



## Energy audit: an initiative to energy conservation

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### ABSTRACT

Energy audit is a systematic and scientific way of study of energy usage in a process or system and finding a solution to reduce the consumption of energy without compromising output. In any process the energy efficiency plays vital role and lead to healthy competition and profit. Energy audit is the beginning of energy management programme which report the possible opportunities. The energy scenario and analysis alerts the necessity of conservation. The audit focuses on losses, procedures and suggests the methods to improve in that area to enhance the energy efficiency of the system. In general audit focuses and not limited to electrical, thermal and other areas of a system where energy is involved. As per the directions of ministry of energy and other concern authorities, the manufacturers need to design, manufacture and practice energy efficient equipments or systems which are eco friendly and do not cause unnecessary burden on the energy systems when in service. The relationship between cost and efficiency must be carefully considered before the choice and installation of any system. In this respect lot of awareness is needed. The practice of correct choice and capacity of a system matters to a greater extent. Energy authorities needs to set policies to retard such wrong or bad developments results in energy threat in the near future.

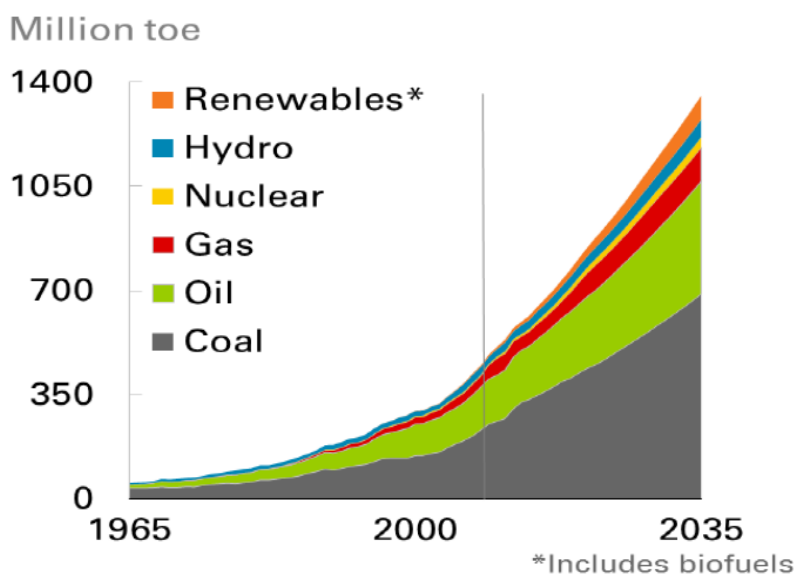
**Keywords:** Energy Audit, Energy consumption, Energy efficiency, Conservation

## 1. INTRODUCTION

The word energy audit refers to a disciplined and detailed study of energy consumption in a plant to find out the losses, improper practices and evaluate impacts (Raminder Kaur, 2013, Ramesh SP, M Emran Khan, 2013). The detailed report contains the quantity of energy usage by the system. From the literatures, the form of energy used is dependent on the type of industry, practices and availability (VA. Kulkarni, P. K. Katti, 2013). The audit generally provides methods and means to save energy and at the same time achieving the expected outcome of the process. For an industry to be competitive and profit oriented, it is the need of the hour to have good energy management system and efficiency. The energy audit generally considers electrical, mechanical and thermal systems. Present energy consumption pattern on global and Indian perspective really alerts the generating systems and consumers about the energy scarcity in the near future based on the current energy reserves (Parker, J. UK 1984). Although the overall growth of a country is justified on the per capita energy usage hence this issue being very serious needs attention of concerned. It is impossible to cut down every process in a system only with the view point of saving the energy. Therefore strong measures must be initiated in this regard to conserve the energy in all means of possibilities to provide national energy security.

## 2. THE ENERGY SCENARIO

The energy scenario focuses on the use of energy from various sources and historical comparisons for the future plans. The present situation is very alarming as the usage and availability finds a gap in the form of short fall globally and locally considering Indian energy scenario (V. A. Kulkarni, P. K. Katti, 2013). The different energy consuming sectors like, industrial, domestic, transport, agriculture is in need to find out the exactness in the current energy usage against the optimal. Therefore a systematic approach in this regard is needed badly. Therefore energy audit is the need of the hour to find out such study and present the possible methods to conserve. The figures and tables shown represent the Indian energy situation (CEA-Central Electricity Authority 2015).



