

Energy Audit a Window to Energy Optimization in Industries

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Abstract: In today's world of severe after effects of our heavy energy use spree, the major concern is to avoid the repercussion of our mistakes. We need to focus on ways to conserve energy in each and every way we can and help reduce our carbon footprints. A lion's share in carbon footprints is of the industrial sector. Coming up with ways of using energy efficiently in industrial sector can help us go a long way in conserving energy and eventually reducing our carbon footprints. This paper talks about and highlights the use of energy audit to strategically find ways to reduce energy consumption. A sincere attempt has been made to conduct a primary Energy Audit on a railway brake block manufacturing company. Identification of a hydraulic power press and estimation of energy saving potential in the all departments has been made by walk-through energy Audit.

I. INTRODUCTION

Energy Audit is similar to a Financial Audit just what changes is the measurand. Financial Audit measures the flow of money whereas Energy Audit measures the flow of energy through a system. Energy Audit helps in developing an energy management program and to understand the energy use profile of a facility. It involves a lot of complexity which differs from one organization to another. From the global perspective, industrial energy efficiency is one of the most important means of reducing the threat of increased global warming as the industry accounts for about 80 percent of the world's annual coal consumption, 40 percent of the world's electricity use, 35 percent of the world's natural gas consumption, and around 10 percent of global oil consumption^[1]. Typically an Audit comprises of following steps^[2]:

- Walk through for data collection and review.
- Plant survey and system measurements.
- Observation and review of operating practices.
- Data analysis.

In short, we analyze where, why, when and how the energy is used in a facility. The vital information gathered from this is then used to look out for energy management opportunities (EMOs). Energy Audit also ameliorates the financial savings due to energy management and its proper use.

Energy Audit categorizes into two types:

- Primary Audit.
- Detailed Audit.

Primary Audit: Its more basic audit wherein we, collect all the information about the companies processes, equipments or machineries used etc. This type of energy audit uses existing or easily obtained data for energy audit. The amount of energy consumptions in a facility is obtained by conducting a simple survey. We pay a special attention to large energy consuming machineries or processes. Our aim is to zero in on energy saving opportunities by visual examination of the organization.

Detailed Audit: It involves detailed technical and economic analysis of energy efficiency measures. Especially those involving large capital investment and long payback periods. This audit is done in three phases namely:

Phase I: Analysis of the data from the energy bills to determine what energy is being used and how the use varies with time. Compilation of the preliminary data of the facility and gathering all the adjustment tools and formation of an audit team.

Phase II: IN this phase the team undergoes briefing in safety and performs a walk-through visit to the facility having a look at all the physical bits and storing or noting information for later use. The team then needs to prepare an energy balance report to keep an account of the energy flow. After identification and analyzing the data, alternatives are searched for. The final step is an audit report with recommendations to change in equipment, process or operation for energy cost savings.

Phase III: Phase Three is where- implementation phase—begins when the energy manager and the facility management agree on specific energy savings goals and initiate some or all of the actions recommended to achieve those goals. Setting up a monitoring system will allow management to assess the degree to which the chosen goals have been accomplished and to show which measures have been successful and which have failed. The results of the monitoring should feed back to the beginning of the audit cycle and thus potentially initiate more analysis, implementation, and monitoring.

Energy prices play a major role in energy audits. Especially in India where energy prices have significantly grown in recent years (2000-2006), the electricity prices nearly doubled and oil prices increased by 70%^[3].

Thus energy audits mainly focus on optimization of the existing technologies with minimum wastage of energy to reduce on the energy bills and pump the savings for investments in the future benefitting the organization or company.

II. ABOUT THE COMPANY

A typical brake block manufacturing company has following major sections:

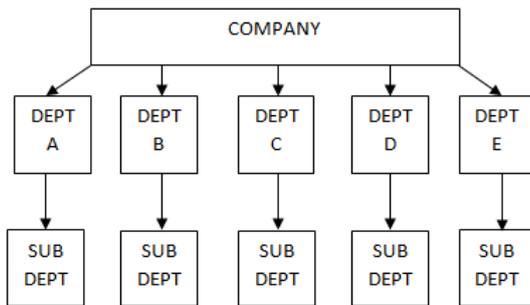
- Mixing section.
- Back-plate section.

- Pressing section.
- Baking section.
- Finishing and packaging section.

The major energy consumption sections as seen are the mixing section due to multiple mixers and their cooling setup, pressing section due to its hydraulic presses and the baking or heat treatment sections due to its ovens.

Thus for a small scale setup like the one we visited the electricity consumption bill can shoot up to an average of 1lakh units.

If not managed properly the energy costs can rise exponentially. The basic energy consumption structure of such a plant is given below: FIG (A)



III. METHODOLOGY

An energy audit is basically more of a systematic assessment of energy use patterns or practices, from point of purchase to the point of end-user. It just identifies how energy is handled and consumed, i.e.

