

An Effective Implementation of Energy Audit Methodology- A Case Study

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ABSTRACT

In India most of the state government has made energy audit mandatory for energy consuming large scale industries. Small and medium scale industrial plants are not always aware of energy-efficiency improvement potentials. Conducting an energy audit is one of the first steps in identifying these potentials. Usually only limited technical and financial resources for improving energy efficiency are available, especially for small and medium-sized enterprises. Information on energy auditing and practices should, therefore, be prepared and disseminated to industrial plants. Energy audits principles or methodology assist industrial companies or facilities in understanding how they use energy and help to identify the areas where waste occurs and where opportunities for improvement exist. This paper aims to highlight several opportunities to create and implement an energy audit plan within a small scale imitation Jewellery making industries in Gujarat. In this paper importance of energy auditing and process of energy audit is discussed.

Keywords: Energy audit, Small scale industry, Audit Methodology, Payback period.

1. INTRODUCTION

Small and Medium Enterprise (SME) sector makes up for a very large part of the industrial structure in any country. In India, this sector is often characterized by the use of outdated technologies. SME's in India are generally considered as less efficient in material and energy use compared to larger companies. A recent study by the Bureau of Energy Efficiency, India (BEE), which takes into consideration the SME sector, revealed that the overall energy saving potential of the clusters is about 72,432 TOE (Ton of oil equivalent) which is 27.4 per cent of the total energy consumption in SME's.[4]

In India energy losses are very high compare to developed country. Various studies in different countries have shown that significant energy-efficiency improvement opportunities exist in the industrial sector, many of which are cost-effective. These energy-efficiency options include both cross-cutting as well as sector-specific measures. Even so, many plants do not have the capacity to conduct an effective energy audit. In some countries, government policies and programs aim to assist industry to improve competitiveness through increased energy efficiency. Manufacturing companies lack the knowledge about the possibilities of energy savings and increased productivity.[5]

An audit encourages a detailed study of how facility uses energy, what the facility pays for that and finally recommending various Energy Efficiency Measures (EEM) that will save huge amount of money in bills. Purpose of energy auditing is to recommend steps to be taken by Management for improving the energy efficiency, reduce energy cost and saving the money on the energy bills.

The energy audit was conducted at Freya Enterprise Ltd, a small scale Imitation Jewellery making industry, Bilimora, Gujarat, to identify the major areas of effective implementation of energy. The energy audit was conducted within a span of fifteen days. This paper outlines the general framework towards implementation of energy efficiency measures for the Imitation Jewellery industries representing energy analysis presented to illustrate the usefulness and practicality of the approach.

2. ENERGY AUDIT

An energy audit can be simply defined as a process to evaluate where a building or plant uses energy, and identify opportunities to reduce consumption. There is a direct relationship to the cost of the audit, how much data will be collected and analyzed, and the number of conservation opportunities identified.

2.1 ENERGY AUDIT OBJECTIVES

- To acquire and analyze data and finding the energy consumption pattern.
- To calculate the wastage pattern based on the results of the first objective.
- To find and implement solutions those are acceptable and feasible.

2.1.1 TYPE OF ENERGY AUDIT

The type of Energy Audit to be performed depends on Function and type of industry

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

- a. Preliminary Audit
- b. Detailed Audit

a) PRELIMINARY ENERGY AUDIT METHODOLOGY

Preliminary energy audit is a relatively quick exercise to:

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

b) DETAILED ENERGY AUDIT METHODOLOGY

A comprehensive audit provides a detailed energy project implementation plan for a facility; since it evaluates all major energy using systems offers the most accurate estimate of energy savings and cost. It considers the interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost. In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

Detailed energy auditing is carried out in three phases shown in Figure 1.