**Figure 1**  
Indian Energy consumption scenario

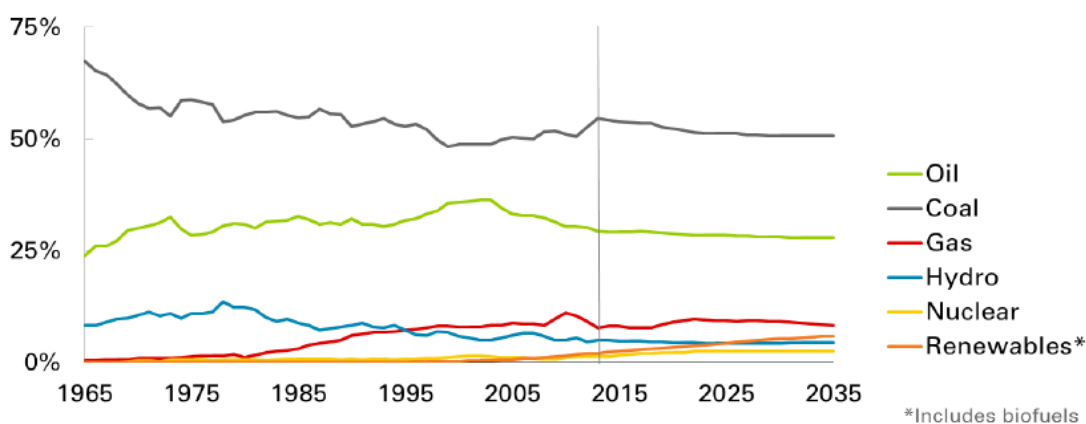
**Table 1**  
Energy demand growth

Demand	Elasticity with respect to GDP		Annual growth rate	
	2015-2025	2025-2035	2015-2025	2025-2035
Oil	0.67	0.62	4%	3%
Gas	0.98	0.44	6%	2%
Coal	0.63	0.63	4%	3%
Nuclear	1.48	0.75	9%	4%
Hydro	0.50	0.68	3%	4%
Renewables	1.76	1.28	10%	7%
Total	0.72	0.65	4%	3%
GDP_PPP			6%	5%

**Table 2**  
Energy supply growth

	Proved reserves	2015-2025	2025-2035
Oil (Billion bbl)	5.74	-2%	0%
Gas (Tcm)	1.43	1%	5%
Coal (Billion tonnes)	60.60	4%	3%
Total		5%	3%

It is clear from the study of data represented above in the Tables (CEA-Central Electricity Authority 2015) that, the pattern and consumption of energy has shown a shift globally and Indian view point. The 85- 88% of the net requirement is supplied by fossil fuels and which will exhaust shortly. An encouraging fact is badly needed in the hydroelectric as the present contribution 6% is very low in comparison with other promising sources (*BP Energy Outlook 2035*. London: BP).



As the fossil fuels are conventional and non renewable will exhaust shortly by another 40-45yrs and about 19-20 yrs in India. As these fossil and oil resources are not spread uniformly around the globe and hence a natural energy imbalance is sure to occur in the near future.

From the fast years, energy consumption is growing from 5.6% p.a. to 5.8% p.a even though the economic growth falling down in India with slowed down GDP growth from 7.4% p.a. to 6.1% p.a. during the period 2000-10 to 2010-14. This resulted slow down in improvements in energy intensity ad GDP also.

