

UNIT 1 ENERGY AUDIT DEFINED

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1.1 INTRODUCTION

Energy is a basic requirement for economic development of any nation. India is a developing country and every sector of our economy like agriculture, industry, transport, commercial, and domestic needs adequate amount of energy. The consumption of energy in all forms has been steadily rising all over the country.

This growing consumption of energy has also resulted in strong dependence on fossil fuels such as coal, oil and gas. Rising prices of oil and gas and potential shortages in future have led to concerns about the security of energy supply. Increased use of fossil fuels also causes environmental problems both locally and globally.

We urgently need to develop a sustainable path of energy development and use. Promotion of energy conservation and increased use of renewable energy sources are some of the likely solutions to the problem.

It is estimated that energy demand in the country is going to increase from about 537 Mtoe (million tonnes of oil equivalent) in 2005 to about 770 Mtoe and to 1300 Mtoe in 2030 as shown in Table 1.1. You can see that the share of commercial energy (coal, oil and gas) which is 67.9% in 2005 is likely to increase to 73.51% in 2015 and to 80.08% in 2030. The share of other energy, however, is going to decrease from 32.1% in 2005 to 26.49% in 2015 and to 19.92% in 2030.

Table 1.1 : Energy Demand of India (Mtoe)

Energy Source	2005	% wrt Total	2015	% wrt Total	2030	% wrt Total
Coal	208	38.59	330	42.86	620	47.69
Oil	129	23.93	188	24.42	328	25.23
Gas	29	5.38	48	6.23	93	7.15
Sub Total	366	67.90	566	73.51	1041	80.08
Nuclear	5	0.93	16	2.08	33	2.54
Hydro	9	1.67	13	1.69	22	1.69
Biomass	158	29.31	171	22.21	195	15.00
Other Renewable	1	0.19	4	0.52	9	0.69
Sub Total	173	32.10	204	26.49	259	19.92
Grand Total	539	100.00	770	100.00	1300	100.00

Source : World Energy Outlook, 2007.

India has the fifth largest installed power generating capacity in the world with 143,000 MW as on April 2008, but still the gap between demand and supply is wide, and increasing. The same is true for coal and petroleum products. One of the important reasons for rising gap between demand and supply is the high specific energy consumption (the energy consumption per unit of production) as compared to world figures(in Giga Joules), as shown in Table 1.2.

Table 1.2 : Specific Energy Consumption in Selected Industries

Industry	Specific Energy Consumption(GJ/Tonne)	
	India	World
Iron and Steel	25.5 to 34.2	16.5 to 18.5
Cement	3 to 3.4	2.9 to 3.0
Fertilisers	38.3 to 39.0	29.3 to 31.8
Aluminium	75.6 to 83.2	70.5 to 73.0
Sugar	0.7 to 0.9	0.6 to 0.9

The solution of this problem lies in energy conservation and energy substitution. Energy conservation assures the optimum use of available energy resources and is a practical approach to reduce demand-supply gap. As far as energy substitution is concerned, India is blessed with a variety of renewable energy sources, the main sources being biomass, biogas, the sun, wind, and small amount of hydro power. Municipal and industrial wastes can also be useful sources of energy, but they are basically different forms of biomass.

The opportunities of energy conservation exist wherever energy is being used. The backbone of any energy conservation programme is energy audit.

In this unit, we will discuss about energy auditing, how it is done and what is its importance.

Point to Remember :

The solution of energy crises lies in energy conservation and energy substitution.

Point to Remember :

Energy conservation assures the optimum use of available energy resources and is a practical approach to reduce the gap between demand and supply.

Objectives

After studying this unit, you will be able to

- define energy audit,
- understand various types of energy audit techniques,
- understand preliminary energy audit,
- understand detailed energy audit, and
- understand how to carry out energy audit of your home.

1.2 ENERGY AUDIT DEFINED

Energy audit is a methodology devised to account for energy input, its utilization and output in any energy using process. More precisely, energy audit is a technique to know how, why and when energy is used. It, therefore, involves measuring actual energy used in a process and comparing it with an estimate of the minimum energy required so as to identify the following:

- opportunities for minimizing wastage of energy, thereby improving energy efficiency,
- scope of the state-of-the-art energy conservation equipments, and
- scope for energy substitution (implementation of renewable energy technologies).

Energy Conservation Act, 2001, defines Energy Audit as “*the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption*”.

SAQ 1

Define the concept and purpose of energy audit.

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1.3 ENERGY AUDIT AND EFFICIENCY

The efficiency of any system should be close to 100% so that all associated energy wastage is minimum. Look at Figure 1.1 below, where we have shown the relationship between energy input, energy output and energy wastage.