- Phase I - Pre Audit Phase
- Phase II - Audit Phase
- Phase III - Post Audit Phase

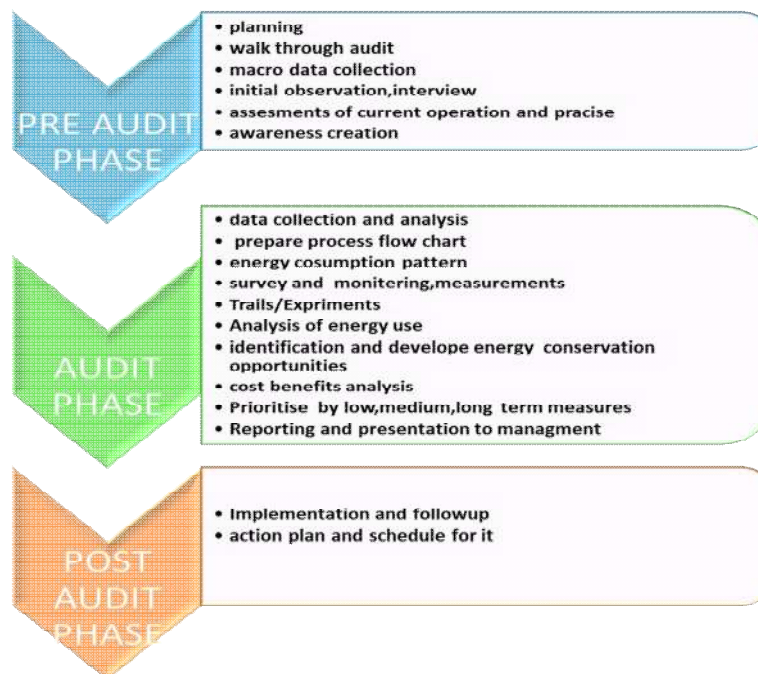








Figure 1 Energy Audit Detailed methodology.

3. METHODOLOGY FOR ESTIMATING ENERGY PARAMETERS

The estimation of energy and/or production parameters is usually based on measuring methods. For every parameter under estimation, a suitable measuring method is selected, which could include one or more measurements of a single or more physical quantity.

Table 1: Typical measurements and instrumentation

	<p>Power analyzer- This instrument is used for measuring electrical parameters like kWh, kVA, power factor, frequency, harmonics. This instrument is used on line and can be able to record the real online data.</p>
	<p>Manometer with pilot tube – This instrument is used for measuring pressure in air ducts carrying exhaust gases or air from fans or blowers.</p>
	<p>InfradThermometer- This instrument is used to measure the temperature. It consists a lens to focus on the detector which converts the energy to an electrical signal that can be shown in units of temperature</p>
	<p>Ultrasonic flow meter- This is a non-contact flow measurement instrument. The ultrasonic signal travelling with the flow travels faster than a signal travelling against the flow. Ultrasonic flow meter measures the transmit time of both signals.</p>
	<p>Lux Meters- A light sensitive cell measures the incident light and evaluates that against the human daylight sensitivity curve.</p>
	<p>Thermograph- Infra-red thermal monitoring and imaging measures the thermal energy radiation from hot and cold surfaces of an object.</p>

4.PAYBACK PERIOD

It is very necessary to know the payback period for the effective implementation of recommendation given here after audit.it may be short term, medium and long term. After all it is a decision if management of the industry.

$$\text{Payback Period} = \frac{\text{Investments in INR (Indian rupees)}}{\text{Net annual saving.}}$$

5.ANALYSIS/CASE STUDY

Energy Audit of a Small Scale Imitation Jewellery has been conducted which is located at Bilimora Gujarat. The process of making Imitation Jewellery shown in Table 2. Material used for the Jewellery is tin, lead. Imitation Jewellery used many types of equipment's and machinery shown in Table-3. The average electrical energy consumption is 2752.114 kwh and average light bill is 20760 INR. The Annul electrical energy consumption is shown in Figure 2. The energy consumption per month of machine and lighting system shown in Figure 4.

Table 2: Process for making Imitation Jewellery.

