

Energy Auditing: Necessity for Energy Management System

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ABSTRACT

Energy conservation could protect the present reserve of energy from the culture of wasting. In this paper energy audit has been focused to assess the state of energy usage. The methodology of energy audit is the measurement of energy performance with respect to production factor. The technical survey for the energy audit to monitor the consumption in industry, domestic area, hospital and power plant has been studied. All attempts are taken to the total energy input correlating with production for the mentioned fields. As a result of the study the areas where the energy is wastefully used and the improvements are felt, are identified and corrective measures are recommended so that the overall field efficiency could be improved. Energy sovereignty of the country could be ensured through the effective practice of energy audit which would determine the way to set increasing energy efficiency of all resources crucial with respect to both environment and economy of the country. Energy auditing is a must for the energy sovereignty of our country.

Keywords: Energy Management, Energy Auditing, Production factor, Courses on Energy Auditing

1. Introduction

For the development of a country the first important requirement that is needed is energy. To develop both socially and economically no option is getting prior without energy, but nowadays energy overview of the world is not in pleasurable condition and for Bangladesh the condition is more bad. Though quantity of natural resource is decreasing day by day, wastage of natural resource in different field is not controlled due to lack of proper management. Energy Auditing will be possible strategy in Energy management case to control such type of wasting in some field like industries, power plants, houses, different types of shops and Hospitals.

2. Definition of Energy Management

The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. The term Energy Management means, the strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization throughout the organization and:

- To minimize energy costs and waste without affecting production and quality.
- To minimize environmental effects.

2.1 Purpose of Energy Management

The purposes of energy management are mentioned below:

- Improving energy efficiency and reducing energy use, thereby reducing costs
- Reduce greenhouse gas emissions and improve air quality
- Cultivating good communication on energy matters
- Developing and maintaining effective monitoring, reporting and management strategy for wise energy usage
- Finding new and better ways to increase returns from energy investments through research and development

3. Definition of Energy Audit

An energy audit is a technique for identifying energy losses, quantifying them, estimating conservation potential, evolving technological options for conservation and evaluating techno economics for the measures suggested. Assist industries in reducing their energy consumption, To promote energy-efficient technologies among industry sectors, Disseminate information on energy efficiency through training programs and workshops, To

promote transfer of energy-efficient and environmental-sound technologies to the industrial sectors in the context of climate change.

3.1 Reason of the requirement of Energy Auditing

In the case of an industry, the three top operating expenses are often found to be energy both electrical and thermal, labor, and materials. In most assessments of the manageability of the cost or potential cost savings in each of the above components, energy would invariably consider at first and thus energy management function constitutes a strategic area for cost reduction. A perfect energy audit will always help managers to understand more about the ways energy and fuel are used in their industry and help to identify those areas where waste can occur and where scope for improvement are needed. The energy audit would give a positive orientation to the energy cost reduction, preventive maintenance, and quality control programs which are vital for production and utility activities. Such an audit program will help to keep focus on variations that occur in the energy costs, availability, and reliability of supply of energy, help decide on the appropriate energy mix, identify energy conservation technologies and retrofit for energy conservation equipment. In general, the energy audit is the translation of conservation ideas and hopes into reality, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame. The primary objective of the energy audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. The energy audit provides a benchmark, or reference point, for managing and assessing energy use across the organization and provides the basis for ensuring more effective use of energy.

3.2 Types of Energy Audits

The type of energy audit to be performed depends on:

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

Thus energy audits can be classified into the following two types:

1. Preliminary audit
2. Detailed audit

3.2.1 Preliminary Energy Audit Methodology

The preliminary energy audit uses existing or easily obtained data. It is a relatively quick exercise to:

- Determine energy consumption in the organization
- Estimate the scope for saving
- Identify the most likely and easiest areas for attention

- Identify immediate improvements and savings like low cost or no cost.
- Set a reference point
- Identify areas for more detailed study and measurement [1]

3.2.2 Detailed Energy Audit Methodology

A detailed energy audit provides a comprehensive energy project implementation plan for a facility, since it evaluates all major energy-using systems. This type of audit 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 detailed 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. Overall Energy Audit follows some criteria that are given below.

