Energy Conservation, Efficiency & Energy Audit

Energy cost is a significant factor in economic activity, on par with factors of production like capital, land and labour. The imperatives of energy shortage call for energy conservation measures, which essentially mean using less energy for the same level of activity. In this paper the author discusses the Conservation, Efficiency, Audit, Fundamentals, Differences and methods, the Objectives of Energy Conservation, Definition of Energy Audit, Scope, short term, medium term and long term measures to be taken for Conservation are discussed. The audit programs, methodology of Saving energy through various means namely: Audit, House Keeping, Lighting, Personnel, Capital Investment, Monitoring are elaborated.

- R. A. Sharma

Energy Audit attempts to balance the total energy inputs with its use and serves to identify all the energy streams in the systems and quantifies energy usages according to its discrete function.

Energy Audit helps in energy cost optimisation, pollution control, safety aspects and suggests the methods to improve the operating and maintenance practices of the system. It is instrumental in coping with the situation of variation in energy cost availability, reliability of energy supply, decision on appropriate energy mix, decision on using improved energy conservation equipments, instrumentations and technology

The Energy Efficiency is of paramount importance in view of the crisis.

Energy Conservation:

Energy Conservation is the deliberate practice or an attempt to save electricity, fuel oil or gas or any other combustible material, to be able to put to additional use for additional productivity without spending any additional resources or money.

Why Conservation Energy?

Energy is a scarce commodity; Energy in any form is a scarce commodity and an expensive resource. However, if we look at the predicted future human pollution figures and consider the probability that the individual life expectation will increase, we see that energy could, in the future, be in short supply. Unless that supply is increased it will be a source of friction in human affairs.

Energy Conservation Objective:

Broadly energy conservation program initiated at micro or macro level will have the following objectives of manufactured goods (either lower process or increased) availability and profitability, and in consequence raise the standard of living both of the workers in industry and of those who buy the products.

a) To reduce imports of energy and reduce the drain on foreign exchange.
b) To improve exports of manufactured goods (either lower process or increased availability helping sales) or of energy, or both.
c) To reduce environmental pollution per unit of industrial output - as carbon dioxide, smoke, sulphurdioxide, dust, grit or as coal mine discard for example.
d) Thus reducing the costs that pollution incurs either directly as damage, or as needing, special measures to combat it once pollutants are produced.
e) Generally to relieve shortage and improve development.

Energy Conservation Vs Energy Efficiency:

The policy goals and concepts will have to be shifted from “Energy Conservation” to “Energy Efficiency”, and from “Energy inputs” to the “Effectiveness of energy use” and “Energy Services”.

What is Energy Conservation?

Energy conservation and Energy Efficiency are separate, but related concepts, Energy Conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress.

Energy Efficiency:

Is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without effecting output, Consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.

Energy efficiency is often viewed as a resource option like coil, oil or natural gas. It provides additional economic value by preserving the resource base and reducing pollution. For example, replacing traditional light bulbs with Compact Fluorescent Lamps (CFLs means you will use only 14/th of the energy to light a room. Pollution levels also reduce by the same amount.

Nature sets some basic limits on how efficiently energy can be used, but in most cases our products and manufacturing processes are still a long way from operating at this theoretical limit. Very simply, energy efficiency means using less energy to perform the same function.

How to Achieve the Objective of Energy Conservation:

A three pronged energy conservation strategy is drawn up:

Short Term Measures

(Potential savings of 5 to 10%).

a. Meeting operational improvements requiring nil / negligible capital investment.
b. Improved fuel storage, handling and preparation practices
c. Insulation of steam lines and equipment
d. House Keeping and scheduling of process equipment
e. Minimizing radiation losses through opening
f. Improved load factor.

Medium Term Measures

(Potential savings of 15 to 20%).

a. Waste heat recovery devises and modifications and design of equipment, needing moderate capital investment with payback period of around three years.
b. Installation of waste heat recovery devices
c. Reducing wall losses in the furnaces with better insulting materials
d. Instrumentation of furnace and process house
e. Change of grate design and firing system
f. Incorporation of condensate recovery system
g. Power factor improvement
h. Optimization

Long Term Measures

(Potential savings of 20 to 25%).

a. Fuel substitution, modernization of equipment, process as well as utilities and capital intensive heat recovery devices with payback period of 5 to 6 years.
b. Replacement of old inefficient boilers / equipments.
c. Substitution of fuel oil to coal in boilers and thermic fuel heater or other equipments.
d. Modernization of inefficient drives
e. Replacement of furnaces with modern efficient ones
f. Standardization
g. Use of correct size of motors
h. Optimization

(Total savings through all measures = 20% to 30%)

Barriers to Energy Conservation

While the technical and economic viability of improving the energy efficiency in India is quite substantial, there also exits a set of barriers that restrict the actual realization of this potential.