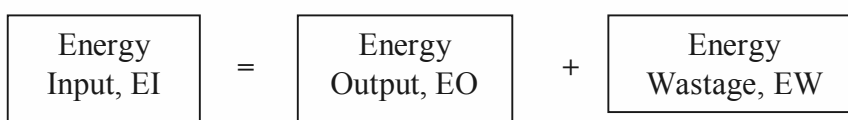


Figure 1.1 : Energy Input and Energy Output Relationship

The efficiency, η , of the system shown in Figure 1.1 is defined as :

$$\begin{aligned}\eta &= \frac{\text{Energy output}}{\text{Energy Input}} \\ &= \frac{EO}{EI} = \frac{EI - EW}{EI} = 1 - \frac{EW}{EI} \quad \dots (1.1)\end{aligned}$$

Thus, you can see that if energy wastage, EW , approaches zero, the efficiency of energy utilization approaches unity (100%) because energy input equals energy output. However, it is almost impossible to make EW equal to zero. But we can certainly make efforts to minimize it.

Energy audit helps in identifying energy wastage in any energy using process.

Example 1.1

A system takes 100 units of energy and converts only 80 units of energy into useful work. What is the efficiency of the system?

Solution

You can make use of Eq. (1.1).

We have $EI = 100$

$$EW = 100 - 80 = 20$$

Thus efficiency $\eta = 1 - (20/100) = 80/100 = 0.8$ or 80 %.

1.4 ENERGY MANAGEMENT AND AUDIT

1.4.1 Energy Management

The main objective of energy management in any energy using process is to produce goods and provide services with the least cost and least environmental effect. The term energy management has been defined in various ways. Three definitions of energy management are given below :

- (i) Energy management may be thought of as a process of adopting judicious and effective use of energy to minimize costs and hence to maximize profits.
- (ii) Energy management may be thought of as a strategy of adjusting and optimizing energy using systems and procedures so as to reduce energy requirements per unit of output.
- (iii) Energy management may be thought of as a mechanism to achieve and maintain optimum energy procurement and utilization. The objective is (a) to minimise energy costs and wastage, without affecting production and quality and (b) to minimise environmental effects.

Reduction of energy wastage and specific energy consumption (energy consumption per unit of production) is the need of the hour.

1.4.2 Principles of Energy Management

The fundamental rules of Energy Management are the following :

- Rule 1 :** Be sensitive to the market; procure all the energy needed at the lowest possible price. This may require you to explore the market availability of energy, and to choose the original source.
- Rule 2 :** The energy use facility should be operated at its maximum efficiency. Ensure minimum losses at every stage of energy transport, distribution and use.
- Rule 3 :** All the energy which is wasted but is reusable should be reused. The energy use system should have a provision of waste heat recovery.
- Rule 4 :** Use the most appropriate energy efficient technology. The guiding principle is that it should be low investment technology to meet the present requirement without affecting the environment.

Energy audit helps in energy management process.

1.5 NEED FOR AN ENERGY AUDIT

You must have seen many units consuming energy and producing products. Let us consider such an energy consuming establishment as shown in Figure 1.2. There are following three major operating expenses :

- (1) Energy costs,
- (2) Material costs, and
- (3) Labour costs.

Usually, the costs associated with energy are higher than those associated with material and labour. Therefore, we need to take extra care of energy related issues. The energy audit plays an important role in identifying the ways energy is used and thereafter in determining the areas of energy wastage and suggesting the scope of improvement.

Thus you can see that energy audit is of paramount importance because it translates the conservation potentials into realities within a specified time frame (short term, medium term and long term measures).

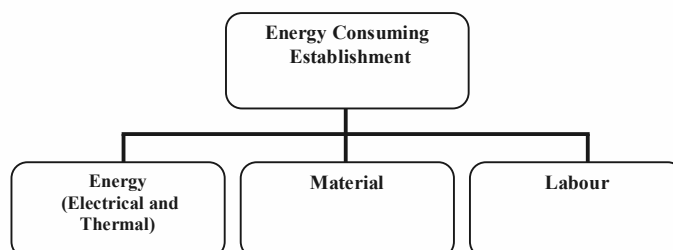


Figure 1.2 : Energy Consuming Establishment

An energy audit can be conducted by an employee of the organization who has appropriate expertise, or by a specialist energy-auditing firm. An energy audit report usually has recommendations for actions, which will result in energy and cost savings. The reports also indicate the costs and savings for each recommended action, and a priority order for implementation.

SAQ 2

Write down all the costs components of an energy consuming unit you have seen.

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1.6 TYPES OF ENERGY AUDIT

The energy audit types or categories depend on various factors like :

- (1) Type of industry (small scale, medium scale or large scale)
- (2) Functions of the industry
- (3) Potential of cost reduction
- (4) Level of energy audit

Broadly speaking, the types of energy audit are classified into the following two categories :

- (i) Preliminary Energy Audit
- (ii) Detailed Energy Audit

These are discussed in the following sections.

1.7 PRELIMINARY ENERGY AUDIT

The preliminary energy audit is relatively simple and quick to perform. It uses only available data and is conducted within 1-3 days. It focuses only on obvious energy wastage area and the resulting conservation measures are implemented quickly without spending much time or money.

The following steps are undertaken :

Step 1 : Identify the types of energy used (electricity, kerosene, petroleum products, coal, etc) i.e. total energy **‘in’**.

