

Energy Management, Conservation and Audit at Shahi Export

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Abstract— Energy is very much important input in all sectors of any country's economy. The standard of living of any country can be directly related to per capita energy consumption. It discusses about energy management techniques, and energy conservation opportunities. For conservation of energy the best option is energy audit. Energy audit is a process to determine when, where, why and how energy is used in a plant or building. Collecting of these information helps to identify the situation where there is need to improve energy efficiency and decrease production cost. By conducting energy auditing, we considering energy as a manageable expense and try to conserve it in day-to-day action.

This work aim is to maintain and accomplish the maximum energy obtained and using throughout the organization. Which reduces the cost of energy without affecting the quality, production and environment and to carry lighting audit and electric load management in shahi exports. It gives an overall view of process involved from setting the status, measures and policies to implementing the policies through audits and come out with new methods to achieve energy conservation for lighting system.

I. INTRODUCTION

Energy management is a process by which a sector or an organization can effectively manage how much energy they produce and how to control, monitor and conserve as much energy as they can while also generating enough energy to meet the demand of the customers.

Taking into consideration the potential of energy conservation, the government has launched various plans to start the drive of energy management and conservation. The Government is not only promoting greater use of renewable energy sources such as solar and wind but is also working towards ultra – super critical thermal power plants, which will run on an indigenous technology helping to reduce the carbon footprint. Equal efforts are being put into the demand side through various policies like the Energy Conservation Act of 2001.

The **Bureau of Energy Efficiency (BEE)**, set up in 2002, works at the central level, to assist the Energy Conservation Act.

A large number of initiatives have been taken up by the Ministry of Power in alliance with BEE, like conservation of energy in areas like lighting at homes, commercial offices and buildings, labelling of appliances etc. With the **Standards and Labelling programmed**, launched in 2006, the Bureau provided customers the right choice to save and conserve energy, and save costs too.

Shahi exports as one of the biggest manufacturing companies and has a current distribution plant. The incoming 11KV current is from Kirloskar Electric Co. Ltd, PSG, Bangalore and it is distributed over shimogga. Shahi has set up two solar power plants in Karnataka with capacities of 32MW and 52MW.

Shahi's vertically integrated textile operations and high-end, value-added services are at the cutting edge of innovation in the apparel industry. Spinning, knitting, and processing, Garmenting, Internal Laboratory, Weaving and processing, Design.



Fig 1 shahi export overview

What is energy conservation and management?

Energy conservation and management in industry refer to the practices, policies, and technologies implemented to reduce energy consumption and improve energy efficiency in industrial processes. Energy conservation aims to reduce energy consumption through behavior changes or operational modifications, while energy management involves implementing systems and technologies to optimize energy use.

Principle of Energy Conservation: Energy conservation means reduction in energy consumption but without making any sacrifice of quantity and quality of production.

Why energy conservation?

1. To reduce energy shortage.
2. To reduce peak demand shortage.
3. To save fuel, natural resources and money.
4. To reduce environmental pollution.
5. It Provides energy security.

General Energy Audit

An energy audit for industry is a comprehensive assessment of the energy use and efficiency of industrial processes, equipment, and systems. The primary goal of an energy audit is to identify opportunities for energy savings, reduce energy waste, and improve the overall efficiency of industrial operations. During an energy audit, trained professionals typically analyze the industrial processes and equipment to determine how energy is used and identify areas where energy savings can be achieved. They may also evaluate the building envelope, lighting systems, HVAC systems, and other factors that contribute to energy consumption in the facility. The audit report typically includes a detailed analysis of energy use and recommendations for energy-saving measures, such as equipment upgrades, process improvements, and changes to operational practices. The report may also provide estimates of the cost savings associated with implementing these measures, as well as the expected return on investment.

An energy audit will reduce the environmental effect directly or indirectly. The functions of the energy audit are,

1. To reduce energy consumption
2. To reduce the energy bill and save the money
3. To improve the comfort level
4. To reduce the carbon footprints
5. To reduce unnecessary waste and pollution

The energy audit is the great and most valuable step to save energy consumption and save money. It may seem that an organization's energy audit provides a point of reference for managing the consumption of energy and also it provides a better plan for the essential use of energy in an organization.

