LABORATORY MANUAL

ENERGY CONSERVATION & AUDIT

SUBJECT CODE: 2180910

ELECTRICAL ENGINEERING DEPARTMENT

B.E. 8th SEMESTER

NAME:____

ENROLLMENT NO: ________________________________

BATCH NO: ____________________________________

YEAR: ______________________________________

Amiraj College of Engineering and Technology,
Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

Amiraj College of Engineering and Technology,
Nr.Tata Nano Plant, Khoraj, Sanand, Ahmedabad.

CERTIFICATE

This is to certify that Mr. / Ms. ____ Of class___________________ Enrolment No _________________________has Satisfactorily completed the course in __________________________________as by the Gujarat Technological University for ____ Year (B.E.) semester___ of Electrical Engineering in the Academic year__________.

Date of Submission:-

Faculty Name and Signature
(Subject Teacher)

Head of Department
(Electrical)

AMIRAJ
COLLEGE OF ENGINEERING & TECHNOLOGY

ELECTRICAL ENGINEERING DEPARTMENT

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SUBJECT: EC& A

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List Of Experiments

Sr. No.	Title	Date of Performance	Date of submission	Sign	Remark
1.					
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DATE:

PRACTICAL : 1

AIM: COMPUTING EFFICIENCY OF DC MOTOR AND INDUCTION MOTOR

APPARATUS:_ COMPUTERS

THEORY :

1) **DC MOTOR :**

A DC motor in simple words is a device that converts direct current(electrical energy) into mechanical energy.

Principle:

It is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a mechanical force whose direction is given by Fleming's Left-hand rule and whose magnitude is given by

Force, **F = B I l** Newton

Where B is the magnetic field in Weber/m^2.

I is the current in amperes and

l is the length of the coil in meter.

The force, current and the magnetic field are all in different directions.

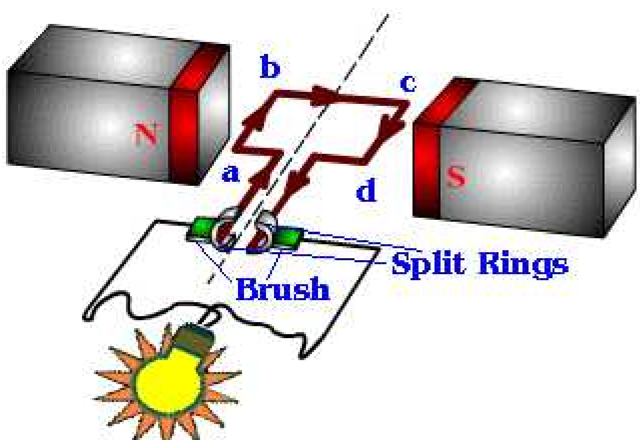


Figure 1: DC motor

CALCULATION OF DC MOTOR:

1. LOSSES: There are three major categories of losses.

1) Mechanical losses
2) Magnetic losses
3) Copper losses

1.1: Mechanical losses : Mechanical losses are the result of :

(a) The friction between the bearings and the shaft,

(b) The friction between the brushes and the commutator, and

(c) The drag on the armature caused by air enveloping the armature.

1.2 : Magnetic losses:

Since the induce E.M.F. in the conductors of the armature alternates with a frequency determined by the speed of rotation and the number of poles, a magnetic loss P_m (hysteresis and eddy-current) exists in the armature.

Rotational losses In the analysis of a D.C. machine, it is a common practice to lump the mechanical loss and the magnetic loss together. The sum of the two losses is called the rotational loss, P_r.

i.e. $P_r = P_{fw} + P_m$

1.3: Copper losses

Whenever a current flows in a wire, a copper loss, P_{cu}, is associated with it. The copper losses, also known as electrical or I^2R losses, can be segregated as follows:

1. Armature-winding loss
2. Shunt field-winding loss
3. Series field- winding loss
4. Interpole field- winding loss
5. Compensating field-winding loss

Stray-load loss

A machine always has some losses that cannot be easily accounted for; they are termed as **stray-load losses.** It is suspected that the stray-load losses in the D.C. machine s are the result of (a) the distorted flux due to armature reaction and (b) short-circuit currents in the coils undergoing commutation. As a rule of thumb, the stray-load loss is assumed to be 1% of the power output in large machines (above 100 horse power) and can be neglected in small machines.

2. FORMULA USED:

We should basically find out the constant losses as follows -

V = D.C supply voltage

Io = no-load line current

Ish = shunt field winding current

Iao = no-load armature current = (Io-Ish)

Pao = no-load armature copper losses

No-load input power =VIo
Constant losses (Pc) =Ps+Pf
Pc = VIo – Pf – Pao + Pf

Therefore,

Constant losses (Pc) = VIo - Pao

3. Calculation of total losses:

Let us consider,

We have to find out the efficiency of the D.C. shunt motor at the load

Current of „I‟ amperes

Then, Armature copper losses = I2aRa = (I – Is)2Ra

Constant losses = Pc (we found them above)

Therefore, total losses = Armature copper losses + constant losses

Total losses = (I - Ish)2Ra + Pc

4. Efficiency:

Efficiency = (output / input)*100

Input to the Motor (Total power) = VI

Motor efficiency

Ƞm = 1 – losses / input

2) CALCULATION OF EFFICIENCY OF INDUCTION MOTOR:

Efficiency is defined as the ratio of the output to that of input,

$$Efficiency,\ \eta = \frac{output}{input}$$

Rotor efficiency of the three phase induction motor ,

$$= \frac{rotor\ output}{rotor\ input}$$

= Gross mechanical power developed / rotor input

$$= \frac{P_m}{P_2}$$

Three phase induction motor efficiency,

$$= \frac{power\ developed\ at\ shaft}{electrical\ input\ to\ the\ motor}$$

Three phase induction motor efficiency

$$\eta = \frac{P_{out}}{P_{in}}$$

3) . References:

1. Dr. Bhag S.Guru, “Electric Machinery and transformers”, oxford university press, 3rd edition.
2. D.R. Kohli-S.K Jain, “A laboratory course in ELECTRICAL MACHINES” Nem Chand & Bros., 2000.

DATE:

PRACTICAL : 2

AIM: CALCULATING THE EFFICIENCY OF BOILER/ BLOWERS / COMPRESSORS.

- **What is boiler Efficiency?**

Recently, saving energy may be one of your most interested themes, and then one of the most important subjects for boiler. Then, we will reply you the followings concerning Boiler Efficiency which is closely related with the boiler saving energy. Definition of Boiler Efficiency is "The percentage of the total absorption heating value of outlet steam in the total supply heating value." In other word, it is a rate how the boiler runs.

$$Boiler\,efficiency(\eta) = \frac{Q x (H - h)}{q x CCV} x100$$

Calculating boiler efficiency

There are two different means of calculating the boiler efficiency:

1. The Direct method
2. The Indirect method.

Direct method

In the direct method, the boiler efficiency is directly defined by the exploitable heat output from the boiler and by the fuel power of the boiler:

efficiency (η) = Heat Input/Heat Output x 100 = Q x (hg - hf)/ Q x GCVhg x 100

Where,
Hg - the enthalpy of saturated steam in kcal/kg of steam
hf - the enthalpy of feed water in kcal/kg of water

Direct Method Advantages

- Quick evaluation
- Few parameters for computation
- Few monitoring instruments
- Easy to compare evaporation ratios with benchmark figures

Disadvantages

- No explanation of low efficiency
- Various losses not calculated

Indirect method

Indirect method determines the efficiency of a boiler by the sum of the major losses and by the fuel power of the boiler:

Efficiency of boiler (η) = 100 – (i+ii+iii+iv+v+vi+vii)
Principle losses:
i) Dry flue gas
ii) Evaporation of water formed due to H2 in fuel
iii) Evaporation of moisture in fuel
iv) Moisture present in combustion air
v) Unburnt fuel in fly ash
vi) Unburnt fuel in bottom ash 28vii) Radiation and other unaccounted losses

Types of Boiler Efficiency:

The efficiency of a boiler may be classified into following three major types:

1. Combustion Efficiency
2. Thermal Efficiency
3. Fuel-to-Steam Efficiency

Amongst all the three above mentioned boiler efficiencies, the fuel-to-steam efficiency is considered to give the most accurate representation of boiler efficiency on the whole. This is due to the fact that fuel-to-steam efficiency takes into account, the radiation and convection losses while performing efficiency calculations. Typically, it is the job of the boiler manufacturer to define boiler efficiency so that any type of economic analysis could be done properly.

