ENERGY CONSERVATION: AN EFFECTIVE WAY OF ENERGY UTILIZATION

Er.Harpreet Kaur*

M/s Kamaldeep Kaur**

Abstract:

Energy plays a key role in achieving the desired economic growth. The entire fabric of developmental goals is webbed around a successful energy strategy. Energy is a pivotal prerequisite of developed economy and social structures. One of the major problems concerning its supply is the depleting nature of the extraction of fossil resources, combined with the need for transition to renewable energy supplies. The last depends on a number of scientific and technological break through. Meanwhile, energy conservation promises to fill the gap between supply and demand. Several measures for conservation of energy are very important for consideration. The conservation of energy, therefore, is using less more wisely than before. Saving a watt is nearly always cheaper than increasing the supply by a watt. The energy industry is one of the most capital intensive. Efficient utilization of energy resource is not only conservational it also saves capital investment. Thus conservation is really the cheapest of energy 'resources' at least until its potential is exhausted. In this paper importance of energy management and its benefits are discussed. Use of energy efficient equipments to save energy is proposed.

Keywords: *prerequisite, depleting, transition, utilization, exhausted, efficient*

* Asst. Prof. (Electrical Dept.), B.C.E.T. Ludhiana.

** Asst. Prof. (M.B.A. Dept.), B.C.E.T. Ludhiana.

1. Introduction:

Electric energy occupies the top grade in the energy hierarchy. It finds innumerable uses in home, industry, agriculture and in transport. The facts that electricity can be transported practically instantaneously, is almost pollution free at the consumer level and its use can be controlled very easily, make it very attractive as compared to other forms of energy. The per capita consumption in any country is an index of the standard of living of the people in that country. Electric energy demand has been rapidly increasing in India since 1947. The increase was very sharp in the seventies. This is attributed to greater industrialisation and large scale use of electric energy for agricultural purpose. However, the per capita consumption in India is ridiculously low as compared to that in developed countries. Table 1 shows the installed capacity and per capita consumption in India [1].

Year	Installed capacity (GW)	Per capita Cons--umption (kwh)
1950	1.71	15.6
1961	4.65	37.9
1969	12.96	77.9
1979	26.68	130.9
1990	63.63	238.0
1997	85.79	334.3
2005	118.426	612.5

Table .1 Electric energy growth in India

The electrical losses are very high in India and are about 4-5 times as compared to other developed countries. These losses are in transmission, distribution, transformation and energy theft. Table 2 shows the percentage losses in different years [2].The losses vary from state to state over a wide range. Many states are trying to reduce the losses but there has not been much success. Strict enforcement and penalties are required to curb electricity theft and pilferage.

Year	Percentage losses
1950	15.2
1961	15.2
1969	17.0
1979	20.0
1990	23.3
2002	33.98
2005	31.25
2007	29.89

Table .2 Electrical energy losses

The seventies and eighties have seen a huge shortage of electric power in India. Some of the reasons of the power shortage are as under:

a. Faulty planning

b. Delay in construction of power projects.

c. Inter –State Disputes.

d. Erratic Monsoons.

e. Plant Outages.

f. Transmission Losses.

g. Poor Utilization of generating equipment.

The energy demand is likely to increase at the rate of about 7.5% in the future. Table 3 gives the future energy demand in different sectors [2]. The total energy requirements at the bus bars will be about 20% higher than given in table 3 because of the losses in transmission and distribution system. It is seen that the maximum increase in demand is likely to occur in residential sector. This is due to increase in population, greater need for housing and rural electrification. The demand for agriculture is likely to reach saturation.

Year	Industrial	Residential	Agriculture	Commercial	Others	Total
2007-2008	264	216	86	36.7	42.3	645
2011-2012	396	346	117	55	61	975
2016-2017	534	469	159	74	82	1318

Table .3 forecast of electrical energy demand (TWh)

Energy is an essential basic need for not only human beings, but also for national economic and social development. However, production of energy is found to exhibit both local and global environmental impacts, if not appropriate technology and management.

