Energy Audit In A Rural Yarn Industry-A Case Study

Kalpana A. Patel, Krunalkumar J. Gandhi

Abstract: In any sector, power, labour, and materials are often considered to be the top three operating expenses. The top would always be fuel if one were to assess the potential savings in each of the constituents. As a consequence, the role of energy management is a strategic field of cost drop. This paper addresses the specific parts of the control of electrical power in small-sized and medium-sized industries, which includes the analysis and assessment of the data collected from Loknayak J. P. Narayan Shtekari Sahakari Sootgirni, Untawad Hol, Shahada. Dist. - Nandurbar. The electrical energy audit was performed under two main headings: (i) light load audit (ii) Power load audit, which includes meters, motors. The readings have been taken and analysed in the chosen industrial case system to determine the level of energy conservation opportunities.

Index Terms: Electrical energy audit, electrical energy conservation, power, industrial unit, motor.

1 INTRODUCTION

Electricity is the most costly and critical kind of energy acquired. It must, therefore, for practical and economical operation, be limited to a minimum [1]. Energy provides advantages over traditional fossil fuels because of its versatility, and efforts to conserve energy leads to noteworthy cost savings [2]. Industries use a considerable amount of electricity, so an effective and energy-efficient system is vital in industries. [3]. Studies in developing countries, such as India, where energy resources are few, and the production of electricity are costly, are of great importance. An energy audit is the transformation of sustainability concepts into practice by combining technically possible approaches within a defined timeframe with economic and other organisational considerations [4]. An energy audit is a system or process study to determine how much and where electricity is used and to identify the means of saving power. Energy audits can mean different things for various individuals. An auditor should be able to deal differently with the complexity of an energy audit, precision of estimates, and level of economic assessment before an audit starts [5][6]. When building mechanical and electrical systems, reducing energy consumption or improve energy efficiency, can save power and mitigate some of the environmental problems that arise, such as the greenhouse effect and ozone layer. An industrial unit’s energy audit was discussed in this study. Through proper maintenance and operation, energy conservation can be accomplished. Such practices include switching off unused equipment, modifying equipment that uses more power, enhancing the management of electricity demand, lowering temperature settings in winter, turning off the lamp, etc. [5].

A scheme of energy management is established with the simple idea of storing cheaper electricity at night and using it during the day [6].

The type of industrial energy audit carried out depends on the purpose, scale, and form of business, the degree, and feasibility of the energy savings and the reduction of costs required [7]. The Energy Audit offers vital knowledge for energy conservation. It also includes the review and assessment of energy-saving steps in practice. It purposes [8]-

- Determining the quality and cost of different energy sources.
- Evaluation of current energy usage trend in multiple operational cost centers.
- Associating energy inputs and production output.
- Identify energy Wastage in significant areas.
- Sets potential energy efficiency goals for individual cost centres.
- Implementing energy conservation and cost reduction initiatives.

3 AUDITING PROCESS

Without the attention of the top administration, the energy audit cannot be executed successfully. First of all, management needs to be convinced of the need for energy management and, therefore, energy audit [9]. The energy audit includes various activities, which may be conducted under the kind of audit, its size, and role. Thus, an energy audit is not a direct but rather iterative procedure. The audit described in this paper is based on the functional exercise given below:

- Walk-through analysis
- Motor load analysis

3.1 Visit and Measurement at Field

Loknayak J. P. Narayan Sahakari Sootgirni is one of the largest manufacturing industries of yarn in India. It is supplying some 60% yarn production in the export market in the U.S., Germany, Italy, etc., and domestically, in several industries [10]. The process flow diagram for processes/operations of the industrial unit is as below.
3.2 Plant Electrical Energy Consumption

In terms of equipment and operational area, the factory's energy consumption was established. The findings were collected during factory visits after measurements. Instruments such as power analyzers, data loggers, clamp meters, have been used for measuring the electricity consumption of the plant. The unit's total load is about 4273.104 KW. From this study, the following points can be observed that the unit uses four transformers rated 11 kv/415 kV, 1000 KVA, and one 33 kV/11 kV, 5000 KVA transformer [10].