<p>1.Casting</p>		<p>5.washing</p>	
<p>2.Cutting and polishing</p>		<p>6.Stone setting</p>	
<p>3.Buffing</p>		<p>7.Final Product</p>	
<p>4.Assembly and soldering</p>			

Table 3: Machine and Electrical Equipment's

SR NO	TYPES	QUANTITY
MACHINERY/EQUIPMENTS		
1	Air compressor	2
2	Metal Die casting machine	2
3	Buffing machine	4
4	Barrel machine	1
5	Jewellery polishing machine	2
6	Jewellery washing machine	1
7	Hot air oven	1
8	Soldering Iron	6
LIGHTING		
1	Tube Light	28
2	CFL	10
3	Ceiling Fan	12
4	Table Fan	4
5	Ac	1
6	Computer	2
7	Printer	1
8	Water Cooler	1

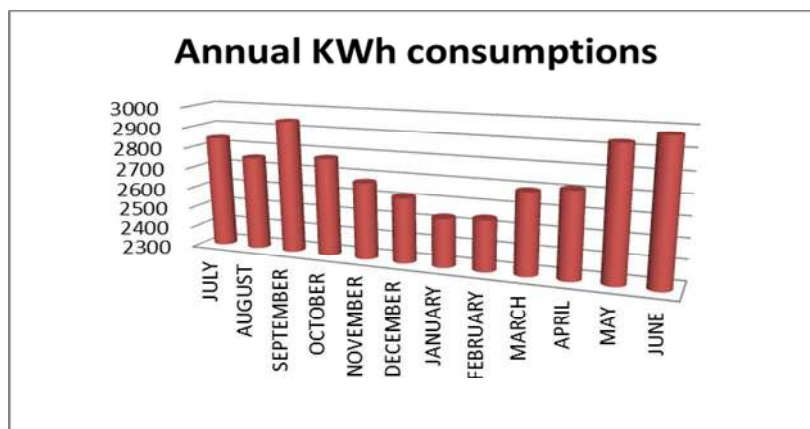


Figure 2: Annual Kwh Consumption

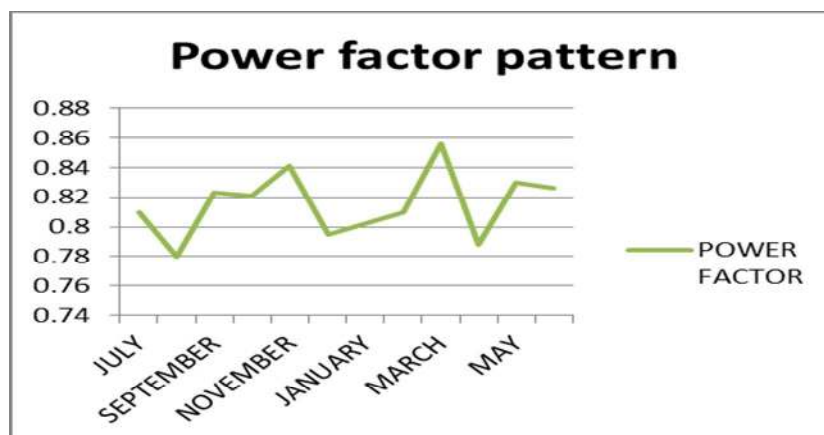


Figure 3: Power factor Pattern

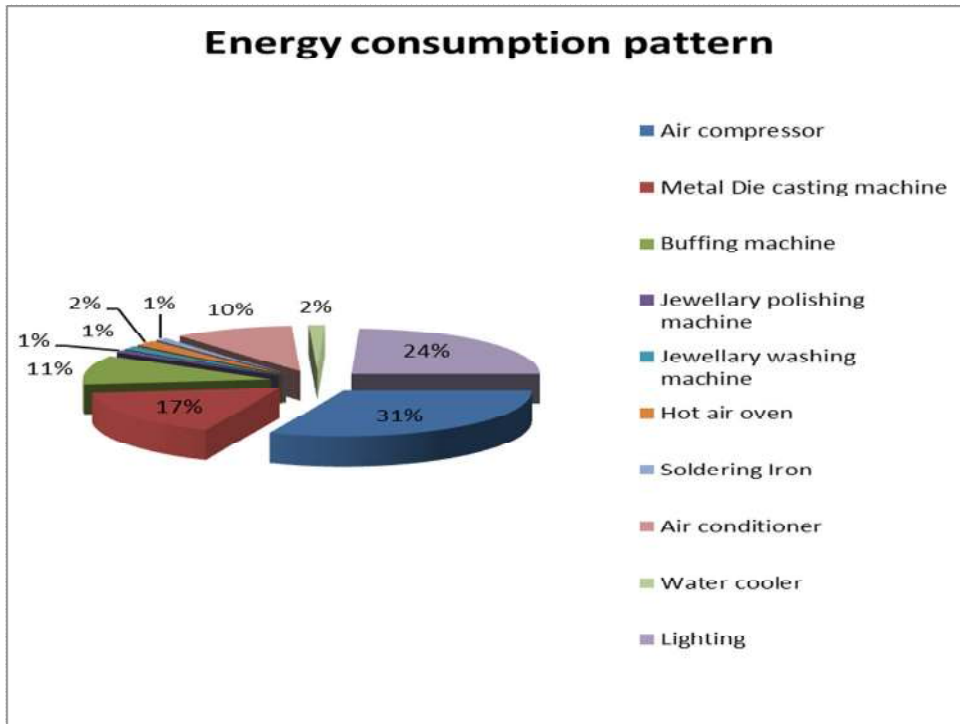


Figure 4: Energy Consumption of equipment's per Month.

ENERGY USE PROFILE

Electricity has a major portion of 65% in jewellery industry and LPG (liquefied petroleum gas) 35% is used for melting the raw material shown in Figure 5. Annual cost for the energy consumption is 383512 INR.

