Energy Conservation through Energy Audit – A Review

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Abstract: Energy is the driving force for the economy of any country. It is highly essential to ensure smooth progress of industrial as well as transport sector of any country. However, the ever increasing depletion of conventional fossil fuel sources as well as increase in environmental hazards due to pollution arising from burning of fuel necessitates the conservation of energy. Energy audit is a systematic approach to achieve energy conservation. It also technically and economically evaluates the benefits achieved for industry through energy conservation. In the present paper, a significant review of published literature in the domain of energy audit has been presented. Such a review will be beneficial to further studies in this area.

I. INTRODUCTION

The growth of an economy is closely related with the growth in its energy consumption. It is widely recognized that the non-availability of energy is a serious obstacle to an economic growth. Energy is the ability to do work and work is the transfer of energy from one form to another. In practical terms, energy is what we use to manipulate the world around us, whether by exciting our muscles, by using electricity, or by using mechanical devices such as automobiles. Energy comes in different forms - heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy.Energy is one of the major inputs for the economic development of any country. In the case of the developing countries, the energy sector assumes a critical importance in view of the ever-increasing energy needs requiring huge investments to meet them [1].

The per capita energy consumption is too low for India as compared to developed countries. It is just 4% of USA and 20% of the world average. The per capita consumption is likely to grow in India with growth in economy thus increasing the energy demand. Energy intensity is energy consumption per unit of GDP. Energy intensity indicates the development stage of the country. India's energy intensity is 3.7 times of Japan, 1.55 times of USA, 1.47 times of Asia and 1.5 times of World average.

The usage of energy resources in industry leads to environmental damages by polluting the atmosphere. Few of examples of air pollution are sulphur dioxide (SO_2), nitrous oxide (NO_x) and carbon monoxide (CO) emissions from boilers and furnaces, chloro-fluro carbons (CFC) emissions from refrigerants use, etc. In chemical and fertilizers industries, toxic gases are released. Cement plants and power plants spew out particulate matter. Typical inputs, outputs, and emissions for a typical industrial process are shown in Figure 1.

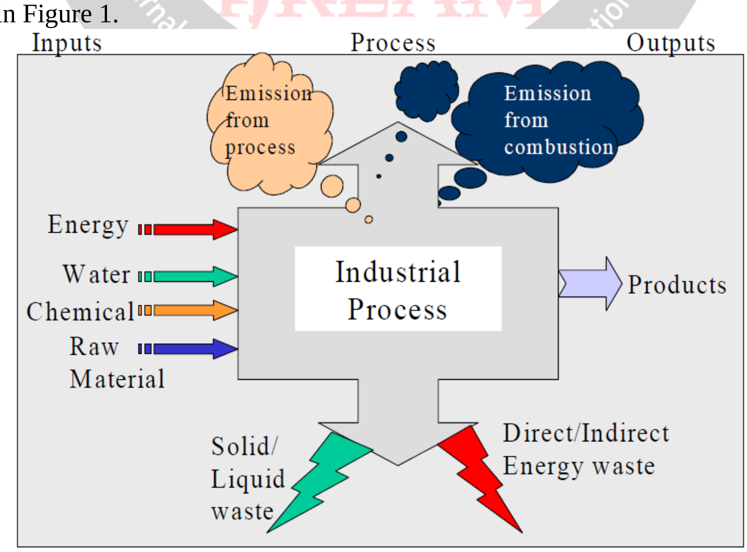

Figure 1 Inputs & Outputs of Process [1]

In both developed and rapidly industrializing countries, the major historic air pollution problem has typically been high levels of smoke and SO_2arising from the combustion of Sulphur containing fossil fuels such as coal for domestic and industrial purposes.

II. ENERGY SECURITY

The basic aim of energy security for a nation is to reduce its dependency on the imported energy sources for its economic growth. India will continue to experience an energy supply shortfall throughout the forecast period. This gap has widened since 1985, when the country became a net importer of coal. India has been unable to raise its oil production substantially in the 1990s. Rising oil demand of close to 10 percent per year has led to sizable oil import bills. In addition, the government subsidizes refined oil product prices, thus compounding the overall monetary loss to the government. Imports of oil and coal have been increasing at rates of 7% and 16% per annum respectively during the period 1991–99. The dependence on energy imports is projected to increase in the future. Estimates indicate that oil imports will meet 75% of total oil consumption requirements and coal imports will meet 22% of total coal consumption requirements in 2006. The imports of gas and LNG (liquefied natural gas) are likely to increase in the coming years. This energy import dependence implies vulnerability to external price shocks and supply fluctuations, which threaten the energy security of the country.