Combustion Efficiency

Combustion efficiency generally gives an idea about the fuel burning capability of a burner. This type of efficiency is determined by the quantity of fuel which is left unburned in the boiler along with the surplus exhaust air. For getting high boiler efficiency, their burners should be well designed to provide low quantities of unburned fuel and excess air. Combustion efficiency tends to vary with the types of fuel sources. In general, gaseous and liquid fuels result in very small amount of unburned fuel as well as 15% surplus air levels; hence they offer highly efficient burning as compared to solid substances. “By operating at only 15% excess air, less heat from the combustion process is being used to heat excess air, which increases the available heat for the load.”

Thermal Efficiency

This type of boiler efficiency is only used to assess the performance of **heat exchanger** units used in boilers. It basically determines the efficacy via which a heat exchanger would convey heat generated by burning process to the fluid in the boiler. While doing so, it does not take into account the radiation and convection losses occurring in the boiler sections. Hence, **thermal efficiency** is not considered valuable for economic analysis since it doesn't reflect correct fuel consumption of a boiler system.

Fuel-To-Steam Efficiency:

Fuel-to-steam efficiency is helpful in determining the overall efficiency of a boiler since it takes into consideration both the thermal efficiency i.e. heat exchanger effectiveness and the radiation and convection losses. This is the type of boiler efficiency which is ought to be used for making all types of economic assessments.

Methods of Determination

The two major methods employed to find out the fuel-to-steam efficiency of a boiler are explained below:

Input-Output Method

This method of efficiency determination largely depends upon the input-output ratio determination of the boiler. In this method, the output of the boiler derived in **BTUs** is divided by the boiler input supplied in BTUs and then the resulting number is multiplied by 100.

Heat Loss Method

It is also referred to as **heat balance** efficiency measurement method. This method of efficiency determination takes into account all kinds of heat losses occurring inside the boiler. The true boiler efficiency is calculated by summing up the percentage of all stack, radiation and convection losses and then finally deducting the resultant sum from 100 percent. This entire calculation will provide actual fuel-to-steam boiler efficiency.

<u>**Types of losses**</u>

Two major types of losses which take place inside a boiler system are mentioned below:

<u>**Stack Losses**</u>

"The **stack temperature** is the temperature of the combustion gases (dry and water vapor) leaving the boiler and reflects the energy that did not transfer from the fuel to the steam or hot water." In other words, it gives an indication about the quantity of heat energy lost due to dry exhaust gases and moisture loss. It is found valuable in determining the true efficiency of a boiler. A lower value of the stack temperature is always preferred for gaining well efficient heat exchanger performance and greater fuel-to-steam boiler efficiency.

<u>**Radiation and Convection Losses**</u>

Radiation losses are defined as the losses which occur due to radiation i.e. emission of heat energy out of the boiler whereas **convection losses** are the losses happening due to the air circulating around the boiler. Nearly all kinds of boilers experience these two significant losses. "Radiation and convection losses, expressed in Btu/hr., are essentially constant throughout the firing range of a particular boiler, but vary between different boiler types, sizes, and operating pressures.

<u>**Conclusion:**</u>

DATE:

PRACTICAL : 3

AIM: Draw the Energy Flow Diagram for the industry/Shop Floor Division

APPARATUS:_COMPUTERS

ABSTRACT:

Different studies have shown that there are opportunities for major energy efficiency improvements in the industrial sector and many of them are cost effective. These energy conservation measures are general and also niche specific. Owners or managers of industrial parks and factories are not always aware of the possibilities for energy efficiency improvements. Energy audit is the first step in order to discover the possibilities of energy savings, prioritizing projects, tracking progress and making system adjustments after investments. Industrial energy audit is a process that makes saving of energy and raw materials possible. Quality of the end product often is also increased. By improving a local electricity grid and overall building and manufacturing process characteristics there is also often observed a decrease in factory down time. Industrial energy audit is quite new in Latvia, but by using the world experience and following standards, projects have been elaborated where the energy savings exceed 70% of total energy demand (Latvijas…, 2011). These processes have defined the topicality of this article; the aim of the article is to analyze energy audit method for industrial plants. Keywords: industrial energy audit, energy efficiency, energy savings, industrial energy audit guidelines

STEPS OF INDUSTRIAL ENERGY AUDIT: An industrial energy audit is a process that facilities energy usage patterns, equipment efficiency, and overall building efficiency is determined in order to propose energy efficiency measures. The result of a successful energy audit is decreased energy consumption, reduced raw material usage and increased quality of the end product. The data collected by an energy auditor is the basis on which the energy efficiency suggestions will be created. The implementation of these measures will reduce manufacturing costs and also the negative effects on the environment. "Industrial energy audit is a new term in Latvian. It is a process aimed at finding loopholes in the production process, a design task in order to save raw materials and energy. Performing industrial energy audits makes it possible to save raw materials, energy, optimizing the manufacturing process or raising the company's profits and increase competitiveness. After an industrial energy audit, the client data will have an accurate list of energy efficiency measures which will reduce costs and the environmental impact. The industrial energy audit consists of the following steps (International…, 2007)"

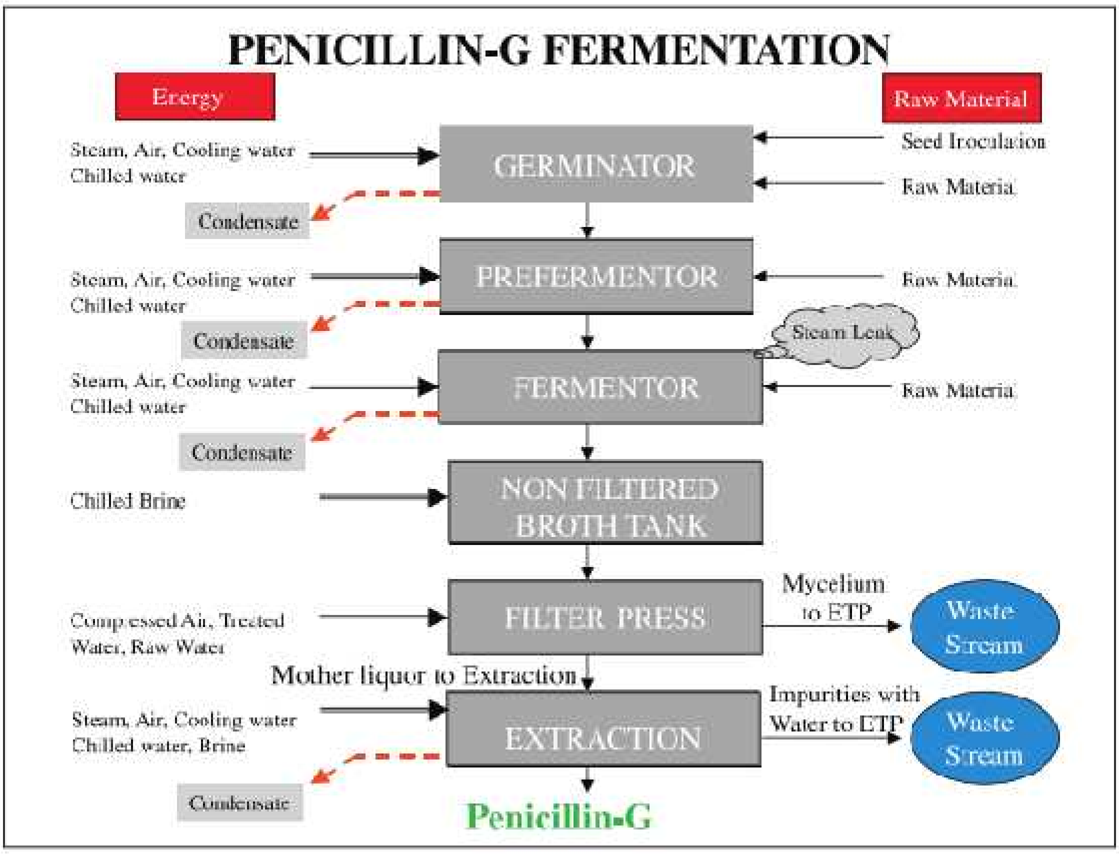
Step 1. Data collection: The presentation of the process or stage. The first task of the energy audit is getting acquainted with the entire production process or stage. What is produced, which inputs are used? How much water is supplied, the amount of energy used, characteristics and quantity of raw materials used and other specific information that can be useful in the audit process, for example waste treatment. The principal scheme. When gathering data for the energy audit the principal scheme can be very useful because it includes all of the energy flows and process relationships. Data collection. Collection of data on the entire production process and a specific period is one of the main steps of the energy audit. When collecting data about the manufacturing process and systems, it is very important to collaborate with the employees as they know the systems very well. The benchmark. The collected data are compared with the data from similar companies across Europe or Latvia. Defining the problem. After comparison of the consumption problematic systems, systems with relatively high energy usage can be defined.