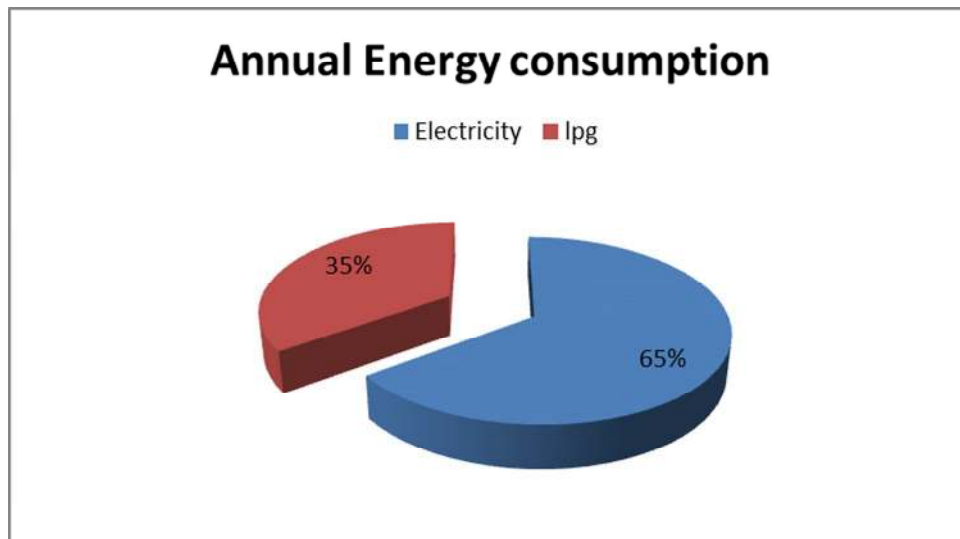


Figure 5: Energy consumption

6.ENERGY AUDIT OUTCOME FOR IMPLEMENTATION

Some areas have been identified through which energy can be saved and for each area Recommendations are given and payback period is calculated.

- 6.1 Layout of Industry
- 6.2 Compressed air
- 6.3 Thermal Energy
- 6.4 LPG consumption
- 6.5 Lighting System
- 6.6 Power factor

6.1 Layout of industry

- The layout of imitation jewellery shown in Figure 6.
- The materials were arranged in an haphazard manner making it difficult for the workers to transport the raw materials.
- Defects in casting were a possibility because of damage during material transfer which resulted in a lot of time wastage and hence productivity was affected.



Figure 6: layout

Recommendation

Arrange better plan layout than existing one. For the Ideal time reduced, process time increased. Waste should be minimized.