### 3. GOALS OF ENERGY AUDIT

The term audit is self explanatory and with energy it is to find out facts and figures of energy usage and possible avenues of conserving the same. The Energy audit activity may find a substitute or a change needed or possible in the system to achieve reduced usage of energy without a major change in the outcome of the process. Every energy consuming sector like industry at the end of year provides an exhaustive summary of usage of energy and transactions as a profit loss ( Eastop, T and Croft, D 1990, Parker, J. UK 1984). The energy consumed and an investment on energy issues is important and therefore focus on this issue is crucial. To reduce the energy usage greater efforts and thoughts must be put. The investment made for the energy audit is not a waste or burden because it pays in parts as a reduction in energy bills. Therefore ministry of power and authorities suggests the same. The general goals of energy audit are as mentioned (CEA-Central Electricity Authority 2015).

- Study the entire system or process, classify and quantify the useful and waste energy consumption.
- Identify the areas of losses, any possible alternatives to reduce higher consumption of energy or improvements by providing justification and methods to come out.
- Identify possible process changes or designs to enhance energy efficiency as applicable and educate the users by conducting energy awareness programs.

## 4. ENERGY AUDIT AND CLASSIFICATION

The process energy audit being an exhaustive study and identification of corners and causes of use and misuse of energy needs good start. The audit process needs a certified energy auditor or a team, type of industry or process, desire to conserve energy, complexity and depth of audit and potential savings. The audit process is generally classified as,

- Walk-through or preliminary energy audit
- Detailed exhaustive energy audit.

### 4.1. Walk through or preliminary energy audit

The preliminary energy audit is essentially a simple walk through or a quickest method to get the information about the energy and the consumption. A gross energy data of systems and operations, causes of energy wastages like failure or loss of insulation, steam and compressed air and idle run or unnecessary operation of machineries is collected. A simple inspection and discussions with operating personnel and in charge of the system or process provides the pattern and facts of energy consumption. The data collected helps to identify main areas of consumption which need microscopic study for the potential. The preliminary audit recommendations are simple, low cost and can be implemented. Sometimes referring to the possibilities of conservation an exhaustive audit is recommended. The report of the primary audit mainly includes following.

- Main energy consuming system or process
- Primary controls to conserve energy
- Energy usage evaluation related to the system or process
- Recommendations of primary audit to take up the detailed or exhaustive audit

### 4.2. Detailed or exhaustive energy audit

Usually detailed energy audit is initiated after the walk through audit. This process involves conduction of sample tests, observations and data recordings by the state of art instruments and suitable software tool. Suitable data analyzers project the information suitably considering standards and legalities. Therefore detailed energy audit contains the quantitative analysis and involves defined priorities and scientific recommendations. Based on the type and complexity the duration of detailed audit vary from weeks to months. The typical sample tests and observations carried out in the system or process are categorized and listed for the ease.

- Energy consumption and energy efficiency of equipments or system
- Plant load factor, power factor and scope for improvement
- Load on motors, generators and transformers
- Use of alternate methods for heating ( in the place of electric heating )
- Efficiency of boilers, heat exchangers, driers, kiln and other combustion systems
- Proper measurement and control of temperature, air (cold, hot and compressed) and water
- Processes, capabilities and specifications

The results obtained from the tests conducted are used to identify the losses and suggests a possible remedy. The detailed energy audit finally recommends certain realistic energy conservation schemes to improve efficiency. The report also contains benefits, costs and payback period etc.

### 4.3. Data and cost benefit analysis

The data collected while auditing needs to be processed and analyzed seriously to find out cost benefit and payback of a remedial suggested. Suitable tools and software may be used to handle typical volume of data collected (Parker, J, UK 1984, , T and Croft, D 1990) . The data may be of the form shown.

- Process flow charts, energy bills and inventory
- Cost of energy delivered to the system or process for a specific time or duration
- Data about the total production obtained during the specific period
- Details of equipments and energy consumption as well as cost.

A statistical analysis of the data and graphical presentation will give the trend of energy consumption and that indicate the state of a system or process may require reviewing for the appropriateness of energy consumption (Energy Statistics 2015. Ministry of statistics and program implementation government of India).

### 4.4. Typical energy audit report

Audit report is a scientific and systematic document representing facts, figures and tables of information related to energy and conservation measure of a system or process. The energy audit report is referred by the process operators, managers and the management committee for various reasons. The user needs to understand the recommendations and their impacts (Pusat Tenaga).