Step 2 Data processing: Creating a team of specialists. After defining the problem, the specialists from the appropriate fields are incorporated into the audit process. Necessary calculations. Calculations are carried out for all of the manufacturing steps, and the possible energy efficiency improvements are identified. Accurate scheme for the production of energy and raw material flows. A pre-established production scheme is improved, supplemented with information acquired in the energy audit process

Step 3 Analysis of results: The most appropriate solutions are identified and justified. Exact energy efficiency suggestions are presented. The goal of the suggestions is improving the manufacturing process and decreasing energy and raw material consumption. All of the suggested improvements are integrated in an overall process diagram or scheme in order to obtain a better understanding on how these changes will affect the overall manufacturing process. Selection of an appropriate solution based on the potential savings, the impact on production processes and technologies, as well as potential investments are selected for energy efficiency measures to be economically justified.

Step 4 Recommendations for improvement: Proposed technology integration in the scheme. Improvements are included in the scheme in a way to better understand how it will affect the entire process. The choice of the right solution. Based upon the potential savings, the impact on production processes and technologies, as well as potential investments and ROI, energy efficiency measures are selected.

Step 5 Economic foundations: All of the energy efficiency suggestions are justified for their economic benefit. Measures considered most often: pay-back time and ability to attract EU structural funds. Choosing economically reasonable energy efficiency measures. After an economical analysis, the most advantageous measures are chosen. Pay off times and capital costs are considered.(International…, 2007) ANALYSIS The main purpose of an energy audit is to find out the energy usage patterns, the amount of energy used, and most important - the amount of energy needed. Next, based on these findings the auditor must develop possible scenarios of energy efficiency with precise recommendations and return on the investment analysis. In Figure 1, the general energy flow is shown, two main parts are considered – total facility energy use and facility energy production (National…, 2010). Often the only measured branch from the facility energy production chart is thermal energy production, but even more often this energy is used in a nonefficient way. A different situation is in the “Total Facility Energy Use” branch, because the energy consumed by the facility is precisely metered due to the fact that this is the metric by which the facility is billed by the energy supply company. But if the energy is used in different processes and facilities, the need for local energy monitoring devices arises. Detailed energy consumption monitoring provides the information necessary for adjusting the manufacturing process in order to obtain higher energy efficiency and lower energy costs even without changing any equipment. This information can also be used to determine the main energy consumers and create an action plan to lower the overall facility energy usage (Canadian…, 2010). Tier 1 layer in Figure 2 accounts for facility energy production and facility energy usage. The total facility energy usage can be either positive or negative depending on the facility type and equipment used. Most of the time the net facility energy use will be negative, because the majority of the companies are only energy consumers and not producers. This is especially true in Latvia; most of the companies lack the capabilities of energy production either for themselves or for selling to the grid. Often this is due to the fact that there are no additional resources to spend on new, energy producing systems and most commonly due to the difficulties of selling energy back to the grid (International…, 2007).



Conclusion:

DATE:

PRACTICAL :4

AIM: INDUSTRY VISIT WITH AN AIM OF

3. **STUDING VARIOUS ENERGY MANAGEMNET SYSTEM PREVALLING IN A PARTICULAR ORGANIZATION/ INDUSTRY**
4. **IDENTIFY THE VARIOUS ENNERGY CONSERVATION METHODS USEFUL IN A PARTICULAR INDUSTRY**

THEORY:

- **ENERGY MANAGEMNET SYSTEM:**

An **energy management system** (**EMS**) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system.

The computer technology is also referred to as SCADA/EMS or EMS/SCADA. In these respects, the terminology EMS then excludes the monitoring and control functions, but more specifically refers to the collective suite of power network applications and to the generation control and scheduling applications.

Manufacturers of EMS also commonly supply a corresponding dispatcher training simulator (DTS). This related technology makes use of components of SCADA and EMS as a training tool for control centre operators. It is also possible to acquire an independent DTS from a non-EMS source such as EPRI

Energy management systems are also often commonly used by individual commercial entities to monitor, measure, and control their electrical building loads. Energy management systems can be used to centrally control devices like HVAC units and lighting systems across multiple locations, such as retail, grocery and restaurant sites. Energy management systems can also provide metering, submetering, and monitoring functions that allow facility and building managers to gather data and insight that allows them to make more informed decisions about energy activities across their sites.

Manufacturing industry energy management

Any type of company responsible for the manufacturing of any type of product (hardware or software) consumes a large portion of total world energy. Energy management works under the following guideline:

1. Plan - data acquisition, processing and documentation, energy target and objective, energy management and action plan
2. Do - resources, raising awareness and training, communication, documentation, operation control
3. Check - monitoring document, corrective and preventive action, planning and record, internal audit
4. Act- management review

- **VARIOUS ENNERGY CONSERVATION METHODS:**

What is Energy Conservation?

Energy conservation is one of the words you are hearing more and more. Unfortunately, a lot of the places you will hear it will be in ads marketing products or lifestyle habits that may have nothing to do with actual energy conservation. To learn what real energy conservation techniques are, you have to begin to understand the theory of conservation behind them.

- ## Practical Methods of Energy Conservation

Below are 8 energy conservation techniques that can help you to reduce your overall carbon footprint and save money in the long run.

1. Install CFL Lights: Try replacing incandescent bulbs in your home with CFL bulbs. CFL bulbs cost more upfront but last 12 times longer than regular incandescent bulbs. CFL bulbs will not only save energy but over time you end up saving money.

2. Lower the Room Temperature: Even a slight decrease in room temperature lets say by only a degree or two, can result in big energy savings. The more the difference between indoor and outdoor temperature, the more energy it consumes to maintain room temperature. A more smarter and comfortable way of doing this is to buy a programmable thermostat.

3. Fix Air Leaks: Proper insulation will fix air leaks that could be costing you. During winter months, you could be letting out a lot of heat if you do not have a proper insulation. You can fix those leaks yourself or call an energy expert to do it for you.

4. Use Maximum Daylight: Turn off lights during the day and use daylight as much as possible. This will reduce the burden on the local power grid and save you good amount of money in the long run.

5. Get Energy Audit Done: Getting energy audit done by hiring an energy audit expert for your home is an energy conservation technique that can help you conserve energy and save good amount of money every month. Home energy audit is nothing but a process that helps you to identify areas in your home where it is losing energy and what steps you can take to overcome them. Implement the tips and suggestions given by those energy experts and you might see some drop in your monthly electricity bill.

6. Use Energy Efficient Appliances: When planning to buy some electrical appliances, prefer to buy one with Energy Star rating. Energy efficient appliances with Energy Star rating consume less energy and save you money. They might cost you more in the beginning but it is much more of an investment for you.

7. Drive Less, Walk More and Carpooling: Yet another energy conservation technique is to drive less and walk more. This will not only reduce your carbon footprint but will also keep you healthy as walking is a good exercise. If you go to office by car and many of your colleagues stay nearby, try doing carpooling with them. This will not only bring down your monthly bill you spend on fuel but will also make you socially more active.

8. Switch Off Appliances when Not in Use: Electrical appliances like coffee machine, idle printer, desktop computer keep on using electricity even when not in use. Just switch them off if you don’t need them immediately.

9. Plant Shady Landscaping: Shady landscaping outside your home will protect it from intense heat during hot and sunny days and chilly winds during the winter season. This will keep your home cool during summer season and will eventually turn to big savings when you calculate the amount of energy saved at the end of the year

CONCLUSION:

DATE:

PRACTICAL :5

AIM: STUDY OF VARIOUS INSTRUMENT USED FOR ENERGY AUDIT: LUX METER, POWER ANALYZE, FLUE GAS ANALAYZER.