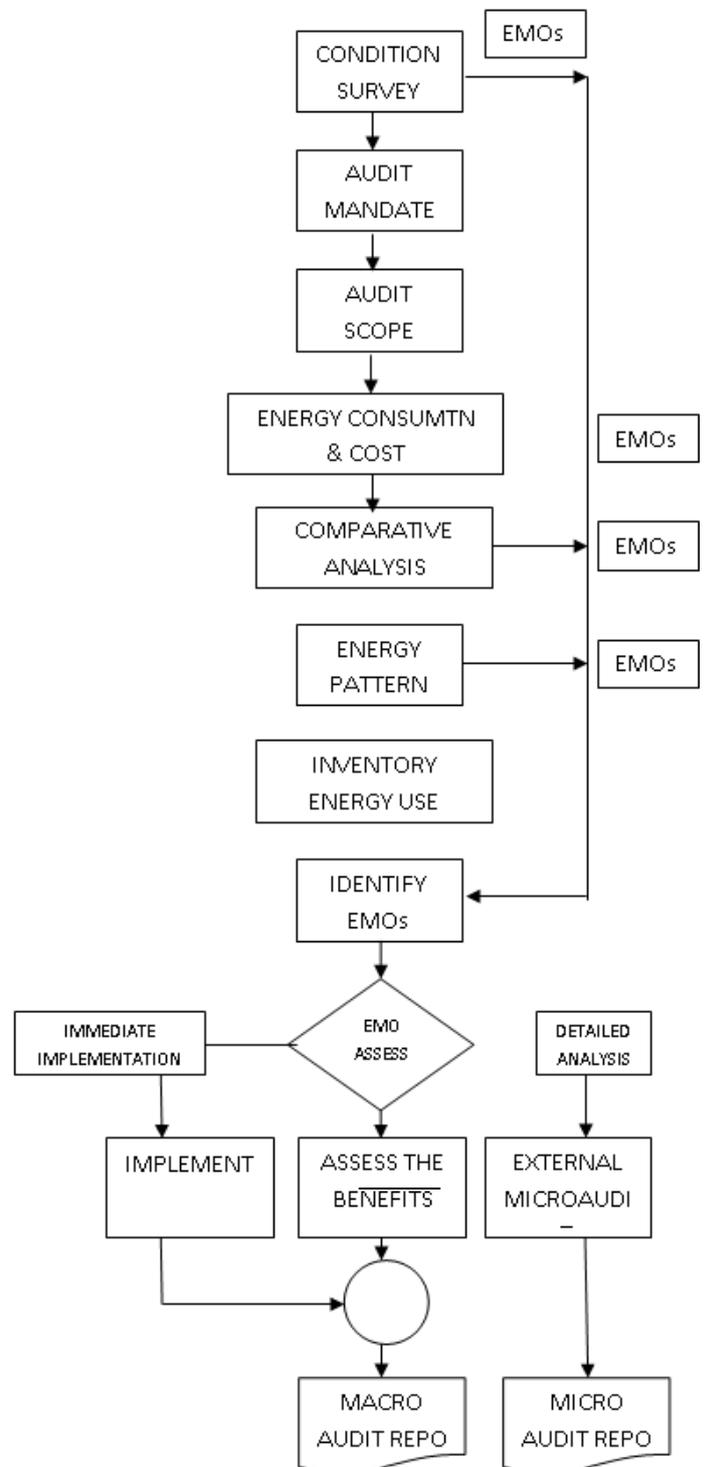
- ❖ Where and how energy enters the facility, department, a piece of equipment or a system.
- ❖ Where does it go and how its been put to used.
- ❖ Spotting any variances between inputs and uses.
- ❖ Looking for ways in which it can be used more efficiently and effectively.

The key steps involved in methodology are as aforesaid:

- **Conducting a condition survey:** Assessing the general level of repairs, operations and house-keeping practices that have an effect upon the energy efficiency and also the flag situations that warrant in depth assessment in the mere progress of the audit.
- **Establishing the audit mandate:** Involves procurement of commitment from management and definition of the expectations and outcomes from the audit.
- **Establishment of the audit scope:** Defining the energy-consuming system or section to be audited.
- **Analysis of energy consumption and cost:** Collection, organization, summarization and analysis of historical energy billings and tariffs that apply to them.
- **Comparison of energy performance:** Determination of energy use indices and comparing them internally from one period to another, from one facility to another similar one within the organization or some others outside that are the best one can get in an industry.
- **Profile energy use patterns:** Determination of the time relationships of energy use, such as the electricity demand profile.
- **Inventory energy use pattern:** Preparation of a list of all energy consuming loads in the audit area and notation of measurements of their consumption and demand characteristics.