Objectives

The objective of this work is to

1. Enable the management for developing plans for energy intensity reduction.
2. Achieve and maintain optimum energy procurement and utilization throughout the organization.
3. Minimize energy cost or losses without affecting production, comfort and quality.
4. Give a positive orientation to the energy cost reduction, prevention maintenance and quarterly central programs which are vital for production and utility activities. Such an audit programmer will help to keep focus on various which occur in the energy costs, availability and reliability of supply of energy, decide on approximation energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.
5. Determine the energy losses and costs without production.
6. Determine the way to reduce energy consumption per unit of product output or to lower operating costs. Energy audit provides a “bench-mark” for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the organization.

II. Methodology

Need for Energy Audit

In any Organization, the three top operating expenses are often found to be energy (both electrical and thermal), labour and materials. If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction. Energy Audit will help to understand more about the ways energy and fuel are used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists. The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programmed which are vital for production and utility activities. Such an audit programmed 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.

Advantage for energy audit

An energy audit will give you a list of action items, with estimated costs and benefits, to reduce your energy usage, energy costs and carbon footprint. With this clear guidance, it's easy to priorities and know exactly what you need to do to reduce your energy costs and greenhouse gas emissions, how much you'll need to spend, and what you can expect to save.

When undertaken by an experienced energy audit:

1. We should be able to identify a greater number of savings opportunities than you could on your own.
2. We will be able to come up an estimate of savings to an acceptable degree of accuracy.
3. we can identify likely desired and undesired consequences of a particular upgrade, and undertake calculations to quantify them.

Energy Management

Energy management is a process by which a sector or an organization can effectively manage how much energy they produce and how to control, monitor and conserve as much energy as they can while also generating enough energy to meet the demand of the customers. Energy loss improvement has some of the methods that are as follows.

Energy is the backbone of any manufacturing setup's operation. Garment factories and textile mills have varying energy requirements, textile manufacturing is typically more energy intensive than garment manufacturing.

In FY 2021, our total energy demand was 911070 MWh, of which 28% was garmenting units. The remaining 72% was consumed in our textile mills. By the action of audit, we should undertake some improvement for the energy consumption.

1. Power factor improvement.
2. Transmission losses.
3. Distribution losses.

1. Power Factor Improvement

Power factor correction is a vital tool for maintaining the terminal voltage of an electrical system that operates at low power factor since any sudden change in power factor and current affect the terminal voltage of the system. If the power factor of any electrical system is improved to unity with the application of capacitors, the current of the same value of the power to be supplied is reduced to a minimum.

This results in total reduction of power losses, terminal voltage drops and sizes of transformers, alternators, cables and switchgears. The general formulas are shown below.

Active power is the product of the applied voltage and active component of the current. $P=IV\cos\phi$ kw

Reactive power is the product of applied voltage and reactive component of the current. $P=IV\sin\phi$ kvar

Apparent power is the product of rms values of current and voltage.

Apparent Power = VI kva

$S= P\pm jQ$

By using these formulas, we calculate power and losses by varying power factor. If power factor is low then the transmission and distribution losses are increased. Hence by increasing power factor to unity it reduces the losses and we calculated voltage drop, reactive power, copper loss by using these basic formulas.

Advantages of power factor Improvement

1. Increased energy efficiency: A low power factor means that the electrical system is less efficient, and more energy is required to perform the same amount of work. Improving power factor can increase energy efficiency, reduce energy consumption and costs.
2. Reduced electricity bills: In some countries, industrial consumers may be subject to a penalty charge for low power factor. By improving power factor, industries can avoid these penalties and save money on their electricity bills.
3. Increased capacity: Improving power factor can increase the capacity of the electrical system, allowing industries to add more equipment or machinery without the need for additional infrastructure.

Overall, improving power factor can bring numerous benefits to industries, including energy efficiency, cost savings, increased capacity, improved voltage stability, and enhanced reliability.