- **Following instrument is used for energy audit:**

1.Flue Gas AnalyzersUsed for optimizing the combustion efficiency by measuring/monitoring the oxygen and CO levels in flue gas of boilers, furnaces etc. and calculation of CO2 percentage in excess air level and efficiency

.2.Temperature IndicatorsUsed for measuring temperatures of gases/air, liquids, slurries, semi solids, powders etc. Using different types of probes

3.Infrared ThermometersUsed for measuring temperatures from a distance using infrared technology.

4.Thermal Insulation scannerUsed for measuring loss of energy in Kcal per unit area from hot/cold insulated surfaces. The total loss can be obtained by multiplying the total surface under study.

5.Steam Trap Monitor Used for performance evaluation of steam Traps

6.Conductivity Meter Used for on the spot water analysis of the amount of dissolved solids in water.

7. PH meterUsed for on the spot analysis of effective acidity or alkalinity of a solution/water. Acidity /alkalinity water.

8.Thermo-hygrometerUsed for measurement of air velocity & humidification, ventilation, Air-conditioning and refrigeration systems etc.

9.Thermo-hygrometer Used for measurement of humidity and temperature and the calculation of dew point to find out the heat being carried away by out going gases in industries. Where product drying requires hot air.

10.Ultrasonic Flow MeterUsed for measurement of flow of liquids through pipelines of various sizes through ultrasonic sensors mounted on the pipelines

11.U-Tube ManometerUsed for measurement of differential pressure.

12.Digital ManometerUsed for measurement of differential pressure.

13.VisguageUsed for measurement of differential viscosity.

14.Used Lube Oil Test KitUsed for testing lube oil.

15.Non-Contact TachometerUsed for measurement of speed of rotation equipment.

16.Demand AnalyzerUsed for measurement and analysis of electrical load and demand control.

17.Power AnalyzerUsed for measurement and analysis of electrical Power.

18.Harmonic AnalyzerUsed for analysis of harmonics in power System.

19.LuxmeterUsed for measurement of illumination level.

20.Clip on Dig. Watt MeterUsed for measurement of power without interrupting the connections.

21.Clip on Dig. PF MeterUsed for measurement of power factor without interrupting the connection.

22.Clamp on amp. MeterUsed for measurement of current without Interrupting the connections.

23.Digital MultimeterUsed for measurement of voltage. Current and resistance

24.Frequency Meter Used for measurement of power supply frequency.

1. **Luxmeter:**

Lux meters are used for measuring brightness in lux, fc or cd/m². Some lux meters are equipped with an internal memory or data logger to record and save measurements. The measurement of light intensity with a lux meter is becoming increasingly important in the workplace due to safety concerns. PCE Instruments' lux meters with data loggers are highly regarded in the industry due to the devices' cosine correction of the angle of incident light. Many lux meters include software for detailed analysis and offer different interfaces for transferring measured data to a computer.

2. **Power Analyzers:**

At PCE Instruments you will find power analysers to measure the power in W, kWh or to analyze and measure harmonics. These power analysers are multi-function power analysers devices that measure precisely direct current, alternating current, AC-voltage, DC-voltage the

intensity of DC or AC, phase rotation and idle, apparent and effective power. The reading of AC power is considered the real value and has a maximum range of 6000

Watts. While a reading is being taken, the polarity changes automatically, if negative values are taken then a minus sign will appear on the device display. Nowadays, power analysers have many features such as, insulated current input, measurement of harmonics, AC and DC current measurement, AC and DC voltage measurement, frequency measurement, phase rotation measurement and idle, apparent and effective power measurement. All this data can also be logged and analysed with the delivered PC-Software. Power analysers of the type PCE PA 6000 can determine the energy in single-phase systems. Power analysers of type PCE-GPA 62 allow the energy measurement in symmetrically loaded three-phase systems. Power analysers of type PCE-PA 8000, PCE-360 and PCE-830 support professional power and energy measurements in single and three-phase systems. Apart from being used as energy-measuring devices, power analysers like the PCE-830 can also be used for network analysis and the determination of harmonics and phase rotation. On our website you will find other power analysers used in the field of electronics. If you can't find the power analysers you are looking for, please contact us and we will help you find the best solution to suit your needs by calling our offices on: UK customers +44(0) 23 809 870 30 / US customers (561) 320-9162 and our technical staff will advise you regarding our measuring instruments. Our engineers and technicians will be happy to help you with the power analysers, and of course, with the other products in the field of regulation and control, and scales and balances.

CONCLUSION:

€DATE:

PRACTICAL :6

AIM: IDENTIFY THE ENERGY CONSERVATION OPPURUNITIES IN A LAB, DEPARTMENT OR INSTITUTE.

THEORY:

- ## ENERGY CONSERVATION

One of the iSERVcmb project aims was to establish where energy and cost savings possible from the iSERVcmb approach were most likely to occur. The project has produced an Energy Conservation Opportunity (ECOs) identification methodology based on measured and modelled data for Buildings, HVAC Systems and HVAC Components, which identifies ECOs specific to buildings, systems and components.

The **energy industry** is the totality of all of the industries involved in the production and sale of energy, including fuel extraction, manufacturing, refining and distribution. Modern society consumes large amounts of fuel, and the energy industry is a crucial part of the infrastructure and maintenance of society in almost all countries.

In particular, the energy industry comprises:

- the petroleum industry, including oil companies, petroleum refiners, fuel transport and end-user sales at gas stations
- the gas industry, including natural gas extraction, and coal gas manufacture, as well as distribution and sales
- the electrical power industry, including electricity generation, electric power distribution and sales
- the coal industry
- the nuclear power industry
- the renewable energy industry, comprising alternative energy and sustainable energy companies, including those involved in hydroelectric power, wind power, and solar power generation, and the manufacture, distribution and sale of alternative fuels

- traditional energy industry based on the collection and distribution of firewood, the use of which, for cooking and heating, is particularly common in poorer countries

Energy conservation refers to the reducing of energy consumption through using less of an energy service. Energy conservation differs from efficient energy use, which refers to using less energy for a constant service.[1] Driving less is an example of energy conservation. Driving the same amount with a higher mileage vehicle is an example of energy efficiency. Energy conservation and efficiency are both energy reduction techniques. Energy conservation is a part of the concept of sufficiency.

STEPS TO IMPOROVE ENERGY IN LAB:

1. **Laying the foundation**

As the saying goes, ―You can't manage what you don't measure.‖ Achieving an active energy management model starts with the collection of data to monitor and measure how and where energy is used. In most laboratories, that means monitoring several utility types—from primary sources such as gas and electricity to secondary media such as steam, hot and chilled water, and compressed air. Each has its associated energy cost and CO2 footprint. Gathering accurate and relevant information from all of these utilities lays the foundation for an effective plan. Data collection - Utility meter and billing data is a good starting point. This can be useful for identifying standing load or idle time consumption and reviewing tariff suitability, but gives only a highly aggregated view without the granularity necessary to pinpoint energy waste. To generate more useful information, a metering strategy should be developed that may include, for example, the ability to account for 90% of energy by end-use type, provide individual metering of loads and feeders of a certain size, and monitor all energy streams by lab facility Figure 2 The energy management lifecycle leverages the deployment of both passive and active efficiency best practices 1. Energy audit and measure Four Steps for Improving Energy Efficiency in Laboratories Schneider Electric White Paper Revision 0 Page 4 or department. Companies should plan for rolling out metering to existing equipment and set standards for new lab purchases.

Modern meters can facilitate remote automatic data collection. Audit approaches can range from a one or two day walkthrough of key energy consuming areas, to a comprehensive audit with detailed recommendations and estimates for energy saving opportunities. Whatever approach is taken, audit outcomes should focus on producing an energy action plan that includes detailed costs and savings potential. Performance contracts - It is often possible to guarantee savings through a performance contract. Under this scenario, the risk and reward is shared with the supplier. Following an audit, an energy action plan is developed and savings opportunities estimated and evaluated. The savings generated from implementing the plan are used to help pay for the cost of the capital equipment over a specified number of years—minimizing the financial risk to the organization. This approach necessitates a higher level of monitoring before and after interventions, with a higher level of involvement from both parties and a more detailed contractual agreement.