2. Related work:

Bhansali, V.K [3] describes that the gap between supply and demand of energy is continuously increasing despite huge outlay for energy sector since independence. Further, the burning of fossil fuel is resulting in greenhouse gases which are detrimental to the environment. The gap between supply and demand of energy can be bridged with the help of energy conservation which may be considered as a new source of energy which is benign and environment friendly. The energy conservation is cost effective with a short payback period and modest investment. There is a good scope of energy conservation in various sectors, viz., industry, agriculture, transport and domestic. The energy audit can unearth huge profits to the industry. The industrial sector has failed to take full advantage of many financial incentives provided by the government to encourage energy conservation strategies. The planners have started appreciating the role and significance of energy conservation in future energy scenario of India. However, the achievements so far are far from satisfactory. It is imperative to develop energy conservation as a mass movement.

Wang Qun and Yang Xing-zhu, [4] describes that with the global "low-carbon economy" booming, energy conservation and emission reduction on tourism is a focus of global concern,

because tourism is the important sector of carbon emission. Many tourism regions have proposed the measurements of energy conservation and emission reduction. Research on tourism emission reduction also began to rise. However, energy conservation and emission reduction on tourism is still in initial stage of development, it encountered many barriers, such as tourists' knowledge on emission reducing, measuring of energy conservation and emission reduction, the effectiveness of energy conservation and emissions offsets plan and so on. They discuss these barriers in detail and put forward a series of measures.

Jeffrey M. Ulmer, Troy E. Ollison [5], describes that manufacturing managers need to understand the interrelated links between advanced manufacturing technology, primary and alternative energy choices, energy output values and costs, and energy conservation over the life of a project. Through an overview of these topics and the manager's energy conservation processing optimization model developed in this paper, manufacturing managers, engineering technologists, and academics gain greater insight to the impacts of energy technologies upon manufacturing activities.

Kuo-Ming Chao, Shah, N., Farmer, R., Matei, A., Ding-Yuan Chen, Schuster-James, H., Tedd, R. [6] describes that climate change is one of the driving forces behind a new wave of energy management systems. Most of the currently available energy management systems in domestic environment are concerned with real-time energy consumption monitoring, and display of statistical and real time data of energy consumption. Although these systems play a crucial role in providing a detailed picture of energy consumption in home environment and contribute towards influencing the energy consumption behaviour of household, they all leave it to households to take appropriate measures to reduce their energy consumption. Some energy management systems do provide general energy saving tips but they do not consider the household profiles and energy consumption profiles of home appliances. The proposed system attempts to address this issue by taking into account household profiles and energy consumption profiles of electrical appliances. The motivation behind this approach is to provide households effective advice on their energy consumption by enabling them to take focused and effective actions towards efficient energy use.

Irawati Naik, Prof.S.S.More, Himanshu Naik [7] describe that energy is crucial to human sustenance and development. Due to the increase in the Demand of energy and deficiency in power generation, day by day the gap between demand and supply of electric energy is widening. Bridging this gap from the supply side is very difficult and expensive proposition. Also limited energy resources, scarcity of capital and high interest costs for the addition of new generation capacity is leading to the increased cost of electrical energy in India. The only viable way to handle this crisis, apart from capacity addition, is the efficient use of available energy, which is possible only by continuously monitoring and controlling the use of electrical energy. Hence energy management program is a systematic and scientific process to identify the potential for improvements in energy efficiency, to recommend the ways with or without financial investment, to achieve estimated saving energy and energy cost. Thus the need to conserve energy, particularly in industry and commerce is strongly felt as the energy cost takes up substantial share in the overall cost structure of the operation which is relevant to our work.