Sample Content of Energy Audit Report

(Referred from the *Industrial Energy Audit Guidelines: A Handbook for*

*Energy Auditors*, published by Pusat Tenaga Malaysia, 2003)

## 0. Executive Summary

- 0.1 Company profile
- 0.2 Energy saving opportunities
- 0.3 Potential savings
- 0.4 Potential demonstration projects
- 0.5 Follow-up actions

## 1. Introduction and scope of work

- 1.1 Background and scope of work
- 1.2 Audited company and team
- 1.3 Approach and metering equipment

## 2. Operational Review of the Factory

- 2.1 Historical development and present situation
- 2.2 Operational regime and production figures
- 2.3 Energy and utilities consumption and cost

## 3. Technological Description of the Processes

- 3.1 Production process
- 3.2 Process Know-How

## 4. Energy Supply and Demand Structures

- 4.1 Electricity supply and consumption
- 4.2 Fuel supply and consumption
- 4.3 Steam supply and consumption
- 4.4 Compressed air supply
- 4.5 Other utilities

## 5. Technical- Financial Framework and Constraints

- 5.1 Basic financial constraints
- 5.2 Technical and financial constraints of energies and utilities
- 5.3 Evaluation of energy saving measures

## 6. Energy Saving Measures

- 6.1 Measure 1
- 6.2 Measure 2
- 6.3 Measure 3

## 7. Annexure

## 5. SAMPLE STUDY OF IMPACTS AND IMPLEMENTATION OF THERMAL ENERGY AUDIT

The term thermal is self explanatory and the audit carried out on systems like boilers, steam delivery and handling, heat exchangers, furnaces, kilns, heat recovery systems and types of fuels and quantity used is known as thermal energy audit (Eastop, T and Croft, D, 1990)The recommendations of the audit have greater impacts on the energy systems causing reduction in usage of energy in comparison to the case before implementations. The potential and processes identified are effectively considered for the conservation by adopting state of art techniques and methods to find out and practice best possible means to achieve conservation without much compromise in the results of the process. The energy in these systems is obtained by burning fuels (gas, liquid or solid). Verification of details, records of production and use against permission, practice of safety and transparency in all the sections is very necessary (Raminder Kaur, 2013,). The accounting up of all the values, variables and exhausts is mandate as per statutory rules, regulations and environmental regards (Ramesh S P , M Emran Khan ). In this view point a brief study on heat, combustion and impacts of such is badly needed. Emission of gaseous and exhaust of waste particles need to be carefully considered keeping an eye on health and safety of personnel handling, machines involved and ambient. The usual materials let into atmosphere are CO<sub>2</sub>, NO<sub>x</sub>, SO<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, H<sub>2</sub>S, H<sub>2</sub>O etc. The procedures to handle raw and waste materials is very challenging task and needs to be managed properly. Various procedures and techniques are to be used by the audit team to find out and justify the facts and remedies. Similarly other potential areas of audit are electrical and mixed or miscellaneous. Ultimately a greater saving, safety and cost benefits are en cashed (Vijaykumar Kulkarni, Pradip Katti, 2013).

## 6. CONCLUSION AND SUMMARY OF PRESENT WORK

The importance of energy audit is highly emphasised in the present work in line with the declining energy generation due to resources and increasing consumption scenario of world and the country. The awareness of energy and cost as well as availability for the future is discussed. The proper conservation methods need to be implemented. The exhaustive report provided by the committee stand as a reference to take adequate measures. As a result of the practice of remedial measure noticeable change in energy consumption is possible. The ministry of power and authorities must set the policies and practices to conserve and save energy for the future and appreciate such activities and initiatives. Therefore the energy audit, a tool to initiate energy awareness and means to conserve energy is justified. The sample audit report referred gives the clarity, potential and areas touched for the energy audit are listed. A detailed work sums to pages.

## FUTURE ISSUES

As the energy consumption and growth of any country are related to each other and there exists a great need for the energy audit to explore and practice conservation measures. Therefore a great amount of work is necessary in optimizing the energy policies, investments, time and practices to meet the goals of energy audit.

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