2 .Upgrade and improve to reduce losses

Once energy data has been captured and analyzed, the next step is to use that data to reduce energy waste. Laboratories often start with the basics: using passive energy efficiency measures to reduce losses from energy consuming devices. A variety of technologies exist to help improve energy efficiency. Examples of passive energy efficiency approaches include:

- Low energy lighting
- Low loss transformers
- High efficiency motors

The importance of motors - Motors should be a major focus of energy efficiency measures, since they typically consume a large percentage of the electrical energy in a lab facility, much of it related to HVAC systems. This can be done in a variety of ways, from awareness programs and incentive contests, to formal training on procedures. The exact approach will vary for each laboratory and location, but the key is to remember that energy efficiency is not just an equipment issue; it is a behavioral issue as well. Motivating and educating employees will improve the effectiveness of any energy efficiency action.

3.Active Energy Efficiency

The passive measures described in Step 2 are important to implement. However, to have an effective energy management program, active energy efficiency should be embedded into the laboratory through automated control systems. Active energy reduction is challenging in laboratories, where maintaining the proper environment is critical to safety, compliance and research success. This is especially true for high-containment laboratories, where there is an overriding need to ensure containment of highly pathogenic organisms and to meet rigorous regulatory standards. But with careful measuring and auditing, it is usually possible to find energy waste that can be safely eliminated, without harming compliance or quality in any way. Real auditing examples of energy waste include basic problems such as heating and cooling ―demand fighting‖, humidity controls set much lower than tolerances require, and no set back to temper conditions for when the lab is not in use. Correcting such problems can yield significant savings, often for little investment. Optimize air flow rates - Air flow systems are especially critical in laboratories, where 100% fresh air is often required, with additional filtering, treating and conditioning to maintain the correct temperature and humidity. In many labs, ventilation systems alone can account for up to 80% of the energy consumption. Much of this energy use can be safely reduced, with the proper monitoring and controls. Often, actual flow rates are much higher than design requirements, and sometimes even the design flow rates are higher than needed due to change of use. Optimize through automation and control Four Steps for Improving Energy Efficiency in Laboratories Schneider Electric White Paper Revision 0 Page 6 Improve the exhaust system - Exhaust systems merit particular attention―

they comprise up to 40% of the ventilation system's energy use, and as much as 30% of a lab's total energy consumption.4 The good news is that, by using automated monitoring and control systems; it is often possible to safely reduce energy use in lab exhaust systems by as much as 50%, which would reduce a lab's total energy use by 15%. Accurate set points - Exhaust systems in labs are typically maintained at full power on a constant basis—24x7 in many labs. Furthermore, these settings are usually based on worstcase scenarios for wind conditions and contaminants. In the case of wind, for example, the most extreme conditions rarely occur. And in the case of contaminants, the EPA states that: "An overly conservative judgment about the potential toxicity of an exhaust stream may result in a high-energy-use exhaust system as volume flow or exit velocity is increased unnecessarily." The agency recommends that exhaust flow be based on scientific measurements of actual contaminants, adjusting exhaust flow accordingly to achieve "an exhaust system that yields acceptable air quality while consuming a minimum amount of energy."5 For example, based on the experience of operating research labs that have used air qualit y monitors in their exhaust flow, it has been found that worst-case airflow rates are needed only about 12 hours per year—which means that lower set points could be used, if proper monitoring were in place, as much as 99% of the time. One laboratory was able to reduce exhaust-related energy use to just 10% of previous levels, through the use of a staged variable-air-volume (VAV) system with anemometer control. This resulted in annual savings of $81,000, plus an additional bonus of $90,000 from the utility company for the conservation measures.6 Manifold exhaust systems - According to ―Laboratories for the 21st Century‖, a manifold exhaust system should be used where possible. This approach, with a primary fan and a backup unit in a common duct system, is more efficient than separately ducted, multiple exhaust fans. A paper from their web site names four ways a manifold exhaust system saves energy:

- Reduces fan power
- Provides adjustable airflow that can modulate energy use to varying requirements
- Requires less energy to disperse exhaust plumes
- Increases energy recovery opportunities Experience has shown that during laboratory retrofit projects, manifold exhaust systems reduce construction costs and help avoid operational disruptions.

CONCLUSION:

DATE:

PRACTICAL :7

AIM: PREPARE A SAMPLE ENERGY AUDIT QUTIONNNARIE.

1	What are the immediate term energy strategies recommended? The immediate term energy strategies recommended are: • Rationalizing the tariff structure of various energy products • Optimum utilization of existing assets • Efficiency in production systems and reduction in distribution losses, including those in traditional energy sources. • Promoting R & D, transfer and use of technologies and practices for environmentally sound energy systems, including new and renewable energy sources.
2	A 3 ϕ AC Load draws 8 KW power at 400 V supply voltage and 15 A line current. Calculate the power factor of the load. Supply Voltage of the System (V_L) = 400 Line Current (I_L) -=15 A Apparent Power = $\sqrt{3}$ x V_L x I_L = $\sqrt{3}$ x 0.400 x 15 = 10.392 KVA Active Power = $\sqrt{3}$ x V_L x I_L x (Cos ϕ) KW Given, active power of the Load = 8 KW Hence, 10.392 COS ϕ = 8 KW $P.F, Cos¤ = \frac{8}{10.392} = 0.77$

3	How benchmarking of energy consumption internally and externally may be useful. Benchmarking of energy consumption internally and externally (historical/trend analysis) are two powerful tools for performance assessment and logical evolution of avenues for improvement. Historical data well documented helps to bring out energy consumption and cost trends month-wise/day-wise trend analysis of energy consumption, cost, relevant production features, specific energy consumption help to understand effects of capacity utilization on energy use efficiency and costs on a broader scale.
4	Why steam is used as a popular mode of conveying energy? The following characteristics of steam make it very popular and useful to convey energy in the industries. • High Specific heat and latent heat • High heat transfer coefficient • Easy to control and distribute • Cheap and inert
5	In a chlora-alkali plant, the inlet brine concentration to cell house is 300 gpl and the outlet concentration is 260 gpl. If 3 MT Salt is added per hour, find out the brine flow rate to the Cell House. Answer : Inlet concentration of brine = 300 gpl Outlet concentration of brine = 260 gpl Salt consumption per litre of Flow = (300-260) gm = 40 gm = 0.040 Kg For 3 MT/hr Salt consumption, flows = 3 x 1000 Kg /hr ---------------------- 0.040 Kg/lit = 75,080 Lit/hr = 75 m^3/hr
6	What are the duties and responsibilities (five each) of Energy Manager as per the Energy

Conservation Act 2001?

Responsibilities

- Prepare an annual activity plan and present to management concerning financially attractive investments to reduce energy costs
- Establish an energy conservation cell within the firm with management's consent about the mandate and task of the cell.
- Initiate activities to improve monitoring and process control to reduce energy costs.
- Analyze equipment performance with respect to energy efficiency
- Ensure proper functioning and calibration of instrumentation required to assess level of energy consumption directly or indirectly.

Duties

- Report to BEE and State level Designated Agency once a year the information with regard to the energy consumed and action taken on the recommendation of the accredited energy auditor, as per BEE Format.
- Establish an improved data recording, collection and analysis system to keep track of energy consumption.
- Provide support to Accredited Energy Audit Firm retained by the company for the conduct of energy audit
- Provide information to BEE as demanded in the Act, and with respect to the tasks given by a mandate, and the job description.
- Prepare a scheme for efficient use of energy and its conservation and implement such scheme keeping in view of the economic stability of the investment in such form and manner as may be provided in the regulations of the Energy Conservation Act.