**TABLE1**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Type of Load</th>
<th>KW</th>
<th>% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Blow Room</td>
<td>192.21 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carding</td>
<td>246.53 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carding filter</td>
<td>138.97 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Speed Frame</td>
<td>149.19 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Draw Frame</td>
<td>118.39 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comber</td>
<td>122.47 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lap Former</td>
<td>32.68 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Luwa System</td>
<td>37.97 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ring Frame Section</td>
<td>1857 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Humidification plant</td>
<td>411.79 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Packing Section</td>
<td>187.03 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Winding Section</td>
<td>250.41 KW</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Total Motor Load</strong></td>
<td><strong>3844.6 KW</strong></td>
<td><strong>88.48%</strong></td>
</tr>
</tbody>
</table>

**TABLE2**

<table>
<thead>
<tr>
<th>Energy-efficient measurement</th>
<th>Annual energy saving in KWH</th>
<th>Annual cost saving in RS</th>
</tr>
</thead>
<tbody>
<tr>
<td>replacing copper ballast</td>
<td>92,768.4</td>
<td>7,42,147.2</td>
</tr>
</tbody>
</table>

**TABLE3**

<table>
<thead>
<tr>
<th>characteristic</th>
<th>LED Tube</th>
<th>Conventional Fluorescent Lights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power consumption (tube only)</td>
<td>15 W</td>
<td>36 W</td>
</tr>
</tbody>
</table>

4 ENERGY SAVING CALCULATIONS

4.1 Survey of Lighting System

A walk-through inspection was attended through visits to measure the lighting necessity of the plant and the potential for the improvement of light quality and lighting levels to minimise power use and electricity billing cost. It is observed after a survey that many fluorescent tubes with copper ballast are used. It has been found that reflectors are currently being eliminated, resulting in light being lost towards the ceiling [10]. It is suggested

- Use of electronic ballast instead of copper ballast.
- Use of reflector in the removed ring frame region. The use of reflector can increase the degree of illumination on the work plane.
- Regularly clean light installations and lamps.

1. Saving energy by replacing copper ballast with electronic ballast with an average running time of 12 hours:-

   - Power consumed annually by using copper ballast = hours of use x no. of days x No. of tubes x watts = (12 × 365 x 1059 × 36)/1000 = 1, 66,983.12 kWh
   - Energy bill annually by using copper ballast = Rate/KWh x Energy used = 8 x 1, 66,983.12 kWh = RS 13, 35,864.96/-
   - Power consumed annually by using electronics ballast = hours of use x no. of days x No. of tubes x watts = (12 × 365 x 1059 × 16)/1000 = 74,214.72 kWh
   - Energy bill annually by using electronics ballast = Rate/KWh x Energy used = 8 x 74,214.72 kWh = RS 5, 93,717.76/-
   - Energy saved by using electronics ballast = 92,768.4 kWh
   - Savings per year through copper ballast replacement = Rate/KWh x Energy saving = 8 x 92,768.4 kWh = RS. 7, 42,147.2/-

Therefore, by replacing copper ballast with electronic ballast, 44.44 percent of energy is saved.
2. Energy Saving By replacement Of Fluorescent tubes

- Energy Consumption of Fluorescent Tube within 12 hours = 0.432 kWh
- Total number of Fluorescent Tubes = 2036
- Energy consumption per year by using Fluorescent Tubes considering 12 Hrs. /day operation = 0.432 x 2036 x 365 = 3, 21,036.48 kWh
- Energy bill annually = Rate/kWh x Energy used = 8 x 3, 21,036.48 kWh = RS. 25, 68,291.84/

LED tubes of 15W will give the same illumination as 36W Fluorescent Tube
- Energy Consumption of LED within 12 hours/day = 0.18 kWh
- Total number of LED = 2036
- Energy consumption per year by using LED Considering 12 Hrs. /day operation = 0.18 x 2036 x 365 = 1, 33,765.2 kWh
- Energy bill annually = Rate/kWh x Energy used = 8 x 1, 33,765.2 kWh = RS. 10, 70,121.6/-
- Energy saving per year by substituting FLT with LED = 14, 98,170.24 kWh
- Annually saved Amount = Rate/kwh x Energy saving = 8 x 14, 98,170.24 kWh = RS. 1, 19, 85,361.9/-
- Average cost per LED = Rs. 200
- Total investment for 2026 number of tubes = Rs.4,07,200/-
- Payback period = Investment/Amount saved = 4, 07,200/1, 19, 85,361.9 = 0.03 years

<table>
<thead>
<tr>
<th>TABLE 4</th>
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<tbody>
<tr>
<td><strong>ENERGY EFFICIENT MEASUREMENT OF FLT TUBE</strong></td>
</tr>
<tr>
<td>Energy-efficient measurement</td>
</tr>
<tr>
<td>replacement of FLT tube by LED</td>
</tr>
</tbody>
</table>