Increasing dependence on oil imports means reliance on imports from the Middle East, a region susceptible to disturbances and consequent disruptions of oil supplies. This calls for diversification of sources of oil imports. The need to deal with oil price fluctuations also necessitates measures to be taken to reduce the oil dependence of the economy, possibly through fiscal measures to reduce demand, and by developing alternatives to oil, such as natural gas and renewable energy. Some of the strategies that can be used to meet future challenges to their energy security are

- Building stockpiles
- Diversification of energy supply sources
- Increased capacity of fuel switching
- Demand restraint,
- Development of renewable energy sources.
- Energy efficiency
- Sustainable development

Although all these options are feasible, their implementation will take time. Also, for countries like India, reliance on stockpiles would tend to be slow because of resource constraints. However, out of all these options, the simplest and the most easily attainable is reducing demand through persistent energy conservation efforts.

III. ENERGY CONSERVATION AND ITS IMPORTANCE

Coal and other fossil fuels, which have taken three million years to form, are likely to deplete soon. In the last two hundred years, we have consumed 60% of all resources. For sustainable development, we need to adopt energy efficiency measures. Today, 85% of primary energy comes from non-renewable, and fossil sources (coal, oil, etc.). These reserves are continually diminishing with increasing consumption and will not exist for future generations (see Figure 2).

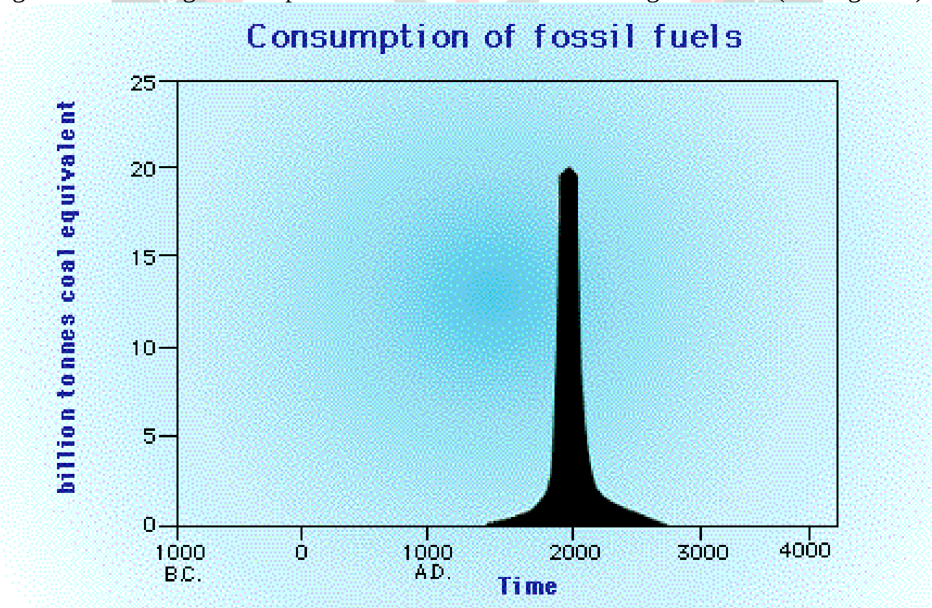

Fig. 2 Consumption trend of fossil fuels by human being [1]

IV. 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. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting 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.

V. DEFINITION & OBJECTIVES 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 objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and:

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

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 programme.

In the present project, we have focused our attention on methodology and results of previous work carried out in the domain of energy audit.

VI. LITERATURE REVIEW

Parthe and Kompelli [2] carried out energy audit in an auto industry entitled "Kohler Power India", Aurangabad in August 2015. Following are details of this company.