3. Need of Energy Conservation:

Energy has an important function. It is the central force behind our productivity, our leisure and our environment. There is a strong correlation between energy use per person and standard of living in each economy. A higher per capita energy consumption means a higher per capita gross national product. Energy is an indispensable component of industrial product, employment, economic growth, environment and comfort. Low cost energy was abundant in the past. Energy cost was only a very small fraction of the cost of finished product. Use of low cost energy for home comfort became very predominant. The subsequent increase in oil prices increased the energy cost in every sector, domestic, commercial, industrial etc. The per capita energy consumption in India is very low as compared to that in advanced countries. However our energy resources are fast getting depleted. Thus energy saving or conservation is essential in developed as well as developing countries. The differences between the new era and the early era of energy conservation are shown in table 4.

Old Energy Conservation	New Energy Conservation
Energy sources are discovered ahead of demand.	Energy sources are being depleted, without replacement.
An issue for individual parties	A societal issue.
A technical aspect of individual machines and processes.	A freestanding issue, struggling to become technically integrated.
Perceived by everyone as an issue of labour requirements and fuel costs, to be addressed by technical and economic means.	Perceived mainly as a resource conservation and/or environmental issue. Distinct interest groups variously seek to address it by economic, technical, political, social, and/or metaphysical means

Table 4 difference between early and new era energy conservation.

3.1 Meaning and Principles of energy conservation.

Energy conservation means using energy more efficiently or reducing wastage of energy. It is important that any energy conservation plan should only to try to eliminate wastage of energy without in any way affecting productivity and growth rate. A small decrease in convenience or comfort can be tolerated. Energy conservation usually requires new investment in more efficient equipment to replace old inefficient ones. Thus energy conservation can result in more job opportunities, lower costs, cheaper and better products etc.There are two principles of energy conservation planning which are discussed below:

- Maximum energy efficient: A device, system or process is working at maximum efficiency when maximum work is done for a given magnitude of energy input. Only a part of the input energy is converted into useful work. The remainder is lost in energy conversion and transfer process and energy discharge.

Work = Energy Input – Energy loss in energy conversion transfer process and energy discharge.

- Maximum cost effectiveness in energy use: Implementation of energy conservation entails additional investment. This investment increases as more and more energy conservation measures are adopted. Because of implementation of these measures the fuel costs decrease as extent of conservation is increased. The total cost per unit output is the sum of annual charges on investment per unit output and fuel costs per unit output. Evidently maximum cost effectiveness in energy use is obtained when total costs are the least.

3.2 Energy Conservation Planning

Energy conservation planning can be divided into four steps:

- Specifying targets and preparing detailed plans: It is the first step in energy conservation planning. The targets should neither be too pessimistic nor too optimistic. The targets and plans can be divided into three categories viz. Programmes which do not require any additional investment, programmes which require small additional investment and need a year or so for implementation and programmes which require major changes and large investment.
- Identifying energy inefficient facilities and equipment: In this step the facilities and equipment which are energy inefficient are identified. The indices used for this purpose are energy efficient index EEI (energy quantity index) and energy effectiveness index (energy quality index EQI).

  EEI = energy used / energy input

  EQI = availability of energy output / availability of energy input

- Implementation of energy conservation measures: The energy conservation measures includes method of installation (i.e., recycling, retrofitting) and method of heat use (e.g. installation of equipment for waste heat recovery and utilisation).

- Evaluation of benefits: In this step overall costs and benefits of programmes are studied and calculated. A behaviour model and a cost function are used to evaluate costs and benefits. A production behaviour model can be written as

Production level = *f1* (capacity, utilisation sales, transportation, energy conservation requirements, pollution controls etc.)

Reduction in energy input =*f2* (technology, age of equipment, location etc)

A cost function takes the form:

Benefits / cost = *f3* (production quantity, unit price etc).