The industrial sector, in spite of being relatively organized, is highly disparate and dispersed, comprising a large number of small manufacturing units.

Although there has been a gradual improvement in the specific energy use by the industrial sector, the energy conservation move has not acquired the desired momentum. Some key factors responsible for this are:

- Conflict of investment priority between energy conservation projects and capacity expansion
- Importance given by many towards initial cost minimi-sation, disregarding the more efficient options (which generally are more expensive)
- Existence of limited competitive pressure to reduce cost because of the growing economy.
- Shortage of capital to fund energy conservation projects
- Shortage of skilled staff and lack of information on techno-logical options.
- No check on manufacture and marketing of cheaper and inefficient products.

Energy Audit Definitions:

1. Energy Accounting

Energy audit simply means an orderly month by month accounting of energy used in a building for comparison against a budget or another standard of performance.

2. Means To Achieve Conservation

Energy audit deals with specific ways and means to achieve energy conservation.

3. Systematic Approach To Decision Making

Energy Audit is the key to systematic approach for decision – making; in the areas of energy management it attempts to balance the total energy inputs with its use and serves to identify all the energy streams in a facility. It quantities energy usage according to its discrete functions.

4. Effective Tool for Energy Management

Industrial Energy Audit is an effective tool in defining and pursuing comprehensive energy management programme. In this field also, the basic functions of management like planning, decision – making, organizing and controlling, apply equally as any other management subject.

These functions can be effectively performed, based on reliable information which can be available to the top management by applying Energy Audit techniques.

5. Ways of usage of Energy

Energy Audit will help to understand more about the ways energy and fuel or used in any industry, and help in identifying the areas where waste can occur and where scope for improvement exists.

6. Construction and Stream Lining

The Energy Audit would give a positive orientation to the energy cost reduction, preventive maintenance and quality control programme which are vital for production and utility activities. Such an Audit program will help to keep alive variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofits for energy conservation equipment and the like.

7. Ideas and Feasible Solutions

In general, Energy audit is the translation of conservation ideas into realities, by blending technically feasible solutions with economic and other organizational considerations within a specified time frame. This technique will be more beneficial than piece – meal injection of short – term measures, without adopting a scientifically evolved strategy including gearing up of organizational structure and other infrastructural requirements.

8. Use and Opportunities

Energy Audit is an in-depth study of a facility to determine how and where energy being used or converted from one form to another, to identify opportunities to reduce energy usage, to evaluate the

economics and technical practicability of implementing these reductions and to formulate prioritized recommendations for implementing process improvements to save energy.

9. Definition As Per Bureau of Energy Efficiency Guidelines

Energy Audit is defined 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".

Scope of Energy Audit:

1. Analysis present consumption and past trends in detail.
2. Review lighting requirements
3. Consider submetering
4. Compare standard consumption to actual
5. Produce an energy balance diagram for the firm.
6. Review existing energy recording systems.
7. Compare consumption with other locations, other firms, previous period and budget, industry norms, foreign companies.
8. Check records against invoices.
9. Compare meter reading against records.
10. Review records of maintenance engineer.
11. Check capacities and efficiencies of equipment.
12. Examine need for automatic controls.
13. Check working of controls.
14. Determine adequacy of maintenance.
15. Review fuel storage and handling.
16. Examine need for improvement instrumentation.
17. Consider training energy management staff.
18. Review new projects with respect to energy use.
19. Examine need for improved instruments.
20. Introduce life cycle costing.
21. Consider changing the management information system to include energy parameters.
22. Develop energy use indices to compare performance/ productivity.
23. Introduce energy use monitoring procedures.
24. Check frequency of energy reporting systems.
25. Examine and monitor new energy saving techniques.
26. Examine need for energy saving incentives.
27. Consider publicity campaign and incentives.

General Audit Programme

A. Records of Consumption & Establishment Of Base Line

1. Produce detailed analysis of energy consumed over the most recent year. Show the amount, and cost per unit, of each fuel. (This will be used for the purpose of the current audit and for providing a baseline for comparison with later years).
2. Review existing records of consumption and determine if adequate information is available to management.
3. Draw Material and Energy Balance.
4. Compare consumption with:
   (a) Other locations (b) previous Periods (c) Budget (d) Similar industries (e) Industry norms.
5. Compare standard consumption to actual for each process and identify losses.
6. Test meter readings against records.
7. Test / check records against invoices.