- **Identification of the Energy Management Opportunities (EMOs):** Inclusion of operational and technological measures to reduce energy waste.
- **Assessing the benefits:** Measurement of potential energy and cost savings, along with any co-benefits if any.
- **Preparing a report of action:** Prepare a report of the audit findings and communicate them to the decision makers for its apt implementation.

THE AUDIT FLOW CHART



IV. OBSERVATIONS DURING THE PRIMARY AUDIT

Adhering to the steps the first step of any primary audit is to pay a walk-through inspection of the facility. Major energy consuming equipments in a typical brake block manufacturing company are the hydraulic, pneumatic and mechanical presses. On collecting the data it was observed that the major chunk of the energy consumed was by the presses in the facility especially the hydraulic ones as it had two shifts, 12 hour each, working on it. The next point that struck us during the visit was the company didn't have any energy manager to keep a track on the energy data and to look for energy saving opportunities in-house.

The facility being old, its infrastructure was such that it didn't allow much light to flow in the edifice due to improper positioning of windows and from the area which let natural sunlight in didn't reflect much to its surrounding, thus the lights had to be kept ON even during the daytime period.

The second most energy consuming equipment in its premises was the baking ovens. On having a look they were absolutely lacking maintenance and were a victim of leaks.

The storage facility for inventory of the raw materials required for the mix was a clearly not so frequently used area which had its fluorescent tubes switched ON throughout the whole day.

Workers weren't aware about the importance of saving energy. Thus, very little care were taken by them in contributing to an efficient environment.

V. RECOMMENDATIONS

Based on the observations during the walk through and analyzing its history energy bills following recommendations were made to act as a source for a detailed audit in the mere future:

- ❖ Considering the fact that the major power consumer which were the presses to be more specific the hydraulic presses which were fitted with a constant speed motor for the hydraulic oil delivery recommendation was made to fit them with a variable frequency drives. The operation on the press had a lot of idle time in between where the mix was heated within with the help of an onboard heating assembly but under a constant pressure of the hydraulic press. During this phase the oil was continuously supplied by the motor which eventually used to return to the reservoir through open by-pass valves. Thus, power was consumed to pump the oil even when the operation was on idle which was sheer wastage of energy. By installing a variable frequency drive it would be able to pump oil as per demand without any excess supply during the idle time. The installation of the VFD (Variable Frequency Drive) itself can save 13% energy over the constant speed motor^[4].
- ❖ The location of the company ensures that the facility is blessed with ample amount of sunlight throughout the day and around the year. But the current infrastructure of the facility fails to use it for its benefit. The roof of the work floor is made of traditional cement roofing sheets which block the available natural ambient light. Recommendation was made to switch to fibre glass roofing sheets available these days with small patches to be fitted with transparent fibre glass sheets so that they

allow ample sunlight to fall in the facility which will definitely improve the lighting conditions and transform the dull atmosphere to a vibrant one. A little repaint of the facility can also improve the ambience and also reflect handsome amount of light to the surrounding area. It will also help to bring in a change for workers which will help them to eradicate the monotonous work feel and improve their working efficiency.

- ❖ The ovens used clearly lacked maintenance. Also on minute observation it was seen that the insulation material on the door to keep in the heat had disintegrated and was falling off on a mere touch. These leaks cause a substantial increase in the energy used as the leaks give off heat and thus the time required to attain a certain temperature range was more and thus the amount of LPG used as fuel also increases. It was recommended to keep a proper maintenance schedule and to replace the insulation on the door panel of the ovens. Also it was suggested to manage the air flow to the ovens by reusing exhaust as combustion air as the exhaust air can contain up to 20% of oxygen due to excess ventilation in the oven and also by minimizing ventilation air. Managing the air flow itself can save up to 35% to 50% of system energy use^[5].
- ❖ It was evident that the storage area was one major section which needed proper attention as it was the least approached place but had all the fluorescent tubes switched ON and remain so the whole period. This is hotspot of unnecessary wastage of energy. Recommendation was made to make use of motion sensors so that the tubes be activated whenever the sensors detect movement or presence of workers. Thus, it will be helpful to reduce the electricity bills.
- ❖ It was seen that the facility was still relying on a lot of fluorescent tubes instead of LED lighting solutions. It was also seen that the tubes were using conventional chokes which consume more power. It was recommended to either switch to complete LED solutions or to change the chokes of tube lights to electronic ballast chokes. Electronic ballast chokes save 13-16 W power over the conventional one^[6].

VI. CONCLUSION

Thus this paper talks about the energy audit as a key to industrial optimization by realizing the importance of energy conservation and then listing the procedures to undergo the audit. To support the idea a primary audit in a brake block manufacturing company is cited to show how wide the scope of improvement is even in a small scale company like this. Just imagine how broadly it can be applied in a large scale industry and the goal of optimization of industrial process can be achieved and thereby contribute towards to greener planet by reducing the wastage of our prized resources.

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