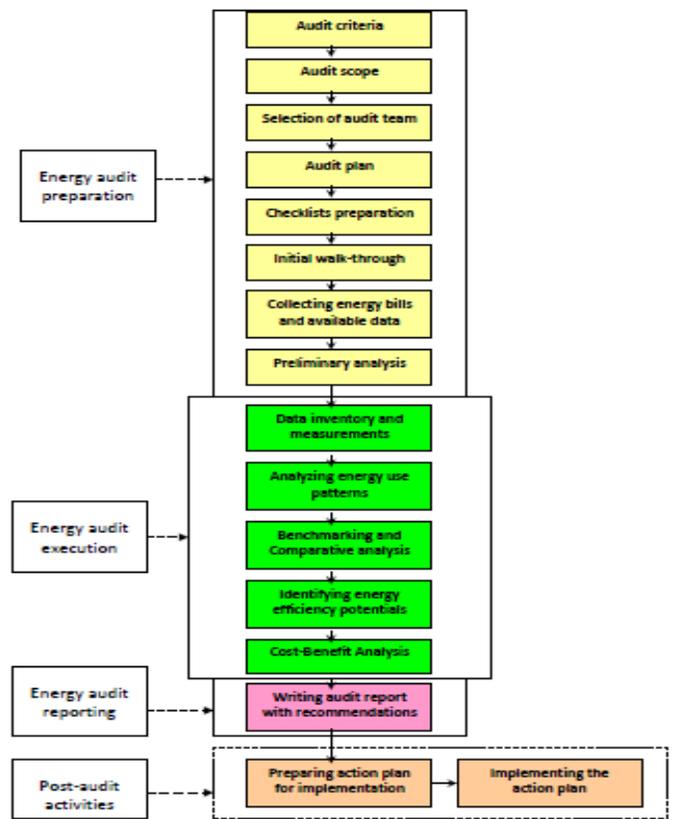


Fig.1 Detailed Energy Audit Process. [1]

4. Process of Energy Auditing in Industries

Auditing in Industries means the checking of the efficiency of the production according to the consumption of energy, this is following some steps.

- Preparation and planning
- Data collection and review
- Plant surveys and system measurements
- Observation and review of operating

Practices

- Data documentation and analysis
- Reporting of the results and recommendations [3]

4.1 Understanding Industrial Operation

Developing an understanding of industrial operations is a prerequisite for the analysis of energy efficiency in an organization. In order to achieve that, we start with data on the general characteristics of the business followed by data collection on energy use, main utilities and characteristics of energy end-use requirements.

Table 1 General Characteristics of Energy Auditing.

Type of the section	
Type of the Product	
Production capacity (t/y)	
Capacity Utilization (%)	
National/Multinational	
History of the Industry	
When Established	
Growth Pattern	
Cost structure	
Raw Material (%)	
Labor (%)	
Energy (%)	
Other (%)	
External Environmental Factor	
Economics	
Board Economic Setting	
Development Trend	
Structure and Share of the market	
Objectives and Strategies	
Specific organizational objectives and strategies as defined by management	

Growth objectives over the next 5 years
Policies and plans, main projects

4.2 Preliminary Energy Audit

A Preliminary Energy Audit is essentially a data gathering exercise which aims to develop an understanding of how energy is used in an Industry and prepare a background for detailed energy audit implementation.

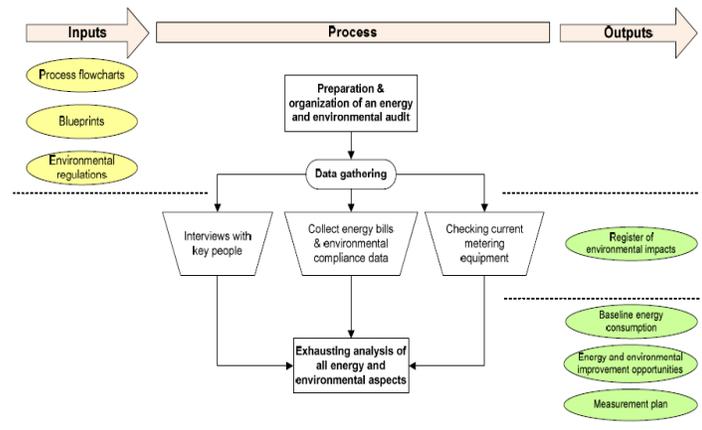


Fig.2 Preliminary Auditing Process. [2]

In an Preliminary auditing process the first requirement is to gather data from key peoples like manager and owner of the factory about the schematic design of the factory production process, production program and capacity, production of the year, using raw material, monthly and annual fuel consumption data by an interview.