6.2 Compressed Air

The Jewellery industry uses a great deal of compressed air for production purposes. The electrical cost of compressed air 24% of the annual operating costs. Leaks can be a significant source of waste energy in any industrial compressed air system, sometimes wasting 20 to 30 % of a compressor's output. Air leakage has been found during the audit.

Recommendation

- A leak test should be conducted on the given compressor and the amount of leakage will calculate.
- Use FLR for the better efficiency.
- Replace old reciprocating compressor to new screw compressor.
- Calibration of the compressor.
- By bringing down the temperature to 26 degree Celsius, 1.5 % power can be saved.
- The power consumption is reduced from 36 to 10 % by applying the following remedial measures.

Payback period for Investing in FLR and a new screw compressor is long (about 3 to 4 years).

6.3 Thermal energy

The fact that jewellery industries are one of the most energy intensive industries is due to melting of scrap and other raw materials. The problematic areas that were encountered were spillage during pouring of molten metal and heat loss due to open conventional method.

Recommendation

- The options for energy savings in melting are preheating of the raw materials.
- Selection and maintenance of furnaces.
- Continuous monitoring and control of melting and heat treating devices.
- A significant amount of energy can be conserved by using a lid system.

6.4 LPG Consumption

Presently Industry using LPG for the melting the raw material without any furnace. The annual cost of its 134400 INR.

Recommendation

- It's recommended to use efficient electrical furnace for melting the metal.
- Pouring system should be improved so that casting time is reduced.

Payback period for Investing in Furnace.

Investment cost = 52530 INR

Annual energy Consumption of furnace =138240 INR

Total cost=190770 INR

Annual LPG cost=134400 INR.

Payback Period = 1 year and 4 month.

6.5 Lighting system

This includes light, fan, ac, computer, .etc. There is the energy saving opportunities in the industry in electrical consuming equipment’s. Total lighting load of industry is around 40% as shown in Figure 4.

Recommendation

- All tube lights chokes replaced with ballast chokes.
- All ceiling fans should be controlled by electronic fan regulators or replace by new efficient fan.
- Use Energy efficient fluorescent lamps.
- Shut off unnecessary computers, printers, and copiers when ideal.
- Replace old Air conditioner with new.

6.6 Power factor

The average power factor of the jewellery industry is 0.81 based on the annual bill. For reduced the energy consumption and for escaping for the penalty, power factor must be close to average power factor value 0.95.[6]. Figure 3 shows the annual power factor of the industry.

Recommendation

It is recommended to improve the power factor to an average value of 0.95 by using capacitor bank. Table 4 shows the recommendations and Payback period for the Lighting system based on the annual saving and investments.

Table 4: Recommendations and Payback period for lighting Equipment’s.

SR NO	Equipment’s	Energy Saving recommendations	Energy saving in watt/month	Annual Saving in INR	Investment in INR
1	Tube Light	use T5 of 28w	756	13934.592	3500
2	Fan(ceiling and table)	Use energy efficient fan 48w	372	6856.704	35236
3	Fluorescent Lamp	use lamp of 29w	110	2027.52	1500
4	Computer	use led screen of 65w	30	552.96	8600
5	Air conditioner	use 5 star ac of 1600w	500	9216	45500
6	for increased power factor	use capacitor	1450	26726.4	5250
Total =			3218	59314.176	99586
Payback Period =			1 Year and 6 moths		

7.CONCLUSION

Energy audit is an effective tool in identifying and perusing a comprehensive energy management program. A care full audit of any type will give the industry a plan with which it can effectively manage the industrial energy system at minimum energy cost. This approach could be useful for an industry in combating essential energy cost and also raps several other benefits like improved production, better quality, higher profit and most important satisfaction of heading towards contributing in world energy saving. [2] After identification of the major sectors of a jewellery industry where energy audit can be carried out some energy saving approaches are presented in this paper based on actual field data. This paper presented the energy saving measures in the form of findings, recommendations and Payback Period. Up till no research work for energy auditing in jewellery industry was found and thereby this work is of significant importance.

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