7 Explain Net Prevent Value and how NPV is calculated.

<u>Net Present Value:</u>

The net present value (NPV) of a project is equal to the sum of the present values of all the cash flows associated with it.

$$NPV = \frac{-CF_0}{(1+k)^0} + \frac{CF_1}{(1+k)^1} + \cdots + \frac{CF_n}{(1+k)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

	Where NPV = Net Present Value CF_t = Cash flow occurring at the end of year ' t ' (t = 0,1, ….n) n = Life of the project k = Discount rate The discount rate (k) employed for evaluating the present value of the expected future cash flows should reflect the risk of the project.
8	Define project and mention various steps involved in Project Management A project is a temporary endeavor undertaken to create a unique product or service. A project is temporary in that there is a defined start (the decision to proceed) and a defined end (the achievement of the goals and objectives) **<u>Steps in Project Management:</u>** The various steps in a project management are: a) Project definition and scope b) Technical Design c) Financing d) Contracting e) Implementation Performance Monitoring
9	Calculate fixed energy consumption for a rolling mill consuming 3,00,000 units electricity to produce 500 MT product per month and having specific energy consumption of 500 Kwh/MT. Total energy consumed = Fixed Energy Consumption + (Specific Energy Consumption x Production) Fixed energy consumption = Total energy consumed – (Specific energy consumption x Production)

	Given, Total Energy Consumption = 3,00,000 Kwh Specific energy Consumption = 500 Kwh / MT Total Production = 500 Mt Fixed Energy Consumption = 300000 – (500 x 500) = 5000 Units
10	Explain briefly about Emission Trading? Article 17 of the Kyoto protocol opens up for emissions trading between countries that have made commitments to reduce greenhouse gas emissions. The countries have option to delegate this right of emissions trading to companies or other organizations. In a system for emissions trading, the total amount of emissions permitted is pre-defined. The corresponding emissions allowances are then issued to the emitting installations through auction or issued freely. Through trading, installations with low costs for reductions are stimulated to make reductions and sell their surplus of emissions allowances to organizations where reductions are more expensive. Both the selling and buying company wins on this flexibility that trades offers with positive effects on economy, resource efficiency and climate. The environmental advantage is that one knows, in advance, the amount of greenhouse gases that will be emitted. The economical advantage is that the reductions are done where the reduction costs are the lowest. The system allows for a cost effective way to reach a pre-defined target and stimulates environmental technology development.

Section - III: LONG DESCRIPTIVE QUESTIONS

1	Explain in detail the difference between Energy Conservation and Energy efficiency and its relevance Energy Conservation and Energy Efficiency are separate, but related concepts. Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of

	production or consumption is reduced without affecting output consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies. Energy efficiency is often viewed as a resource option like coal, oil or natural gas. Energy efficiency provides additional economic value by preserving the resource base and reducing pollution. For example, replacing traditional light bulbs with Compact Fluorescent Lamps (CFLs) will use only ¼ of the energy to light a room. Apart from the economic benefits, energy conservation and energy efficiency measures would assist in controlling the CO_2 emission.
2	Explain in detail the methodology for conducting a detailed energy audit. A detailed energy audit is carried out in three phases: a) Pre-audit phase b) Audit phase & c) Post Audit phase **<u>Pre Audit Phase:</u>** A structured methodology to carryout an energy audit is necessary for efficient working. An initial study of the site is essential, which will give an energy auditor an opportunity to meet the personnel concerned to familiarize the site and assess the procedures necessary to carry out the energy audit. The main aim of this visits are: • To identify the main energy consuming areas/plant items to be surveyed during the audit. • To identify any existing instrumentation/additional metering required • To decide whether any meters will have to be installed prior to the audit e.g. Kwh steam, oil or gas meters. • To identify the instrumentation required for carrying out the audit **<u>Audit Phase:</u>** As a first step during the audit phase, Energy Auditor would collect the base line data, preparation of process flow charts etc. The monitoring and measurement will be next stage. As per the field observations, detailed trials may be conducted for selected energy guzzlers in the plant. Once all the operating data and design data and other operational practices are collected/observed, detailed analysis of the data will have to be done. Based on the analyses, Energy Conservation opportunities may be developed and the economic viability of the options has to be established.

	The study has to properly documented and the suggestions and findings are to be presented to the top management **<u>Post-Audit Phase</u>:** In post audit phase the energy Auditor/Engineer may assist and implement the energy conservation recommendation measures and monitor the performance.
3	During a ESP performance evaluation study, the inlet gas stream to ESP is 289920NM^3/hr and the dust loading is 5500 mg/ NM^3. The outlet gas stream from ESP is 301100M^3/hr and the dust loading is 110 mg/NM^3. How much fly ash is collected in the system? Based on Mass balance, Inlet gas stream dust = Outlet Gas stream dust + Fly ash a) Inlet gas stream flow = 289920 NM^3/hr Dust Concentration = 5500 mg/NM^3 Inlet dust quantity = $\frac{289920 \times 5500}{1000000}$ = 1594.50 kg/hr b) Outlet dust quantity = 301100 (NM^3/hr) x 110 (mg/NM^3) x $\frac{1}{1000000}$ = 33.12 kg/hr c) Fly Ash = Inlet gas stream dust – Outlet gas stream dust = 1594.56 – 33.12 = 1561.44 kg/hr

DATE:

PRACTICAL : 8

AIM: PREPARE A SAMPLE ENERGY AUDIT REPORT.

1.1 Objective

The objective of this Preliminary Energy Audit, sometimes referred to as a "Walk Through Audit", is primarily to assess the viability of implementing an energy efficiency upgrade of the facility using energy contracting prior to investing extensive resources in procuring an Energy Performance Contract (or Energy Performance Related Payment), including a subsequent Investment Grade Audit, for a project which is not commercially viable.

This objective will be achieved by:

- Identifying a suitable energy performance indicator for existing and target energy use to quantify the potential for energy savings. This also help assess the impact of the energy conservation measures in achieving this potential and provide a sense-check of calculations.
- Identifying a suite of measures, including savings and implementation budget, which together are of sufficient scale and combined payback to create a financially viable project suitable for implementation as a single package of works. Where appropriate, non-energy savings, such as water or maintenance, will also be quantified.
- Identifying essential client requirements to be incorporated in the works (such as replacement of windows). Savings and implementation budget figures will be provided.
- Identifying other benefits, including renewal of plant which has reached end of life or resolution of comfort issues. These may need to be quantified.
- Identifying additional metering and recording requirements, including any environmental conditions that are likely to be required for a baseline should the measurement and verification of savings be necessary. The associated installation budget will be included.
- Identify any potential technical, financial or other risks to the project as currently defined.

This Preliminary Energy Audit is not an Investment Grade Audit and has been completed in a relatively short period of time with using readily available site information, sector performance indicators, and rules of thumb. It is a concise, or walkthrough survey that has been prepared with all reasonable skill, care and diligence possible within a short period of time. All figures are indicative. In the event that all or part of this report is circulated to contractors or ESCOs to assist in preparation of tenders, neither the author nor the Client accept liability or responsibility for the accuracy or completeness of the information contained herein, which is classified as 'verifiable', i.e. the tenderer is at liberty to verify any or all of such information.

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1.2 Description of Site& Scope of Assessment

Give a brief overview description of site – location, age, size, activities, staff levels, shift system, etc.

If there are multiple buildings, list the ones included in the scope of assessment in the table below; otherwise give the same info for the building in question and delete the table.

1.3 Essential Works

Identify any works the client regards as an essential element to include in any works contract. These must be assessed for budgetary cost and savings as part of this Audit. It may emerge during this analysis that such essential works are not cost-effective to implement, even as part of the overall works contract: this is ultimately a client decision

Energy Consumption

1.4 Annual Consumption

Give an overview of the overall annual energy consumption / spend. Include the AUPof each energy. [Client Name]'s annual energy consumption is set out in table.

1.5 Main Energy Consumers

The main energy consumers at the site that have been quantified for this assessment are summarised in Tables 2 & 3 below. In the tables below identify the main energy consumers at the site and their share of total if you have the data available to break this down quickly, or if you need to do this analysis as part of the study. Do not go through a big energy balance exercise if it is not relevant to the rest of the report. If you prepare underpinning calculations in the accompanying spreadsheet, complete the tables in the spreadsheet and paste the results in here.

1.6 Energy Performance

The objective of this subsection is to establish how the facility is performing.

Energy Performance Indicators

The term "Energy Performance Indicator" is used here to reflect trends in energy use in that facility over time, normalised so that inter-year data is comparable. For instance, hotel electricity use might be corrected for occupancy, or fossil fuel use might be corrected for weather (degree days). In some cases there may be no annual normalisation required, e.g. office building electricity use where there is not a significant cooling load. It is not intended to spend time on an elaborate analysis, merely to understand if normalised energy use is rising, falling, or staying the same.

