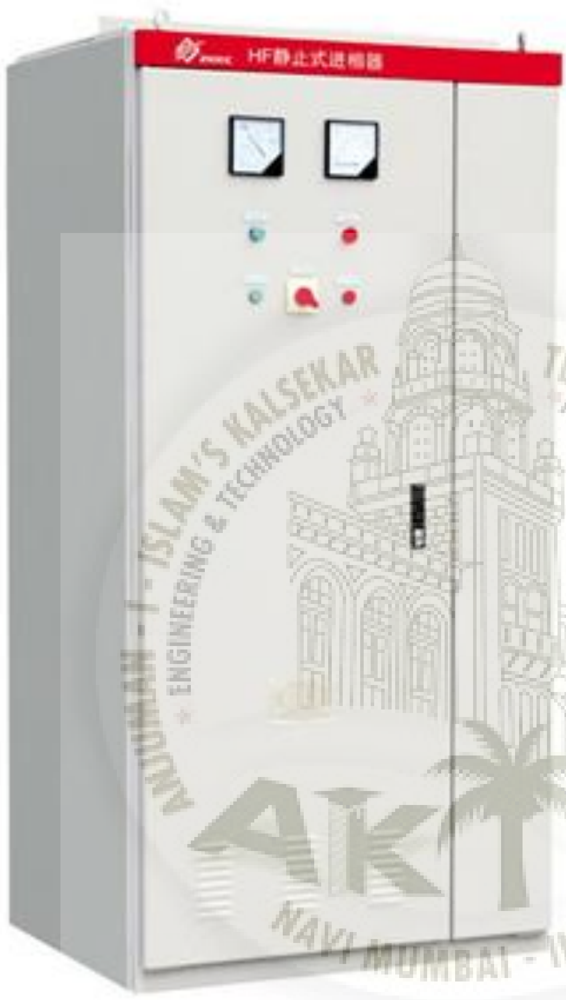
- Long life (almost 25 years)
- High Reliability
- Step-less adjustment of power factor.
- No generation of harmonics of maintenance
- The faults can be removed easily
- It's not affected by harmonics.
- Require Low maintenance (only periodic bearing greasing is necessary)

Disadvantages:

- It is expensive (maintenance cost is also high) and therefore mostly used by large
  power users.
- An auxiliary device has to be used for this operation because synchronous motor has no self starting torque
- It produces noise

Phase Advancer:

This is an ac exciter mainly used to improve pf of induction motor. They are mounted on shaft of the motor and is connected in the rotor circuit of the motor. It improves the power factor by providing the exciting ampere turns to produce required flux at slip frequency. Further if ampere turns are increased, it can be made to operate at leading power factor.



The phase advancer helps in solving the problem when it is connected to the rotor circuit of the motor. The exciting ampere-turns provided by the advancer are at the slip frequency. A leading power factor can also be obtained by providing more ampere-turns.

The main advantage of using a phase advancer includes reduced amount of reactive power drawn by the motor. It can also be used in places where a synchronous condenser is unacceptable. However, the phase advancer cannot be used for motors below 200 H.P. which is uneconomical.

Advantages:

- Lagging kVAR (Reactive component of Power or reactive power) drawn by the motor is sufficiently reduced because the exciting ampere turns are supplied at slip frequency (fs).

- The phase advancer can be easily used where the use of synchronous motors is Unacceptable

Disadvantage:

- Using Phase advancer is not economical for motors below 200 H.P. (about 150kW)

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.

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 / kvah

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

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 5thof 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 beequal.

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.


CABLE CHAMBER
MAIN POWER PANEL
412.2
125.2
0.994

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.

Fault 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 lead to heating up of the main panel

CONCLUSION & FUTURE SCOPE:

Operations and maintenance

- Conduct a nighttime audit to find out what’s on afterhours that shouldn’t be.
- Improve operations and maintenance practices by regularly checking and maintaining equipment to ensure it’s functioning efficiently.
- Optimize start-up time, power-down time, and equipment sequencing.

lighting

- Turn off lights when not in use or when natural daylight is sufficient. This can reduce lighting expenses by 10 to 40 percent.
- Maximize daylighting. After all, sunlight is free! Open or close blinds to make the best use of natural daylight and take advantage of skylights or other natural daylight sources to reduce lighting during daytime hours.

Office equipment

- Enable the power management function on office computers, which automatically puts monitors to sleep when not in use. To enable this function, visit www.energystar.gov/powermanagement.
- Activate sleep settings on all printers, copiers, fax machines, scanners, and multifunction devises so that they automatically enter a low-powered sleep mode when inactive. Use the owner's manul to make the setting changes yourself, or ask your service vendor to ensure your machines are configured to take full advantage of these features.

Heating and cooling

- Set back the thermostat in the evenings and other times when the building isn’t occupied.
- Regularly change or clean HVAC filters every month during peak cooling or heating season. Dirty filters cost more to use, overwork the equipment, and result in lower indoor air quality.
- Adjust thermostats for seasonal changes.

- Use shades and blinds to control direct sun through windows in both summer and winter to prevent or encourage heat gain.

Communication and education

- Educate employees and building occupants about how their behaviors affect energy use. ENERGY STAR has plenty of materials to help in the communications toolkit.
- Ensure that team members from every department are trained in the importance of energy management and basic energy-saving practices. Hold staff meetings on energy use, costs, objectives, and employee responsibilities.

Outside help

- Measure and track energy performance using EPA's ENERGY STAR Portfolio Manager tool.
- Use ENERGY STAR Target Finder to integrate efficiency goals into the design of new properties.
- Ask your utility if they offer free or inexpensive energy audits and/or equipment rebates.

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ENERGY MANAGEMENT PRINCIPLES by C.B. SMITH

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www.businessmanagementideas.com/energy-management/

www.bee-india.nic.in/