Energy Audit

Ravindra M Datar

Senergy Consultants Pvt Ltd
03, Aastha II, Opp. Lakme Ltd, B K S Devashi Road, Govandi East, Mumbai 400 088
(Email: ravindra.datar@gmail.com)

Abstract

This paper discusses systematic and scientific methods for conservation of energy of any facility; be it an industry, commercial premises, shops & malls, office, or even a small house. It also suggests effective monitoring and control mechanism for sustainability of the savings and opportunities for further improvements in continuous basis.

The paper presents some of the not so common case studies witnessed by the author during various energy audit studies carried out by him. An impact of energy audit on system designs and improvements at design stage is also briefly touched upon.

1. Introduction

We have been taking various steps and measures for saving energy right from the day human being started using energy. But the efforts were kneejerk reactions to circumstantial compulsions without any significant impact on long term consumption. However with any scarcity and security beginning to be the key issues, systematic methodology was evolved to conserve energy on sustainable basis and also adopt renewable energy sources.

Energy Audit is the first step toward systematic efforts for Conservation of Energy. Like financial audit it tells you how and where the energy is being consumed. But going beyond the audit, it further it tells you how efficiently and effectively the energy is being used, how much of energy is being wastefully utilized and at what places.

Energy audit provides us with the tool to benchmark our consumption against our own best figures as well as that of the best in the segment – nationally as well as internationally.

We can also incorporate many of the energy conservation measures during designing of the system, to additionally save in the capital costs.

2. Energy Audit

Energy Audit is the first step toward systematic efforts for Conservation of Energy. It involves collection and analysis of energy related data on regular basis and in a methodological manner.

The study not only identifies various gaps and weak areas but also provides us tool to take corrective actions and monitor the performance.

2.1 Specific Energy Consumption

The specific energy consumption is the energy consumed by the installation per unit output. All the measurements are generally based on the purchased values of energy and final output from the installation. This has been corrected to energy consumed per unit of area for building and commercial premises. This can be extended to include specific machinery / equipment or even part of the plant / process.

The values are to be computed on day to day basis to analyze the deviations and take corrective actions.

2.2 Targets & Benchmark

The benchmark values are generally set for specific energy consumption and / are energy costs for the complete facility. The target or benchmark values are set as the goal that one plan to achieve in the specified period of time and on consistent basis. The internal benchmark values based on the best values achieved by the organisation; while the external benchmark values are the values reached by similar organisation / competitor.

The benchmark sets the goal while subsequent steps of the audit provide us the direction to reach the goal.

2.3 Energy Accounting & Unaccounted Consumption

This involves carrying out detailed measurement by installing meters and sub-meters or otherwise to prepare authentic break up of the energy consumption. This helps in identifying the major consumers of energy and also

defines the gap between energy supplied and energy consumed.

This helps in identifying unknown avenues of losses like compressed air / steam / water leakages, cable losses, even theft and even fault in supply measurement in an extraordinary situation.

2.4 Equipment Performance

This is one of the most important and intricate part of the energy audit study; covering all the mechanical as well as process equipments like air compressor, refrigeration systems, pumps, boilers, dryers, evaporators.

It involves carrying out measurements as per the laid down procedures to ascertain actual output of the equipment / machine and also energy consumed per unit of the output.

The underperformance of equipments is one of the major reasons for energy losses.

2.5 Distribution System

The generation of all the utilities is at centralized places, while the consumption is distributed through out the facility. The electricity is also distributed throughout the plant through maze of cables.

The distribution is a necessary evil which if not controlled eats away substantial part of the energy. The Electricity Boards lose over 35% of power generated in the country in Electrical Distribution System.

2.6 Utilization

Loading a 10 Ton truck with 1 Ton of material would never be termed as efficient operation, even if the truck gives the best mileage and runs on the best highway. The effective utilization is mapping the actual process requirements and matching them with the utility / service provider.

Mismatch between discharge pressure of air compressor with the actual plant requirement would be another commonly found example.

2.7 Recovery from Waste Energy

The recovery of waste energy has gained great importance in recent times. It has become common practice to install waste heat boiler for DG sets, feed water / combustion air preheating from boiler exhaust.

The recovery of heat from bathroom drain has also been key focus area in the countries having extremely cold weather.

2.8 Cost of Energy

Purchasing at lowest cost is the simplest form of saving. Replacing furnace oil or LPG with coal has gained momentum due to phenomenal rise in cost of furnace oil.

The power cost is optimized by maintaining unity power factor, availing bulk discount. The cost is also reduced by sourcing power through installation of capital power plant, co-generation systems and even wind mills.

2.9 Renewable Energy

As the name suggests renewable energy is not only an unending source of energy but it is also environment friendly and non-polluting.

Some of the economically feasible alternatives include water heating, wind mills, biofuel from agro / municipal waste, bio-methanation of high COD effluent.

2.10 Energy Monitoring

Monitoring is like regular and routine health check, which is essential to realize the savings on sustainable basis. It also helps in conterminous improvements.

3. Case Studies

3.1 Specific Energy Consumption

The graph of energy cost plotted at the beginning of the audit revealed very specific energy high consumption at lower level. There was practically no reduction in the energy cost at lower level of the production, as can be seen from Initial Graph.

The reasons for which were analyzed to formulate strategy to reduce the same through operational improvements. The typical steps included monitoring the machine operations, rationalizing flow rates. There was no capital investment; there was considerable reduction in specific energy cost at lower production levels, as can be seen from Stage Graph.

The subsequent steps involved small modifications and investments to further reduce the specific energy consumption at lower production level. The measure included installing variable speed based controllers for key pumps / fans.

3.2 Energy Recovery from Waste Stream

A marine processing unit receives fishes laced with ice from various contractors. These are washed with chilled water before further processing. The waste ice as well as wash water as sent to Effluent Treatment Plant. The chilled water generated through a 150 TR refrigeration system.

It was suggested to recover energy from the waste ice and the wash water and pre-cool the water fed to the refrigeration system. The waste ice was collected in the same pit and pumped through a plate type heat exchanger to cool the incoming water to the refrigeration system.

3.3 Captive Power Plant

In a captive power plant, the condensing temperature was observed to be 60 ^{o}C, despite being in reasonably normal climate.

The detailed study pointed at faulty cooling water system resulting in lower cooling water flow rate and higher approach temperature.

The corrective actions brought down the condensing temperature to 35 ^{o}C, saving 12% on fuel cost or generating equivalent higher power.

The turbine exhaust is always steam which is condensed in a condenser with the help of cooling water. The system is maintained under vacuum to extract maximum energy from the exhaust steam.

3.4 Pumping System

The power consumption of the pumping system depends on differential pressure, flow rate as well as efficiency at the operating point. For an industrial cooling water system, the pumps were observed to be operating with 30% throttled discharge. The delivery valves of all the pumps were throttled to avoid overloading of the pumps
.
The problem was traced to overdesign of the pumps as the system pressure was considerable lower than the pump selection pressure. As the actual pump pressure is governed by the system pressure, the pump was operating away from the design point giving more flow and consuming more power. To avoid overloading of the motor, delivery valves were throttled, just to operating the motors at full load power.

The impellers of the pumps were resized by suitably trimming the diameter to eliminate throttling of the valves. The savings or around 30% was realized just by impeller trimming.

4. Conclusion

Energy Audit is the first step toward systematic efforts for Conservation of Energy. It involves collection and analysis of energy related data on regular basis and in a methodological manner.

The correction of gaps identified through Energy Audit not only leads to energy savings but also greatly influences System Design.

Energy Monitoring and system improvement is an ongoing process, due to dynamism of the energy costs and business environment.