3.3 Objectives of the energy management programme.

The primary objective of energy management is to maximize profits and minimize costs. The main objectives of energy management programs include:

- 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 strategies for wise energy usage.
- Finding new and better ways to increase returns from energy investments through research and development.
- Reducing the impacts of curtailments, brownouts or any interruption in energy supplie

4. Energy Conservation Legislation or Energy Conservation Act.

Many countries in the world have realized the importance of energy conservation measures. In some countries laws have been framed to make energy conservation, audit and demand side management mandatory for all utilities, industries, and government departments and public. Government of India has recently promulgated "Energy Conservation Act" to promote these activities. The important provisions of this act are:

- Setting up a 'Bureau of Energy Efficiency (BEE)'. This bureau will coordinate all energy conservation measures in state and private sector.
- Mandatory energy audit for designated consumers.
- Creation of facilities for research and development in energy conservation technologies.
- Rational tariff of electricity with a view to promote DSM.
- Laying down of energy efficiency standards for energy consumption by different equipment.
- Mandatory display of energy efficiency labels on equipments.
- Phasing out the manufacture of inefficient equipments and prohibiting the manufacture and sale of such equipments.
- Laying down energy efficiency norms for buildings.
- Promotion of cogeneration.
- Reduction of Transmission and Distribution losses.
- Making available financial resources for institutional setup and promotion of energy conservation.
- Establishment of regime of fiscal incentives and disincentives.
- Formulation energy conservation norms for large consumers especially in energy incentive industries.
- Devising strategies to create awareness among different categories of consumers.

4.1 Energy policy

A number of high level committees have been set up in the past by the government of India to examine in detail the various issues and suggest measures for ensuring development of energy sector for sustaining the economic growth and meting the basic needs of the people. The recommendations made by these committees are kept in view while formulating the five year plans. The strategy in energy sector adopted for all five year plans incorporates the changing

needs of the economy and the society. India follows an energy policy which is divided into short term, medium term and long term measures.

Short term

- Maximize returns from the assets already created in the energy sector.
- Initiate measures for reducing technical losses in production, transportation and end use of all forms of energy.
- Initiate action to reduce the energy intensity of the different consuming sectors of the economy and promote conservation and demand management through appropriate organisational and fiscal measures.
- Initiate steps for meeting fully the basic needs of the rural and urban households so as to reduce the existing inequities in energy use.
- Maximize satisfaction of demand for energy from indigenous resources.

Medium term

- Initiate steps towards progressive substitution of petroleum products by coal, lignite, natural gas and electricity so as to restrict the quantum of oil imports.
- Initiate action for accelerated development of all renewable energy resources.
- Promote programmes to achieve self-reliance in the energy sector.
- Initiate appropriate organisational changes in the case of different energy sub-sector consistent with the overall energy strategy.

Long term

- Promote an energy supply system based largely on renewable sources of energy.
- Promote technologies of production, transportation and end use of energy that are environmentally benign and cost effective.

4.2 Professional Certification and Accreditation

As per the Energy Conservation Act, it is mandatory for all the designated energy consumers to get energy audit conducted by an Accredited Energy Auditor and to designate or appoint

an Energy Manager. The Government of India has specified the passing of the National level certification examination as the qualification for a Certified Energy Manager & Certified Energy Auditor. BEE has taken up the challenge of creating a cadre of professionally qualified energy managers with expertise in energy management, project management, financing and implementation of energy efficiency projects, and policy analysis.

5. Award Scheme Methodology:

To accelerate the energy conservation programmes, the government of India has declared 14th December (every year) as the National Energy Conservation Day. .An Energy Conservation Award Committee has been set up under the Chairmanship of Chairperson (Central Electricity authority) for deciding the award winners. The other members of the Committee are drawn from the Ministry of Power, National Productivity Council (NPC), Confederation of Indian industry (CII) and from the Bureau of Energy Efficiency (BEE) which also provides the administrative and technical support to the committee. The Ministry of Power (MOP) has also set up a Technical Sub-Committee to assist Award Committee in the finalization of Awards. It is hoped that National energy Conservation Award Scheme would help in motivating the other energy consumers in joining and promotion of a nationwide energy conservation movement. Table 5 shows the energy saving during eleventh five year plan (2007 to 2012) [8].