Total Connected Load - 1865 KW Electricity Board Sanction Max. Demand - 837 KVA, Available Power Source - Transformer 1 500 KVA, Diesel Genset as Standby DG 1 - 320 KVA, Diesel Genset as Standby DG 2 - 500 KVA

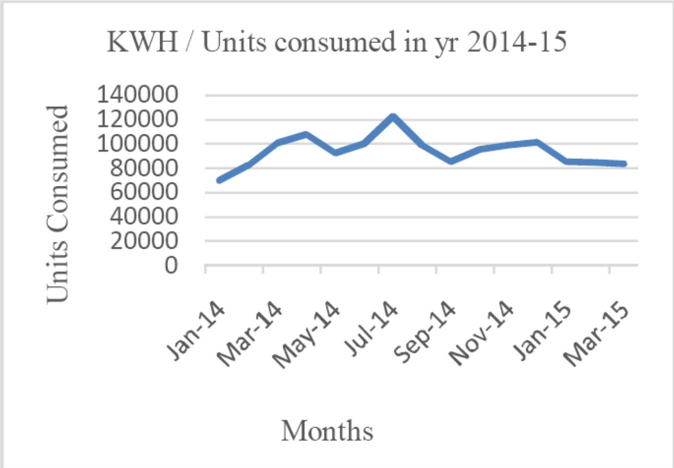

Fig. 3 Units consumed in Year 2014 [2]

Authors observed that the units (kwh) consumption pattern is constant. Not having any major sudden changes in units consumed. One or two spikes in month July 2014 are observed high. This is shown in Figure 3. Authors reported total monthly saving of 15,552 kWh on 240 Sodium Vapour (SV) lamps considering 12 hours of operation, when it was replaced with LED lamp of 70 W rating.

After this, authors proposed for using VFD's for KD15 and LGA Test cell fresh air blowers for reducing electricity power consumption. The monetary saving of Rs. 28,479 was obtained after use of VFD which required an investment of Rs. 4,65,000 and gave a payback period of 16 months. VFD saved 4069 kWh per month by implementing on 5 blowers.

Then, authors proposed to replace breeze air blowers instead of conventional blowers in the engine assembly section to maintain the environment free from dust. In this way, 10 HP blowers were replaced with 3.5 HP blowers which resulted in saving of 10,653 kWh per month.

Prashanth et al. [3] identified that there is substantial energy crisis as well as lack of energy efficient practices in Indian foundry industries. To address this issue, this research investigated to find a solution to reduce the wastage of energy in foundries. Authors conducted an energy audit for this purpose and identified that key areas affecting the energy efficiency were compressed air, raw materials and furnace.

The audit was started by studying the compressed air system. The faults present were identified and remedial measures were arrived upon. All compressed air systems were observed to have leaks. This is highly possible in any typical plant which has not been maintained well. On the other hand, proactive leak detection can reduce leaks to less than 10 percent of the compressor output. A typical leak test was conducted on the given compressor unit and the amount of leakage was calculated. The results of leakage test indicated that the plant was losing 23.422 kWh of energy per day because of leaks present in compressed air system. This did cost the plant a loss of Rs. 210.8 per day and ultimately, a loss of Rs. 65,570 per year.

Authors observed that about 105 kg of sand is wasted per day during strike off operations. To overcome this problem, a sand recovery system was designed to save about 100 kg of sand which sums up to become about 3 tonnes of sand every month. In the modified design, the mould box was placed on the top of the system. Authors used honeycomb design because of which sand wasted during striking off operation is getting accumulated in the system itself. This accumulated sand was then reused for further mixing operations. This modified design produced zero sand wastage. This resulted in overall cost saving of Rs. 10,000. The total cost of sand saved per year is about Rs 1,20,793.

Rathod et al. [3] carried out energy audit in tobacco industry. authors analyzed monthly electricity bill for last one year showing kWh consumption, maximum demand charges, time of day charges as well power factor. The power factor of the plant for the last year varied between 0.996 and 0.999. Thus, it was concluded that power factor obtained for last year was found to be satisfactory.

Authors reported that contract demand for the plant was 750 kVA and minimum billable demand was 638 kVA. Electricity bill analysis indicated that the contract demand was never exceeded in the last one year. Hence it was suggested to reduce the contract demand to 600 kVA. On the basis of this, authors calculated that this measure could save Rs. 2.15 Lakh per year for the company without any investment.

After this, authors observed that volumetric efficiency for compressor 1 and compressor 2 was 68% and 80%. So it was concluded that volumetric efficiency of compressor 2 is significantly on lower side than that of compressor 1. Hence it was suggested to check and clean suction air filter and perform proper maintenance and overhauling of air compressor. Because of this remedial action, there was an estimated saving of Rs. 0.18 Lakh possible with an investment of Rs. 0.15 Lakh. This gave a payback period of 7 months for the company.

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