4.2 Survey of Air Conditioner

Loknayak J. P. Narayan Sahakari Sootgirni has 20 AC units. Which consume nearly 30kW of the total load. However, it has been found in many places that AC is not utilised in the best practice. Such ineffective methods raise the AC load and hence the consumption. Certain guidance on the most effective use of ACs [11]-

- If possible, set the thermostat to the highest temperature, which will make you feel calmer. It should be kept at a temperature of 22 - 24 degrees.
- The insulating area is a factor that leads to the enormous energy consumption associated with your AC unit.
- Over time, air filters accumulate dust and debris on the air conditioners and then gradually restrict airflow. If the airflow is low, the AC unit stresses to maintain the cooling of your office, allowing it to consume more energy.
- The thermostat is heat sensitive. If the temperature is higher than expected, the AC will remain operational until the entire area is cold enough. Therefore, it is useful to keep away the heat-generating electronics and devices such as televisions, computers, and lamps from the thermostat.
- Ceiling fans use less power to make it more efficient for your AC unit.
- AC units are always subject to regular servicing, so trained professionals may be wise to complete the task once per year.

By following the above guideline, the Energy consumption of AC will be reduced to nearly 10%. So, average power saved per AC is almost 150w.
- Total no. of AC units = 20 ( 10 ACs in office, 10 ACs in processing unit )
- Average power saved per AC = 150w
- Average usage of office AC per annum = 313 x 8 hr = 2504 hr
- Annual saved Energy = 10 x 150 x 2504 Kwh = 3756 Kwh
- Average usage of AC per annum = 340 x 24 hr = 8160 hr
- Annual saved Energy = 10 x 150 x 8160 Kwh = 12, 240 Kwh
- Total Annual saved Energy = 3756 + 12, 240 = 15, 996 Kwh
- Annual saved Amount = Rate/kwh x Energy saved = 8 x 15, 360 Kwh = Rs. 1, 27, 968/-

<table>
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<tr>
<th>TABLE 5</th>
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<tbody>
<tr>
<td><strong>ENERGY EFFICIENT MEASUREMENT OF AC</strong></td>
</tr>
<tr>
<td>Energy-efficient measurement</td>
</tr>
<tr>
<td>By Applying the above measures</td>
</tr>
</tbody>
</table>
Saving of energy by substituting the metal fan with FRP fan
= No. of motors X rating of motor × % cost saving by replacement x working hrs./annum

Saved annual Amount = Rate of energy x Energy saved

Substituting a metal cooling fan by FRP fan
- Fan motor’s power rating = 7.5KW
- Number of fan motors = 7
- Metal fan’s energy consumption = 7 x 7.5 x 8760 = 459900 KWh
- Energy bill annually = Rate/KWh x Energy used = 8 x 459900 kWh = RS. 36,79,200/-
- FRP fan’s energy consumption = 5.6 x 7 x 8760 = 343392 KWh
- Energy bill annually = Rate/KWh x Energy used = 8 x 343392 kWh = RS. 27,47,136/-
- Annual saving of energy by substituting the metal fan with FRP fan = 116508 KWh
- Annual saved Amount = 116508 x 8 = Rs. 9,32,064/-
  - Rate per FRP Fan = Rs. 15000/-
  - Total investment for 7 number of fans = Rs.1,05,000 /-
  - Payback period = Investment/Amount saved = 105000/ 9,32,064 = 0.11 years

<table>
<thead>
<tr>
<th>TABLE6</th>
<th>ENERGY EFFICIENT MEASUREMENT OF FRP FAN</th>
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</thead>
<tbody>
<tr>
<td>Energy-efficient measurement</td>
<td>Annual energy saving in KWH</td>
</tr>
<tr>
<td>Substituting a metal cooling fan by FRP fan</td>
<td>116508</td>
</tr>
</tbody>
</table>

5 CONCLUSION
The consumption of electricity is increasing daily in the industry. The energy audit describes some energy-saving initiatives that the industry can take to reduce electrical energy use through waste reduction and energy efficiency improvement. The energy audit can minimise energy consumption and enhance energy efficiency in the lighting and motor cooling fan to achieve maximum energy performance. Upon completing the Energy Audit of L. J. N. Cotton Mill, we described energy-saving load areas and made recommendations. The advantages of energy and cost savings will be obtained if industry management incorporates these energy-efficient steps in the industry.

6 REFERENCES