The existing EnPIs at the site that have been quantified for this assessment are summarised in Tables 4 below. Give details of EnPIs in use at site – definitions & recent values. If none, then say so.

Table 4: Energy Performance Indicators

If there are EnPI’s (or you have produced any), copy & paste Table 4 from spreadsheet – sheet entitled ‘Table 4 - EnPIs’. Otherwise delete this text.

If there are historical DEC ratings for the building, provide these as they illustrate a trend. Ideally chart the DEC values for each DEC year.

Use other EnPIs where it is useful to do so.

Benchmarks

The term “Benchmark” is used here to reflect a comparison of this facilities existing and projected energy use (i.e. when energy saving measures proposed herein are implemented) with industry norms. Benchmarks give an indication of existing performance, the potential for further savings and a sense check for the overall savings that this audit has identified.

Table : Energy Benchmarks

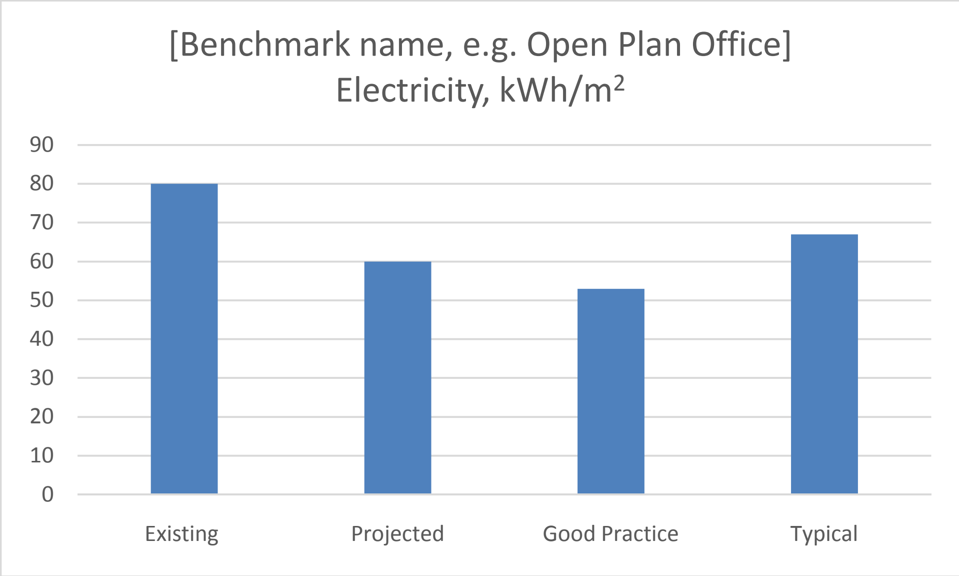
Example table: modify/delete as appropriate, copy & paste Table 5 from spreadsheet – sheet entitled ‘Table - Benchmarks’.

[Benchmark Name & source] kWh/m2/p.a.	Electricity	Fossil Fuel	Other
Existing			
Projected			
Good Practice	53	103	
Typical	67	169	

Example text: The fossil fuel use of 80kWh per m² is projected to fall to 50kWh per m2 if all the energy conservation measures are implemented. This reduction, whilst significant, is reasonable as the projected energy use will be in line with “Good Practice” benchmarks for the sector.

[Benchmark Name] Electrical Performance Breakdown of Energy Consumption (kWh)

Example chart: replace with your chart from spreadsheet



[Benchmark Name] Fossil Fuel Performance Breakdown of Energy Consumption (kWh)
Example chart: replace with your chart from spreadsheet

2 Scope and Expected Savings

2.1 Recent/Existing Energy-Saving Initiatives

Give a summary of energy-saving initiatives that have been implemented at the site (if any). If there are proposed / mooted initiatives that have not yet been implemented and you believe that they are still worthwhile, include them in Table 6 overleaf. By discussing work done to date with the facilities staff you will get an indication of their progress and the remaining potential for further savings; for instance, have the facilities staff been working steadily and plucked the low-hanging fruit, or is there good potential for easy savings.

2.2 Suggested Opportunities for Energy Savings

We identified a number of opportunities for further energy savings at the site; these are summarised in [Table 6] overleaf, with further detail in Section 4. The focus has been on measures suitable for implementation as a single cost-effective works contract (including by EPC) and those identified by the client as essential works (Section 1.4).

3 Baseline Data Requirements

The objective below is to identify baseline data requirements for the eventual measurement and verification of savings, so the client can put in place the infrastructure and begin gathering this data once they receive this report. It is not intended that you include Baseline Data here – a separate Baseline Data template is available in Stage 3. Due consideration should be given to the likely scope and nature of the final contract: a traditional contract will not require baseline data, an EPRP may require the measurement and verification of a small number of key parameters, a full scale EPC may involve the measurement and verification of the facility as a whole. Refer to the International Protocol for the Measurement and Verification of Performance (IPMVP) for guidance on measurement boundaries. The final contract type will not have been assessed at this point, but you and the client will be forming a view as to the likely contract type and you can use this to bring judgement as to what parameters should be measured at this point.

3.1 Utilities

To implement a performance contract (i.e. EPRP or EPC) it is necessary to have a mechanism to measure and verify (M&V) energy savings. An M&V plan is prepared by the ESCO later in the process, but the ESCO will need energy baseline data against which to compare future energy use. Note that a traditional contract does not require that savings be measured and verified.

Having regard for the possible need to measure and verify savings in the future, it is essential to have the necessary metering and monitoring infrastructure in place, and to begin gathering energy baseline data. This is the client's responsibility.

CONCLUSION:

DATE:

PRACTICAL :9

AIM: PREPARE A TECHNICAL REPORT ON ENERGY CONSEVATION ACT 2003.

THORY:

The Electricity Act, 2003 is an Act of the Parliament of India enacted to transform the power sector in India.

The act covers major issues involving generation, distribution, transmission and trading in power. While some of the sections have already been enacted and are yielding benefits, there are a few other sections that are yet to be fully enforced till date.

Background

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.

Generation

The Act delicenses power generation completely (except for hydro-power projects over a certain size)

As per the Act, 10 per cent of the power supplied by suppliers and distributors to the consumers has to be generated using renewable and non-conventional sources of energy so that the energy is reliable.

Electricity generation has been made a non-licensed activity and the techno-economic clearance from the Central Electricity Authority (CEA) has been done away with for any power plant, except for hydro-electric power stations above a certain amount of capital investment. This has been provided in section 7 and 8 of the Electricity Act 2003. The generators can sell electricity to any licensees or where allowed by the state regulatory commissions, to consumers directly. The provision of direct sale of electricity by the generators, when and where allowed, would promote more IPP participation in the power generation, as these consumers are more creditworthy and bankable compared to many SEB's. However the act provides for imposition of a surcharge by the regulatory body to compensate for some loss in cross-subsidy revenue to the SEB's due to this direct sale of electricity by generators to the consumers.

Distribution

The Act delicenses distribution in rural areas and brings in a licensing regime for distribution in urban areas.

However, as per the Act, only 16 states in India have notified what constitutes as rural areas and therefore the rural distribution is yet to be freed up in nearly one third of the country.

Key features

The main features of the act are as follows:

1. Generation is being de-licensed and captive generation freely permitted, i.e. any generating company may establish, operate and maintain a generating station without obtaining a licence under this Act with the only exception that it should comply with the technical standards relating to connectivity with the grid referred to in clause (b) of section 73.

   Note: Hydro-projects, however, need concurrence from the Central Electricity Authority.
2. No person shall

   (a)transmit electricity; or
   (b)distribute electricity; or
   (c)undertake trading in electricity,
   unless he is authorised to do so by a licence issued, exceptions are informed by authorised commissions through notifications.

3. Central Government may, make region-wise demarcation of the country, and, from time to time, make such modifications therein as it may consider necessary for the efficient, economical and integrated transmission and supply of electricity, and in particular to facilitate voluntary inter-connections and co-

ordination of facilities for the inter-State, regional and inter-regional generation and transmission of electricity. Transmission utility at the central and state level to be a government company with responsibility of planned and coordinated development of transmission network.