B. House keeping

1) Control Mechanisms – check that all control mechanisms are effective and frequently tested.

2) Measurements: Consider whether further instruments would be useful in measuring or controlling particular parameters (e.g., temperature, pressure humidity, flow rate).

3) Maintenance: Determine whether maintenance is adequate (e.g., annual cleaning of boilers / equipments is unlikely to be sufficient to avoid fouling and corrosion of tubes).

4) Maintenance Improvements: Consider how maintenance could be improved:

   - Consider more skilled manpower.
   - Design changes (e.g., fitting of by-pass facilities, pipeline strainers, sight glasses of space above volatile liquids).
   - Latest Maintenance Technique like: Predictive, Proactive, Maintenance, etc.

5) Storage & Handling: Review control storage and handling.

   - Temperature Control: consider whether temperatures are adequate or excessive.
   - Vapourisation: Consider whether vapourisation could be reduced (e.g., by reducing the vapour space above volatile liquids).
   - AC Temperatures are within limits are excessive.

6) Review space heating / cooling:

   Fast Response: Check that the installation has fast response to control.

   Protection: Check that control devices are protected from unauthorized interference.

   Parameters Not Excessive: Check that temperature, air movement and ventilation are not excessive.

   No Windows: Ensure windows are not used for temperature control in heated buildings.

   Insulations: Check insulation throughout the plant, including tanks and pipe runs, roofs, walls, doors, windows, floors, etc…

   Integration: Check that systems are properly integrated (e.g., boiler and refrigeration plants do not conflict).

   Review heating installation:

   (**N.B**: The purpose of this Audit step in conjunction with (A) above, is to determine when and how much heat is lost, with a view to recommending remedial action if appropriate).

7) Review lighting:

   - Consider if the most efficient form of lighting is used for each purpose.
   - Check lighting levels maintain proper illumination.
   - Use latest energy efficient lamps
   - Say good-bye to inefficient lights / lamps say electric bulb, etc.

8) Review tariffs or Contracts for Supply for Energy including CMD:

   - Ensure the most appropriate tariffs are used, discuss with suppliers, if appropriate.
   - Check CMD requirements. A lot of saving is done in several cases

9) Peak Demands: Check all reasonable steps are taken to minimize peak demands for electricity e.g., re-schedule tasks to off-peak periods.

   Heat Recovery: Use an emergency type diesel generator as booster / alternative to electricity, Preferably including waste heat recovery.

   Monitor consumption precisely.
   Use maximum demand meter.

10) Consider the feasibility of using night rate electricity.

11) Sub-Metering: Consider sub-metering, so that consumption can be broken down into controllable units i.e., cost centers, thereby making some individual personally responsible.

C. Personnel:

1. Consider if specialist workers are adequately trained and motivated e.g.

   Energy Manager, Maintenance Engineer, Instrument Engineer, Furnace Operator / Equipments Operator.

2. Review Energy Conservation Propaganda or Education e.g.: a) Posters (b) House magazines (c) Circulars (d) Requests for suggestions from employees (e) Talks and short courses. (f) Involvement of unions.

D. Capital investment:

1. Review energy capital projects under consideration:

   - Check calculation of return / pay – back.
   - Review arguments for and against making the investment.
   - Check that tax implications are correctly taken into account.

2. Review efficiency of furnaces, boilers and process equipment.
   (N.B: About 86 percent of all energy used by industry is converted in boilers or furnaces).

   - Consider whether they should be replaced.
   - Consider whether they should modified: By pre-heating air,

   a) By adding metering facilities
   b) By recovering waste heat
   c) By improved insulation
   d) By replacing burners (modern burners have improved turndown capability which can show a 30% return on capital).
   e) By adding economizers
   f) By returning condensate to boilers.

   - Consider the size of equipment vis-à-vis demand.
   - Determine whether use of cooling water is restricted to an economic level.

Energy Audit & Management

Energy Audit is the key to a systematic approach for decision – making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management program.

Top 3 operating expenses:

In any industry, the tree top operating expenses are often found to be (a) Energy (both electrical and thermal), (b) Labour and (c) Materials.

Energy is mostly top in many industries:

If one were to relate to the manageability of the cost or potential cost savings in each of the above components, energy would invariably emerge as a top ranker, and thus energy management function constitutes a strategic area for cost reduction.

Reference Book:

Electrical India
September 2006
Vol. 46 No. 09

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