Sr. No	Name of Scheme	Targeted Saved Capacity
1	Bachat Lamp Yojna (BLY)	4000MW
2	Standards and labelling programme	3000MW
3	Energy Savings in Existing buildings	200MW
4	Energy Conservation Building Code (ECBC) Implementation	500MW
5	Agricultural DSM and Municipal DSM	200MW
6	Small and Medium Enterprise Scheme	500MW

Table .5 Energy Efficiency target for eleventh five year plan (2007 to 2012)

5.1 Role of Private Sector in Energy Management

The involvement of private entrepreneurs in the energy sector is likely to lead to one or more of the following benefits:

a. The fiscal position of the Central and State Governments is very tight. The involvement of private sector will make more money available for the energy development, generation etc.

b. A public sector utility cannot match a private sector one in matters of efficiency and management. The involvement of private sector will result in better efficiency and management in energy field.

c. The reliability of electric supply in India is very poor. The public sector utilities are not paying attention to this aspect. Most of the time the continuity of supply is affected by voltage and frequency conditions. It is expected that there will be definite advantage in this respect after involvement of private sector.

d. Electric utilities in many countries have adopted cogeneration programs to reduce energy costs. A cogeneration program becomes attractive when thermal and electrical load from cogeneration can be utilized the year around. It is expected that this methodology will get a boost after private sector is involved.

e. The public sector utilities are not paying attention sufficient attention to programs like reactive power compensation, reduction of system losses, improvement of good tele- communication and instrumentation facilities for load dispatch etc. It is expected that these aspects will also get sufficient attention.

However the present proposal is to involve private sector only in energy management and distribution. Very soon, it will be realized that involvement of private sector is needed in energy transmission also. The above mentioned benefits can be realized only if the private sector is involved in all aspects viz. Generation, transmission and distribution.

6. Results and benefits of energy conservation:

Saving of usable energy, which is otherwise wasted, has direct impact on economy environment and long -term availability of non- renewable energy resources. Energy conservation implies

reduction in energy consumption by reducing losses and wastage by employing energy efficient means of generation and utilization of energy. There are three important aspects of energy conservation:

6.1 Economic Aspects

a. Reduction in cost of product: Energy conservation ultimately leads to economic benefits as the cost of production is reduced. In some energy- intensive industries like steel, aluminium, cement, fertilizer, pulp and paper. The cost of energy forms a significant part of the total cost of product. Energy cost as a percent of total cost of product in the entire industrial sector in India varies from as low as 0.36% to as high as 65%. Using energy efficient technologies will reduce the manufacturing cost and lead to production of cheaper and better quality products.

b. New job opportunities: Energy conservation usually requires new investments in more energy efficient equipments to replace old inefficient ones, monitoring of energy consumption, training of manpower etc. Thus energy conservation can result in new job opportunities.

6.2 Environmental Aspects:

Every type of energy generation/ utilization process affects the environment to some extent, either directly or indirectly. The extent of degradation of the environment depends mainly on the type of primary energy source. Also, during every energy conversion stage a part of energy escapes to the surroundings and appear in the form of heat. Thus, energy is generated and utilized at the expense of adverse environmental impacts. Adoption of energy conservation means can minimize this damage.

6.3 Conservation of Non- Renewable Energy Assets:

The vast bulk of energy used in the world today comes from fossil fuels, which are non-renewable. These resources were laid down many millions of years ago and are not being made any longer. This finite non-renewable asset is being used up very fast. The quantity of fossil fuels that world community uses in one minute actually took the earth a millennium to create. Therefore its prices are bound to go up relative to everything else. It is necessary to abandon waste practices in energy utilization and conserve this resource by all means for future generations.

Conclusions:

Energy supply is now not considered a commodity but a service. In view of that the quality of energy supply and reliability become much more a proposition for the user's satisfaction rather than a simple one time commodity sale. India's strong economic performance of recent years requires continuing effort from the newly formed Government to widen the ambit of economic reform. Though the Government has given higher priority for the power development projects, the Indian power sector is struggling with formidable difficulties of meeting the heavy demands of electricity due to higher amount of power losses and energy thefts. Energy conservation is the only route that can get better mileage out of the available resources. The need is to consider the possibility of evolving an appropriate strategy for energy conservation measures in the country to achieve economical and environmental benefits.

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