2. Transmission and Distribution Losses

Transmission and distribution losses refer to the amount of electrical energy that is lost as it is transmitted and distributed through power lines and other electrical infrastructure before it reaches the industry. Transmission losses occur during the transfer of electricity over long distances from the power generation source to the local distribution grid. These losses occur due to factors such as resistance in the transmission lines, electromagnetic interference, and other inefficiencies. Distribution losses occur during the transfer of electricity from the local distribution grid to the industry. These losses occur due to factors such as transformer losses, conductor losses, and other inefficiencies. The amount of transmission and distribution loss varies depending on the distance between the power generation source and the end-user, the quality of the infrastructure, and other factors such as the voltage levels and load demand.

For industries, transmission and distribution losses can have a significant impact on energy costs and overall efficiency. By reducing transmission and distribution losses through measures such as upgrading infrastructure, improving power factor, and implementing energy-efficient practices, industries can reduce their energy costs and increase their competitiveness.



Fig 2 Transmission line

Transmission and Distribution losses are at the level of 33 per cent with huge revenue losses to the distribution utilities. The transmission losses are further sub-grouped depending upon the stage of power transformation and transmission system as transmission losses (400kV/220kV/132kV/66kV), and as distribution losses in 33kV and lower levels of transmission. The commercial losses are caused by pilferage due to theft, defective meters, and errors in meter reading, and in estimating unmetered supply of energy. The technical losses are intrinsic to the power transmission system and are caused due to I²R losses, transformer losses, insufficient reactive compensation

3. Voltage drops in transmission line-

Voltage drop is the decrease of electrical potential along the path of a current flowing in an electrical circuit. Voltage drops in the internal resistance of the source, across conductors, across contacts, and across connectors are undesirable because some of the energy supplied is dissipated.

In an industrial setting, voltage drops in transmission lines can occur due to several factors, including:

1. Distance: The further the transmission line, the greater the resistance and the greater the voltage drop.
2. Current Load: The amount of current flowing through the transmission line can cause voltage drops. Higher current loads result in greater voltage drops.
3. Cable Size: The size of the cable used in the transmission line can impact voltage drops. Smaller cables will have a higher resistance and will experience greater voltage drops.
4. Temperature: Temperature changes can also impact the resistance of the transmission line, which can result in voltage drops.
5. Reactive Power: Reactive power, or the power required to maintain voltage levels, can also cause voltage drops.

To prevent voltage drops in transmission lines in industrial settings, it is important to use cables with appropriate sizes, minimize the distance between the power source and the load, and regulate the reactive power. Additionally, implementing a voltage regulation system that automatically compensates for voltage drops can help ensure stable power delivery to the industrial equipment.

Example 1

According to the information given by the shahi export, the transmission line has a voltage of 11 kV, current of 100 A, and connected load of 2 MVA. The line has a length of 2 km and a single run. The conductor used is Coyote, which is made of aluminium. The resistance of the line is 0.2 Ω and the reactance is 0. The power factor of the line is 0.8.

Voltage – 11kV

Current – 100A – I_L

Connected load – 2MVA

Distance of line – 2km – L

No of line(runs) – 1

Resistance of line – 0.2Ω

Reactance of line – 0

Power factor of the line – 0.8

Name of the conductor – Coyote

Type of conductor – Aluminium

$$\text{Voltage drop} = \left\{ \frac{\sqrt{3}(R \cos\phi + X \sin\phi)I_L}{\text{No of Runs} * 1000} \right\} * L$$

$$\text{Voltage drop} = \left\{ \frac{\sqrt{3}(0.2*0.8 + 0*0.8)100}{1 * 1000} \right\} * 2k$$

$$\text{Voltage drop} = 69.27V$$

$$V_R = 10930.73$$

$$\text{Regulation} = (V_S - V_R) / V_R = (11*10^3 - 10930.73) / 10930.73$$

$$\text{Regulation} = 0.6\%$$

Losses

$$P = I^2R$$

$$P = 100^2 * 0.2 * 2k$$

$$P = 4kW \text{ for } 3\phi \text{ } 12kW$$

The voltage drop is 69.27 V, which results in a voltage at the load end of 10,930.73 V. The voltage regulation is 0.6%. The losses in the line are 4 kW (for 3-phase, 12 kW).

Example 2

According to the information given y the shahi export, the electrical system appears to have a voltage of 110kV, current of 10A, and a connected load of 2mva, with a distance of 2km and a single line.