Step 2 : Establish energy consumption balance, i.e. Total energy **‘in’** = Total energy **‘out’**.

Step 3 : Identify energy wastage areas and energy conservation potential which could be implemented quickly with no expense or with minimum expense, i.e. Total energy **in** = Total energy **out** + Energy **wastage**.

Step 4 : Identify areas for more detailed audit.

Points to Remember :

The energy audit plays an important role in

- (1) identifying the ways energy is used
- (2) in determining the areas of energy wastage
- (3) pinpointing the scope of improvement.

The simplest way to understand the concept of energy audit is to conduct an energy audit of your home.

The energy audit of your home will help you to analyse :

- How much energy is being used in your home.
- Where it is being used.
- How much it costs.
- How much of the cost can be avoided, what you can save, where and how.

A step by step plan for home energy audit is as follows :

- (i) Investigate the energy use in your home,
- (ii) Make an inventory of energy use devices, e.g. lights, fans, TV, air conditioners, etc.
- (iii) Monitor your monthly energy use.
- (iv) Calculate energy costs.
- (v) Analyse energy costs.
- (vi) Identify the energy wastage areas.
- (vii) Decide what to do for reducing energy wastage.

You will learn about home energy audit in detail in Unit 3. Now we will describe energy audit instruments in the next unit.

SAQ 3

1. Make a list of all energy using devices in your house.

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SAQ 4

1. Note down the energy ratings of each of following energy using devices in your home.
 - (a) Lighting device in kitchen -----
 - (b) Refrigerator -----
 - (c) Microwave Oven -----
 - (d) TV -----
 - (e) Geyser -----

1.8 DETAILED ENERGY AUDIT

As the name implies, the detailed energy audit gives more accurate estimate of energy savings and associated costs. It essentially involves all the steps mentioned under preliminary energy audit with emphasis on the following :

- Energy use by all major equipments,

- Energy balance calculations, and
- Costs of energy saving measures.

Point to Remember :

A detailed energy audit can take from several weeks to several months depending upon the unit to be audited.

The following steps are involved in detailed energy audit.

Step 1 : Collection of primary energy data from the records.

Step 2 : Conducting energy survey for collecting energy data, the data for material balance, material and process diagram.

Step 3 : Identification of energy conservation measures by carrying out energy balance.

Step 4 : Carrying out cost benefit analysis of recommended energy conservation measures.

SAQ 5

List the information to be collected during detailed energy audit.

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1.9 LET US SUM UP

An energy audit establishes both *where* and *how* energy is being used, and the *potential for energy savings*. It includes a walk-through survey, a review of energy using systems, analysis of energy use and the preparation of an energy budget, and provides a baseline from which energy consumption can be compared over time.

The backbone of any energy conservation programme is energy audit. The energy audit can be classified in to two broad categories; preliminary energy audit and detailed energy audit.

The preliminary energy audit is relatively simple and easy to perform. It focuses only on obvious energy wastage areas and the resulting conservation measures are implemented quickly without spending much time and energy.

A detailed energy audit can take from several weeks to several months depending upon the unit to be audited.

The simplest way to understand and experience energy audit and energy conservation is to start energy audit of your home.

1.10 KEY WORDS

Energy Audit

Energy audit is a methodology devised to account for energy input, its utilization and output in any energy using process.

Preliminary Energy Audit

It uses only available data and is conducted within 1-3 days. It focuses only on obvious energy wastage area and the resulting conservation measures are implemented quickly.

Detailed Energy Audit

The detailed energy audit gives more accurate estimate of energy savings and associated costs. It essentially involves all the steps to be taken under preliminary energy audit.

Energy Management

Energy management may be thought of as a process of adopting judicious and effective use of energy to minimize costs and hence to maximize profits.

Energy Efficiency

A process of using less energy/electricity to perform the same function.

Fossil Fuel

Fuels formed in the earth after millions of years by chemical and physical changes in plant and animal residues under high temperature and pressure; examples are oil, coal, natural gas or their by-products.

Kilowatt (KW)

A unit of electric power (energy consumed per unit time) equivalent to 1,000 watts.

Kilowatt- hour (KWh)

A unit of energy; the energy consumed by 1 KW of power in 1 hour.

Payback Period

The time to be taken by an energy saving device to recover the cost of the device through cost of energy saved

1.11 ANSWERS TO SAQs

SAQ 1

The concept and purpose of energy audit is :

- To find opportunities for minimizing wastage of energy thereby improving energy efficiency.
- To find scope of the energy conservation equipments.
- To find scope for energy substitution (implementation of renewable energy technologies).

SAQ 2

The cost components will vary from one energy unit to another. However, the three components will always be there. These are :

- Energy costs (coal, oil, gas, electricity, etc.).
- Material costs (the cost of all the materials used in the unit).
- Labour costs.

SAQ 5

The information to be collected during detailed energy audit is as follows :

- (1) The consumption by types of energy, by sections, by processes and by end-use.
- (2) Data for material balance.
- (3) Data related to energy costs.
- (4) All possible sources of energy supply.