Table 2 Production process of An Industry.

Production program and capacity
Production in the year
Raw materials

Short process description	
Draft scheme of the production process	
Draft scheme of the Boiler system	
Draft scheme of the Electric conversion system	
Total annual operating time [h/yr]:	
Number of shifts per working day:	
Total number of employees	
Number of employees in energy group:	
Head of group:	
Total annual cost of production:	
Total annual cost for energy and water:	

Table.3 Annual fuel consumption. [2]

Month	Deliveries [t]	Cost of delivery []	Working days in a month	Consumption [t]	Cost of consumed fuel []
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
I					
II					
III					
IV					
V					
VI					
VII					
VIII					
IX					
X					
XI					
XII					
Total					

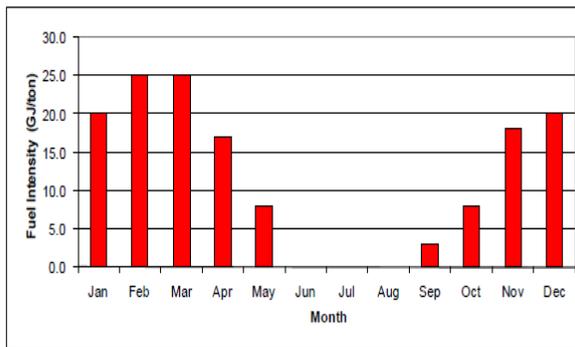


Fig.3 Bar diagram of Annual Fuel consumption reference of a Textile Mill. [3]

Table.4 Annual electricity consumption. [2]

Month	Active energy		Reactive energy		Total cost []
	Consumption [kWh]	Price/unit [/kWh]	Consumption [kVArh]	Price/unit [/kVArh]	
<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
I					
II					
III					
IV					
V					
VI					
VII					
VIII					
IX					
X					
XI					
XII					
Total					



Fig.4 Bar diagram of Annual Electricity consumption reference of a Textile mill. [3]

4.4 Identification of Energy conservation opportunities

As a part of Preliminary Auditing during inspection of the plant, opportunities for energy conservation have to be identified. The following checklist should serve as a reminder as to where to look for Energy Conservation Opportunities. [2]

- Electrical system
- Air Conditioning
- Refrigeration
- Lighting
- Industrial boiler
- Steam
- Compressed Air
- Furnaces, kilns and oven

4.5 Detailed Energy Audit

A detailed energy audit aims at establishing actual energy performance of selected end-users and processes. Based on identified of energy conservation opportunities during the preliminary audit. DEA is the long term inspecting process consisting of all

types of data like production processing, equipments efficiency and performance, consumption of energy and Economic and Financial Evaluation of energy performance improvement measures includes cost-benefit analysis. The audit results have to be summarized in a report, together with an action plan containing the priorities for the implementation of performance improvement project Fig9. Detailed Energy Audit [2]

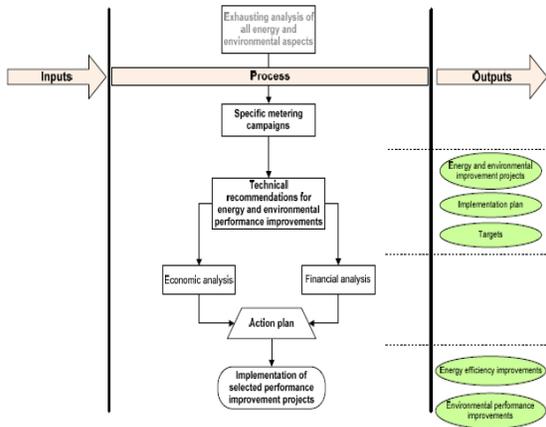


Fig.5 Process of Detail Energy Audit

4.6 Preparation and presentation of Detailed Energy Audit report and Action Plan

4.6.1. Recommended chapters for Detailed Energy Audit report

Information that must be remained in the audit report are following below:

- Executive summary
- General data on factory and processes
- Observations and comments on operational, housekeeping and maintenance practice
- Current level of production and energy consumption and energy balances
- Specifications of identified energy performance improvement measures
- Expected values of energy cost savings
- Investment analysis:
 - Economic aspects: Payback period
 - Financial aspects: Cash flow
- Quantitative target for improving energy performance
- Implementation plan for achieving the set targets
- Technical details and specifications must be attached

4.6.2. Approach to preparing an energy action plan

The order of consideration of energy conservation measures:

1. Improvement of maintenance practices
2. Improvement of operation practices
3. Improvement of equipment efficiency
4. Improvement of process efficiency

The order of priority for the implementation of energy conservation measures:

1. Introduction of systematic energy management practices including awareness, training and motivation programs
2. Improvement of energy metering, control and monitoring
3. Improved housekeeping and maintenance
4. Implementation of energy performance improvement projects with a short payback

5. Measurement of Energy Performance of a Plant of an Industry

Plant energy performance is the measure of whether a plant is now using more or less energy to manufacture its products than it did in the past, as a measure of how well the energy management program is doing. It compares the change in energy consumption from one year to another considering production output. Plant energy performance monitoring compares plant energy use from a reference year with subsequent years to determine the extent of improvement that has been made.

Production factor

The production factor is used to determine the energy that would have been required to produce this year's production output if the plant had operated in the same way as it did in the reference year. It is the ratio of production in the current year to that in the reference year.

$$\text{Production Factor} = \frac{\text{Current year's production}}{\text{Reference year's production}}$$

[1]

Reference Year Equivalent Energy Use

The reference year's energy use that would have been needed to produce the current year's production output can be called the Reference year energy use equivalent or Reference Year Equivalent for short. The reference year equivalent is obtained by multiplying the reference year energy use by the production factor that is obtained above .

Reference year equivalent = Reference year energy use X Production factor [1]

The improvement from the level of the reference year is called Energy Performance and is a measure of the plant's energy management progress. It is the reduction or increase in the current year's energy use over the reference, and is calculated by subtracting the current year's energy use from the reference year's equivalent. The result is then divided by the reference year equivalent and multiplied by 100 to obtain a ratio.

$$\text{Plant energy performance} = \frac{\text{Reference year equivalent} - \text{current year equivalent}}{\text{Reference year equivalent}}$$

X 100 [1]

From this measurement an Auditor can get idea of energy use, consumption, wastage and efficiency of a plant. If any result is not under satisfaction than Auditor can suggest to the Industry manager or owner to replace or change the design of the audited plant.

6. Reason of the requirement of Energy Auditing in Bangladesh

Power crisis is the main problem in Bangladesh. Though combining efficiency of all power plants are 10390 MW, productions are varied between 6000 to 6500 MW [4]. The main background reason is the lack of maintenance and the lack of able man power for proper maintenance process. we do not generate any power from some our power plant such as Horipur EGCB power plant which is capable of generating 412MW power but the production is zero [4]. Moreover existing generating power are also wasted in industrial site as well as household by using low efficiency but high power consuming equipments. In this case energy audit can play a vital role by inspecting and measuring the efficiency of the using equipments both in industries and power plants along with household. They can give their own suggestion to the Industry owners, government in the use of the efficient equipments from their experience. In future Bangladesh will be set up 2000MW Nuclear power plant at Ruppur and 1320MW coal based power plant at Bagherhat and Moheskhali [4]. Energy Auditor will be required in such type of mega power plant for checking better production efficiency.

7. Proposal for Energy Audit program:

• During auditing process an auditor must follow the ISO-50001 Energy Management system Act [5]

• For perfect auditing an auditor must be well trained

• Universities of Bangladesh can be opened training program for the auditors and it will be either short term or long term course [5]

• For the training program following subjects like Lighting Systems, Air conditioning system, Motors and Drivers, Idea of general economics, Measurement Tools for Energy, Electric Utility & Natural Gas Bills, Heating, Electrical Distribution system savings, Heat Pumps, Ventilation, Domestic Hot Water, Water Conservation, Idea of general economics, Studies in Environment Pollution [3] [5]

7. Conclusion

Energy Auditing is a process of analyzing the energy performance of a field such industry, power plant, Home, etc. As Bangladesh is now in serious energy crisis, wastage of energy is not a good practice. In this condition, for the conservation of energy regular inspecting is a good option and for this task Energy Auditing will be shown good contribution in the conservation of energy process. It will be opened a new job option for students of Bangladesh.

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