Voltage – 110kV

Current – 10A – I_L

Connected load – 2MVA

Distance of line – 2km

No of line – 1

$$\text{Voltage drops} = \left\{ \frac{\sqrt{3}(R \cos\phi + X \sin\phi)I_L}{\text{No of Runs} * 1000} \right\} * L$$

$$\text{Voltage drops} = \left\{ \frac{\sqrt{3}(0.2*0.8 + 0*0.8)10}{1 * 1000} \right\} * 2k$$

$$\text{Voltage drops} = 6.927V$$

$$V_R = 109993.073$$

$$\text{Regulation} = (V_S - V_R) / V_R = (110*10^3 - 109993.073) / 109993.073$$

$$\text{Regulation} = 0.00629$$

Losses

$$P = I^2 * R$$

$$P = 10^2 * 0.2 * 2$$

$$P = 40W \quad \text{For } 3\phi \quad 120W$$

The voltage drops were calculated as 6.927V, and the voltage regulation was found to be 0.00629. The losses were calculated as 40W for a single-phase system or 120W for a three-phase system. Hence, a poor distortion power factor more damaging and less desirable than a poor displacement power factor.

From Example 1 And 2

$$V = \frac{\text{Example 1}}{\text{Example 2}} = \frac{11}{110} = 0.1$$

$$\text{Loss} = \left(\frac{\text{Example 1}}{\text{Example 2}} \right)^2 = 0.01$$

$$69.27 * 0.1 = 6.927$$

$$4K * 0.01 = 40W$$

Comparing Example 1 and 2. In Example 1, we have calculated the voltage ratio as 0.1, which is obtained by dividing the voltage of Example 1 by the voltage of Example 2. In Example 2, you have calculated the loss as 0.01, which is obtained by dividing the voltage drop of Example 1 by the voltage of Example 2. Additionally, we have calculated the voltage drop to be 6.927V and the losses to be 40W, assuming a single-phase system, based on the given values in the examples.

It's important to note that voltage ratios and losses can be important considerations in the design and operation of electrical systems. The voltage ratio can impact the efficiency of power transmission and distribution, and losses can result in wasted energy and decreased system performance. Therefore, understanding and optimizing these values can be important in ensuring the reliability and effectiveness of electrical systems in industry.

Advantage for voltage drop

Voltage drop is generally not desirable for industry as it can result in reduced efficiency and performance of electrical equipment, and in some cases, can even cause damage to the equipment. However, there are some specific scenarios where voltage drops can be intentionally used for certain advantages, such as:

1. **Voltage Regulation:** In some cases, voltage drops can be used to regulate voltage levels in a circuit. This is achieved by intentionally adding resistive elements in the circuit, which can cause a voltage drop and regulate the voltage level.
2. **Load Management:** Voltage drops can also be used to manage electrical loads in a system. For example, if a certain area or machine is experiencing high demand for power, intentionally inducing voltage drops can help balance the load and prevent overloading the system.

Result and Discussion

Calculating transmission and distribution loss, voltage drop, and power factor improvement is useful for industries in several ways, including:

1. **Energy efficiency improvements:** Calculating transmission and distribution loss can help industries identify areas where energy is being wasted and implement measures to reduce energy consumption. By reducing transmission and distribution loss, industries can improve energy efficiency and reduce energy costs.
2. **Equipment efficiency improvements:** Calculating voltage drop can help industries identify areas where equipment is not receiving the required voltage, leading to reduced efficiency and increased wear and tear. By addressing voltage drop, industries can improve equipment efficiency, reduce downtime, and lower maintenance costs.
3. **Cost savings:** By improving power factor, industries can reduce electricity bills and avoid penalties for low power factor. Calculating power factor and implementing measures to improve it can lead to significant cost savings for industries.
4. **Increased capacity:** Improving power factor can increase the capacity of the electrical system, allowing industries to add more equipment or machinery without the need for additional infrastructure.

III. Conclusion

The detailed energy auditing of the textile industry is carried out by adopting the systematic energy auditing methodology. The scope for the energy conservation through power quality improvement is presented in the work successfully. From the textile industry's detailed energy auditing, how much of energy used by every unit was accounted. On basis of energy audit, energy management is carried through some methods. The energy conservation is ensured by reducing voltage drop, copper loss and power factor improvement. The significant per month energy consumption is 10232800kWh.

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