4. Open access in transmission with provision for surcharge for taking care of current level of cross-subsidy, with the surcharge being gradually phased out.
5. The state governments are required to unbundle State Electricity Boards. However they may continue with them as distribution licensees and state transmission utilities.
6. Setting up State Electricity Regulatory Commission (SERC) has been made mandatory.
7. An appellate tribunal to hear appeals against the decision of (CERC's) and SERC's.
8. Metering of electricity supplied made mandatory.
9. Provisions related to thefts of electricity made more stringent.
10. Trading as a distinct activity recognised with the safeguard of Regulatory commissions being authorised to fix ceiling on trading margins.
11. For rural and remote areas, stand-alone system for generation and distribution is permitted.
12. Thrust to complete rural electrification and provide for management of rural distribution by panchayat, cooperative societies, NGOs, franchisees etc.
13. Central government to prepare National Electricity Policy and Tariff Policy.
14. Central Electricity Authority (CEA) to prepare National Electricity Plan.

Role of CEA

The role of CEA is limited to policy recommendations, monitoring electricity sector performance, advising the Ministry of power on technical issues, data management/dissemination of the power sector, etc.

Preparation of technical standards for construction of electrical plants, electric lines and connectivity to the grid is the responsibility of CEA as per section 73 (b) of the Electricity Act, 2003.[2] However, as per section 7 of this Act, a generating company may establish, operate and maintain a generating station if it complies with the technical standards only relating to connectivity to the grid as given in clause (b) of section 73.

This implies that generating stations need not follow compulsory the CEA technical standards specified for construction of electrical plants and electric lines. Similarly, transmission / distribution licensees need not implement compulsory the standards for construction of electric lines except the Grid Code/ Grid Standards for the operation and maintenance of transmission lines specified by CEA under clause 73 (d) of this Act.

Many times, these CEA standards are conservative compromising optimum design features /cost/ utility and also do not give full clarity in selection of the system / sub system capabilities of electrical plants and electric line.

CONCLUSION

DATE:

PRACTICAL :10

AIM: STUDING THE VARIOUS ENERGY CONSERVATION METHODS USEFUL IN POWER GENERATION, TRANSMISSION AND DISTRIBUTION.

- ## Abstract:

Electrical energy is universally accepted as an essential commodity for human beings. Energy is the prime mover of economic growth and is vital to the sustenance of a modern economy. Future economic growth crucially depends on the long-term availability of energy from sources.

Areas of application of Energy Conservation are Power Generating Station, Transmission & Distribution system, Consumers premises. Steps are to be taken to enhance the performance efficiency of generating stations. Energy Conservation technology adopted in Transmission & Distribution system may reduce energy losses, which were in tune of 35% of total losses in Power system. Acceptance of Energy conservation technology will enhances the performance efficiency of electrical apparatus used by end users. Implementation of Energy conservation technology will lead to energy saving which means increasing generation of energy with available source.

Scope of the paper is about Implementations of Energy conservation technologies, case studies, related to Electrical systems adopted by industries, Municipal Corporation, Hospitals, residential consumers, Utilities. This paper also covers Roll of Government, State nodal agencies, Energy Act, and Energy Policies. Energy Conservation In Electrical Field (Full-length paper)

THORY:

- ### Energy Scenario:

Energy is prime factor for national economic development. India ranks sixth in the world in total energy consumption and needs to accelerate the development of the sector to meet its growth aspirations. Per capita energy is use in India is much below compared to many countries.

Installed capacity of India: 110,000MW Installed capacity of Maharastra: 20,289.5MW Available power: 13,375MW Peak demand: 18,049MW Power shortage: 4,774MW Limited Fossil fuel stock up to 50 to 100 years only

- **Need of energy conservation:**

Fossil fuels like coal, oil that has taken years to form is on the verge of depleting soon. In last 200 years we have consumed 60% of all resources. For sustainable development we need to adopt energy efficiency measures. Today 85% of primary energy sources come from non-renewable and fossil sources. These reserves increasing consumption and will exist for future generations.

- **Energy Conservation in Power generating station**:

To generate 1MW power generation cost is Rs 4.5 to 5.25 crores and T& D cost is Rs.2 crores . But cost of saved power is Rs.1Crores/Mw.

The important note is time period to set a power plant is 5 years; to set up transmission line 1 year and to plan energy conservation is only 1 month. We have less opportunity for EC in generating area but we can improve the performance efficiency of generators by optimization of load, optimal distribution of load among different units, periodical maintenance and also increasing the capacity by adopting advanced technology using renewable energy sources.

- **Energy Conservation in Transmission & Distribution:**

In India the power transmission and distribution (T&D) system is a three tire structure comprising of state grids, regional grids and distribution network.

To meet the energy demand power system networks are interconnected through INTRA-REGIONAL LINK.

The inter-regional power transmission capacity of India at end of 2007 was 14000 MW. T&D system in India is characterized by heavy losses of about 34.54% according to statistics of 2005-06, as compared to 10-15% in developed countries Power losses in T&D system can be classified as Technical losses and Commercial losses.

- **Technical Losses In T&D System:**

Power losses occurring in T&D sector due to imperfection in technical aspect which indirectly cause loss of investment in this sector, are technical losses. These technical losses are due to inadequate system planning, improper voltage and also due to poor power factor etc.

3 ENERGY CONSERVATION TECHNIQUES:

EC Techniques In Transformers:

i) Optimization of loading of transformer:
ii) By proper Location of Transformer preferably close to the load center, considering other features like centralized control, operational flexibility etc. This will bring down the distribution loss in cables.

iii) Maintaining maximum efficiency to occur at 38% loading (as recommended by REC), the overall efficiency of transformer can be increased and its losses can be reduced 4

iv) Under fluctuating load condition more than one transformer is used in Parallel Operation of Transformers to share the load & can be operated close to the maximum efficiency range ii) By Improvisation In Design And Material Of Transformer:

v) To reduce load losses in Transformer, use thicker conductors so that resistance of conductor reduces and load loss also reduces.

vi) To reduce Core losses use superior quality or improved grades of Cold Rolled Grain Oriented (CRGO) laminations.

<u>Replacing By Energy Efficient Transformers:</u>

i) By using energy efficient transformers efficiency improves to 95 % to 97%.

ii) By using Amorphous transformers efficiency improves to 97 % to 98.5%.

iii) By using Epoxy Resin cast/ Encapsulated Dry type transformer- efficiency improves to 93 % to 97%.

- ## Energy Conservation In Transmission Line:

• High Voltage Direct Current (HVDC) is used to transmit large amount of power over long distances or for interconnections between asynchronous grids

• By transmitting energy at high voltage level reduces the fraction of energy lost due to Joule heating. (V α1/I so I 2 R losses reduces).

• As load on system increases terminal voltage decreases. Voltage level can be controlled by using voltage controllers and by using voltage stabilizer

• If required reactive power transmitted through transmission lines, it causes more voltage drop in the line. To control receiving end voltage, reactive power controllers or reactive power compensating equipments such as Static VAR controllers are used.

- ## Energy Conservation In Distribution Line:

a) Optimization of distribution system: The optimum distribution system is the economical combination of primary line (HT), distribution transformer and secondary line (LT), To reduce this loss and improve voltage HT/LT line length ratio should be optimized.

b) Balancing of phase load- As a result of unequal loads on individual phase sequence, components causes over heating of transformers, cables, conductors, motors. Thus, increasing losses and resulting in the motor malfunctioning under unbalanced voltage conditions.

c) Harmonics: With increase in use of non-linear devices, distortion of the voltage and current waveforms occurs, known as Harmonics. Due to presence of harmonic currents excessive voltage and current in transformers terminals, malfunctioning of control equipments and Energy meter, over effect of power factor correction apparatus, interference with telephone circuits and broad casting occurs. Distribution Static Compensator (DASTACOM) and Harmonic filters can reduce this harmonics.

d) Energy Conservation by using power factor controller: Low power factor will lead to increased current and hence increase losses and will affect the voltage. We can use 5 Power Factor Controller or Automatic Power Factor Controller that can be located near receiving substations, load centers or near loads.

e) Energy Conservation By Demand side management control Demand-side management is used to describe the actions of a utility, beyond the customer's meter, with the objective of altering the end-use of electricity - whether it be to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands - in the overall interests of reducing utility costs. Nearly energy of 15,000 MW can be saved through end-use energy efficiency. By using DSM saving potential in… Industry and Agriculture - 30-35% Commercial / Government establishments and residential houses. -25-30%

CONCLUSION: