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Energy Conservation – Green Computing Approach

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ABSTRACT-

The gap between supply and demand of energy is continuously increasing despite huge outlay for energy sectorsince independence.All the existing energy sources have environmental, social and economic impacts. The greenhouse effect results global warming, air pollution and energy security have led to increasing interest and more development in energy conservation. Fossil fuel reserve in India is depleting in a rapid way with development of the 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. For reducing cost and increasing efficiency, then use energy conservation, management and audit.The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization as,To minimize energy costs / waste without affecting production and quality. To minimize environmental effects.There is a good scope of energy conservation in various sectors, industry agriculture, transport and domestic, This paper will give overview of energy conservation techniques and management.

KEYWORDS-(introduction ;materials ;methods and techniques ;results ;conclusion.)

1.INTRODUCTION

Energy is the ability to do work and work is the transfer of energy from one form to another. Energy comes in different forms - heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy. 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 In this paper we study energy conservation and energy efficiency by how to reduce energy demand to reasonable minimum Cost, recover and re-use heat where possible and also study use of energy efficient equipment to supply remaining energy demand, and provide a means to manage use of energy and also study energy and environment and study how to carry out energy audit.

Adequate amount of energy, especially electricity consumption boosts up any country's development activities. Not only in the developed countries in the world but also in developing countries such as-Bangladesh, the application of electric power both in household appliances and industrial equipment are growing rapidly. The per capita electricity consumption Bangladesh is increased to 348 kWh [1]. However, almost 70% of total rural population in the country has no electricity access yet because of the high consumption rates in urban regions. Therefore, Bangladesh is suffering from acute shortage of electricity supply especially during the summer season. Annually, 143.83kWh electrical energy is consumed per household of which 56.14% is consumed in lighting purpose only as shown in Fig1.

Domestic energy consumption is closely interrelated to the consumer's energy saving awareness which also related to the selection of new energy efficiency appliances. Efficient consumption of electricity contributes in security of sufficient supply, saving of energy and reduction in consumption cost as well as greenhouse gas emission.

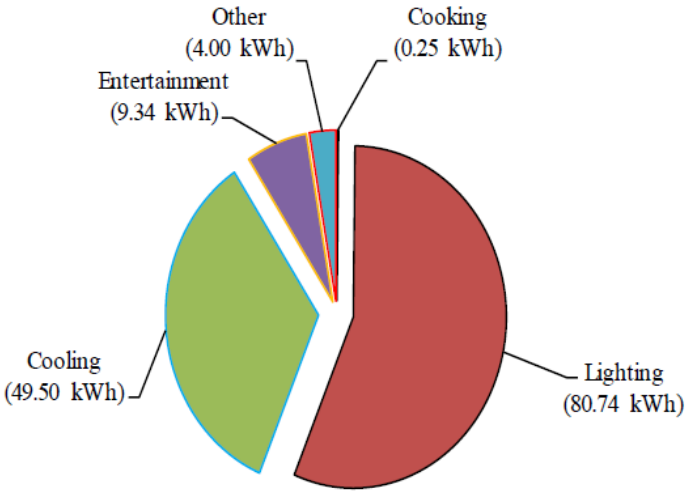

Fig.1. Sector wise electricity consumption per household

2.SCENERIO OF INDIA IN ENERGY CONSERVATION

India has over 17 percent of the world's population and hence a significant consumer of energy resources. India consumes its maximum energy in Residential, commercial and agricultural purposes in comparison to China, Japan, Russia, EU-27 and US . It is found that the share of energy consumption in India and China has also been on the raise due to sharp urbanization, population explosion, and intensive growth of IT and related business . Development of the society highly depends on availability of energy. Hence meeting energy demand for the nation is an important task for sustainable development of the country. In all five year planning in India, energy sector has received significant priority. It is found that requirement of electricity during year 2010-11 was 861,591 million units and availability was 788,355 million units, i.e. a shortage of 73,236 million units (8.5%). In the year 2011-12, the requirement was 933,741 million units and the availability was 837,374 million units, again resulting in shortage of 96,367 million units (10.3%) . It is seen that there exist a considerable gap demand and supply of power. It is very much essential to minimize the gap between generation and demand. From 1991 to 2007 a number of reforms have been introduced by the government to improve the power system in India. It in turn revolutionized the growth in power capacity, reliability in supply, growth in the revenue collection . The conservation of energy is an important means to reduce peak and average demand of energy. It is observed that investment in energy efficiency and energy conservation is highly cost effective . End user efficiency can considerably be improved by Energy conservation technology. It is possible to save energy with the implementation of energy conservation technology which means increasing generation of energy with available source . The improvement of end user efficiency is a part of demand side management which reduces the amount of energy consumption by the end users. It in turn reduces the burden from the existing power supply system which also reduces in unit cost of the energy . In domestic, commercial and industrial sector, lighting system consumes significant amount of energy. It consumes 50% of total energy consumption in commercial buildings and 10% in industries. A number of places are found having inefficient lighting design for a particular task . In all the sectors both indoor and outdoor lighting efficiency can be improved with higher efficient lighting sources which will help to reduce the gap between demand and supply.

India is the one of the most populated country in the world and one of the most growing countries in the world. In order to have sustainable growth rate, energy in the usable form plays an important role. From the time of independence, India has raised the power generation capacity from 1362 MW to many folds at present [10]. In every five year planning, energy got significant importance. But the gap between generation and the demand is increasing day by day. The fossil fuel reserve in India is not very vast and may be depleted totally by the middle of the century which indicates an alarm situation of near future. Energy consumption pattern of different sectors in India in the year 2007 are given in the table I. Hence to keep up the growth rate of every sector, meeting required energy demand is essential.

Table I: Sector wise energy consumption

Areas	*Consumption (Year-2007)*
Domestic	21%
Commercial	18.0%
Industrial	32%
Transportation	29%

3. ENERGY SCENERIO AND ENERGY SOURCES

Energy can be classified into various types based on following criteria-
- Primary and Secondary energy
- Commercial and Noncommercial energy
- Renewable and Non-Renewable energy

Primary energy sources are those that are either found or stored in nature. Common primary energy sources are coal, oil, natural gas, and biomass (such as wood). Other primary energy sources available include nuclear energy from radioactive substances, thermal energy stored in earth's interior, and potential energy due to earth's gravity.

Secondary energy sources like steam, electricity are derived from primary energy sources like coal, oil & gases & are suitable for transportation, distribution and control.

Commercial Energy sources that are available in the market for a definite price are known as commercial sources that are available in the market for a definite price are known as commercial energy. Commercial energy forms the basis of industrial, agricultural, transport and commercial development in the modern world.

Non-commercial energy sources that are not available in the commercial market for a price are classified as Non-commercial energy. Example: Firewood, agro waste in rural areas; solar energy, animal power, wind energy.

Renewable energy sources are those that are essentially inexhaustible, like wind power, solar power, geothermal energy, tidal power and hydroelectric power

Non-renewable energy is the conventional fossil fuels such as coal, oil and gas, which are likely to deplete with time.

4. ENERGY CONSERVATION AND EFFICIENCY

Energy conservation: -Energy is defined as the ability to do a work and work is transformation of energy from one form to another and also the energy can neither be created nor destroyed. It includes any behavior that results in the use of less energy.

Examples Shut lights off , Don't leave water running, Recycle (bottles, can, papers, glass, etc.) ,Walk or ride a bike, Open a window in the summer instead of turning on the air conditioning ,use public transportation.

Energy efficiency: -It involves the use of technology that requires less energy to perform the same function. A compact fluorescent light bulb that uses less energy to produce the same amount of light as an incandescent light bulb is an example of energy efficiency. The decision to replace an incandescent light bulb with a compact fluorescent is an example of energy conservation. Driving the same amount with a higher mileage vehicle is an example of energy efficiency.

Need of Energy Conservation: -Fossil fuels like coal, oil that has taken years to form is on the verge of depleting soon. In last 200 years we have consumed 60% of all resources. For sustainable development we need to adopt energy efficiency measures. Today 85% of primary energy sources come from non-renewable and fossil sources. These reserves increasing consumption and will exist for future generations.

Energy survey conducted by **Ministry of Power** in 1992 reveled that there is requirement of improvement in energy generation efficiency, improvement in energy transportation (transmission & distribution systems) and enhancing the performance efficiency of use end apparatus. Study of **'Energy strategies for Future'** evolved two things - efficient use

of energy, energy conservation and use of Renewable Energy. Energy conservation emerges out to be the first and least cost option.

5.MATERIALS

5.1 THE SCOPE AND POTENTIAL

The developing countries like India areobliged to maintain a certain growth rate for whichenergy is a basic ingredient. Failure to meet theenergy demand for the basic needs of the economywill cause inflation unemployment and socioeconomic disorder. The major energy projects arecapital-intensive and result in the degradation of theenvironment and ecology. Energy efficiency andconservation in the past have been neglectedon the assumption of continuous availability of fossil fuel.

Energy conservation is the strategy of adjusting and optimizing energy using systems and procedures to reduce energy requirements per unit of output without affecting socio-economic development. Energy conservation means going with what is available, while in developed countries 1%increase in G.N.P. needs barely 0.6% increase in energy consumption in whereas in India the corresponding increase in energy consumption is nearly 1.5%

1. Transmission and Distribution Losses

India has a complex transmission anddistribution network. The Transmission anddistribution (T & D) losses in Indian Power Systemsare rather high. According to Central ElectricityAuthority (CEA) statistics, on all India basis thelosses are around 20 percent. According to theestimates of a few other independent agencies, thereal T&D losses may be even higher than the figurepower systems with those of more developedIn order to estimate the cost effectiveness ofthe various modern techniques available for reductionof T&D losses in the context of Indian environment,it is essential to have an idea regarding the energy losses taking place at the various stages oftransmission and distribution of power as well as afurther break—up of the line losses andtransformation losses. The T&D losses can bedivided in to two parts, namely. Extra-high voltage(EHV) /High Voltage (HV) transmission and lowvoltage distribution. Out of total 15% T&D lossestargeted to be achieved.

2. Long Term Objectives of Energy Conservation

1. To bring attitudinal changes in all energy users so that they strive for maximum energy efficiency in all products, projects, buildings, processes, domestic and commercial use, agricultural and transport use inconsistent with economic considerations.
2. Take necessary steps to discipline those who fail to fall in line with the above changes.
3. To adopt policies which make energy conservation easy and attractive for being adopted by all energyusers.
4. To take steps to prevent inefficient use of energy in future projects, buildings, products, processes etc. inevery sector of energy Use.

5.2 AREAS OF CONSERVATION

The main areas where conservation was possible are as follows:-

1. Improvement in power factor would result in reduction in actual maximum demand on the system.
2. Improvementin plant load factor results Optimum utilization of plant capacity and increasingproduction
3. 80% of the industrial electricity consumption isaccounted for by induction motors which are mostlyused for pumping and compressor application, etc.
4. Various furnaces, electrolysis baths and vessels operating at higher temperature are found to have inadequate insulation. Higher surface temperaturemeans loss of electrical form of energy by radiation .This can easily be prevented by applying properinsulation to limit the surface temperature rise aboveambient up to 200C.

6.METHOD

1) Energy Audit

The Energy Audit is an accounting tool, an analytical device to detect energy waste.. One series of entries consists of amounts of energy which were consumed during the month in the form of electricity ,gas, fuel, oil, steam: and the second series lists how the energy was used: how much for lighting, air conditioning, heating, production processes

and other activities. Energy Audit, therefore, is a crucial tool for energy management because it indicates the scope for conservation by identifying the waste areas .Nearly 20-30 percent savings on energy conservative estimate, be easily achieved by any industry, if energy conservation measured identified by energy surveys are adopted. Moreover, at least 10 percent savings are possible simply by following good housekeeping practices which require no investment whatsoever. Even when a conservation measure demands investment, it is generally always paid back in less than two years.

2) Financial Incentives

Recognizing the importance of energy conservation projects by the Government and the financial institutions terms of concessions/reliefs income-tax, excise duties, customs duties, sales taxsubsidies, liberalization of licenses and loans atconcessional terms. It is in thiscontext that Industrial Development Bank of India (IDBI) has introduced toschemes, with a sharp focus on energy conservationobjectives in industries. These schemes are (a) EnergyAudit Subsidy Scheme, and (b) Equipment Finance forEnergy Conservation Scheme. TheSE Schemes whichwere initially in operation for a period of 2 years havebeen extended up to the end of the Five Year Plan. .

3. Energy Audit Subsidy Schemes

Assistance would be available under this scheme for preliminary as well as for detailed energy audit. The charges of the approved consultancy agency for carrying out the energy audit would be partly subsidized by IDBI which will bear 50% of the cost, the balance to be borne by the applicant company. For preliminary audit, the amount of subsidy available under this scheme per undertaking/company would be limited to Rs. 10,000 or 0.01 percent of gross fixed assets of the undertaking/company whichever is less. The limit of assistance for detailed energy audit would be Rs. 1.00lakh or 0.05% of the gross fixed assets of the undertaking/company whichever is lower. Assets value shall be exclusive of revaluation reserves.

4. Equipment Finance For Energy conservation Scheme

For the purposes of EFEC scheme, equipment shall include plant machinery, miscellaneous fixed assets erection and installation charges, technical know-how fees for designs and drawings. Assistance under the scheme would be available only for installation of equipment for effecting energy conservation in the existing plants/processes and not for expansion or diversification of production capacities, even though, the same may also result in energy conservation. Assistance under the scheme would be in the form of term loan.

7.ENERGY CONSERVATION TECHNIQUES

7.1EC Techniques in Transformers:

i) Optimization of loading of transformer:

By proper Location of Transformer preferably close to the load center, considering other features like centralized control, operational flexibility etc. This will bring down the distribution loss in cables**.**
Maintaining maximum efficiency to occur at 38% loading (as recommended by REC), the overall efficiency of transformer can be increased and its losses can be reduced Under fluctuating load condition more than one transformer is used in Parallel Operation of Transformers to share the load & can be operated close to the maximum efficiency range.

ii) By Improvisation in Design and Material of Transformer:

To reduce load losses in Transformer, use thicker conductors so that resistance of conductor reduces and load loss also reduces.
To reduce Core losses use superior quality or improved grades of Cold Rolled Grain Oriented (CRGO) laminations.

iii) Replacing By Energy Efficient Transformers:

By using energy efficient transformers efficiency improves to 95 % to 97%.
By using Amorphous transformers efficiency improves to 97 % to 98.5%.
By using Epoxy Resin cast/ Encapsulated Dry type transformer- efficiency improves to 93 % to 97%.

7.2 Energy Conservation in Transmission Line:

To reduce line resistance-„R" solid conductors are replaced by stranded conductors (ACSR or AAC) and by bundled conductors in HT line.
High Voltage Direct Current (HVDC) is used to transmit large amount of power over long distances or for interconnections between asynchronous grids By transmitting energy at high voltage level reduces the fraction of energy lost due to Joule Heating. (V α1/I so I 2 R losses reduces). As load on system increases terminal voltage decreases. Voltage level can be controlled by using voltage controllers and by using voltage stabilizer if required reactive power transmitted through Transmission lines, it causes more voltage drop in the line. To control receiving end voltage, reactive power Controllers or reactive power compensating equipment's such as Static VAR controllers are used.

7.3Energy Conservation In Distribution Line:

a) Optimization of distribution system: The optimum distribution system is the economical combination of primary line (HT), distribution transformer and secondary line (LT), to reduce this loss and improve voltage HT/LT line length ratio should be optimized.
b) Balancing of phase load- As a result of unequal loads on individual phase sequence, components causes over heating of transformers, cables, conductors, motors. Thus, increasing lossesand resulting in the motor malfunctioning under unbalanced voltage conditions.
c) Harmonics: With increase in use of non-linear devices, distortion of the voltage and current waveforms **occurs**, known as Harmonics. Due to presence of harmonic currents excessive voltage and current in transformers terminals, malfunctioning of control equipment's and Energy meter, over effect of power factor correction apparatus, interference with telephone circuits and broad casting occurs. Distribution Static Compensator (DASTACOM) and Harmonic filters can reduce this harmonics.
d) Energy Conservation by using power factor controller:
Low power factor will lead to increased current and hence increase losses and will affect the voltage. We can use Power Factor Controller or Automatic Power.

7.4Conservation In Lighting system:

Good lighting is required to improve the quality of work, to reduce human's / worker's fatigue, to reduce accidents, to protect his eyes and nervous system. In industry it improves production, and quality of products / work.
a) Optimum use of natural light: Whenever the orientation of a building permits, day lighting has to be used in combination with electric lighting. The maxim use of sunlight can be get by means of transparent roof sheets, north light roof, etc.
b) Replacing incandescent lamps by Compact Fluorescent Lamps (CFL's): CFL's are highly suitable for places such as Living rooms, Hotel lounges, Bars, Restaurants, Pathways, Building entrances, Corridors, etc.
c) Replacing conventional fluorescent lamp by energy efficient fluorescent lamp: Energy efficient lamps are based on the highly sophisticated technology. They offer excellent color rendering properties in addition to the very high luminous efficacy.
d)Replacement of conventional ballast by Electronic ballast: Installation of high frequency (28 –32Mhz) electronic ballast in place of conventional ballasts helps to reduce power consumption up to 35%.
e) Installation of separate transformer for lighting: In most of the industries, the net lighting load varies between 2 to 10%. If power load and lighting load fed by same transformer, switching operation and load variation causes voltage fluctuations. This also affects the performance of neighboring power load apparatus; lighting load equipment's and also reduces lamps. Hence, the lighting equipment has to be isolated from the power feeders. This will reduce the voltage related problems, which in turn provides a better voltage regulation for the lighting this also increases the efficiency of the lighting system.
f) Installation of servo stabilizer for lighting feeder: Wherever, installation of separate transformer for lighting is not economically attractive and then servo stabilizer can be installed for the lighting feeders.
g) Control over energy consumption pattern: Occupancy Sensors, Daylight inked Control are commonly used in commercial buildings, malls, offices, where more no. Of lights are to be controlled as per operational hours microprocessor based Light control circuits are used. As a single control unit itcan be programmed to switch on /off as per the month wise, year wise and even season wise working schedule.

7.5Energy Conservation in Motors:

Considering all industrial applications 70% of total electrical energy consumed by only electric motors driven equipment's.

a. **Improving power supply quality:** Maintaining the voltage level within the BIS standards i.e. with tolerance of +/-6%and frequency with tolerance of +/-3% motor performance improves and also life.

b. Optimum loading: Proper selection of the rating of the motor will reduce the power consumption. If the motor is operating at less than 50% of loading (η<50%) significant power saving can be obtained by replacing with properly sized high efficiency motors. If the motor is operating at loads below 40% of it‟s capacity, an inexpensive and effective measure might be to operate in star mode.

c. Improving transmission efficiency: Proper selection of power transmission means (belts, gears) will reduces transmission losses.

d. Stopping idle or redundant running of motors or lights will save 100% power.

e. By use of Soft Starter: Soft starters are essentially stator voltage controllers; helps to overcome above problem. It helps to **restrict** starting current and also provide smooth start and stop operation.

f.By improving power factor: For improving p.f.connect the capacitor bank, which will improve the p.f. of the system from installation to generating station. Maximum improvement in overall system efficiency is achieved, which also reduces Max. Demand of the system and that will reflect in energy bill.

g. Use of high efficiency or Energy efficient motors

The energy efficient motors have reduced losses through improved design, better materials and improved manufacturing techniques. Generally motor life doubles for each 10 0C reduction in operating temperature. While selecting EEM, select with 1.15service factor, design for operation at 85% of rated load.

8.RESULTS

Energy Management:

The fundamental goal of energy management is to produce goods and provide services with the Least cost and least environmental effect.

Or "The strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems"

The objective of Energy Managementis 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.

Aim of Energy audit (need)

- to minimize costs for energy
- to minimize operational costs
- to minimize costs for repairs and reconstruction
- to increase quality of environment that contributes to increased work productivity

Ten Steps Methodology for Detailed Energy Audit

Phase I –Pre Audit Phase		
Step No	**Plan of action**	**Purpose/Results**
Step 1	• Plan and organize •Walk through Audit •Informal Interview with Energy Manager, Production / Plant Manager	• Resource planning, Establish/organize a Energy audit team • Organize Instruments & time frame • Macro Data collection • First hand observation & Assessment of current level operation and Practices.
Step2	•Conduct of brief meeting / awareness programme with all divisional heads and persons concerned (2-3 hrs.)	•Building up cooperation • Issue questionnaire for each department • Orientation, awareness creation

Phase-2 Audit phase		
Step 3	•Primary data gathering, Process Flow Diagram, & Energy Utility Diagram	•Historic data analysis, Baseline data collection • Prepare process flow charts • All service utilities system diagram •Design, operating data and schedule of operation • Annual Energy Bill and energy consumption pattern (Refer manual, log sheet, name plate, interview)
Step 4	•Conduct survey and monitoring	•Measurements : Motor survey, Insulation, and Lighting survey with portable instruments for collection of more and accurate data. Confirm and compare operating data with design data
Step 5	•Conduct of detailed trials /experiments for selected energy guzzlers	•Trials/Experiments: 24 hours power monitoring (MD, PF, kWh etc.). •Load variations trends in pumps, compressors etc. •Boiler/Efficiency trials for (4 – 8 hours)
Step 6	•Analysis of Energy Use	•Energy and Material balance & energy loss/waste analysis
Step 7	•Identification and development of Energy Conservation (ENCON) opportunities	•Identification & Consolidation ENCON measures •Conceive, develop, and refine ideas Review the previous ideas suggested by energy audit if any •Use brainstorming and value analysis s •Contact vendors for new/efficient technology
Step 8	•Cost benefit analysis	•Assess technical feasibility, economic viability and prioritization of ENCON options for implementation •Select the most promising projects
Step 9	•Reporting & Presentation to top management	•Documentation, Report Presentation to the top management
Phase III –Post Audit phase		
Step 10	•Implementation and Follow-up	Assistant implement ENCON recommendation measures and Monitor the performance •Action plan, Schedule for implementation •Follow-up and periodic review

9.CONCLUSION

Some important conclusions are listed below:

1. The energy efficiency and conservation may be viewed as a new source of energy, benign and clean, having little investment and short payback period. This approach can go a long way in bridging the gap between demand and supply of energy.
2. It is absolutely necessary to bring attitudinal changes in all energy users in respect of energy efficiency. This can be achieved, to a large extent, by imparting energy education at school level itself.
3. A high power Apex Body at national level may be constituted to coordinate various activities in this field.
4. Energy efficiency standards should be setup for all major machinery, equipment and appliances. This single approach will go a long way in ensuring energy efficiency in various sectors.
5. The concept of energy audit, on regular basis, may be introduced in every industry. Energy audit should be given the same importance as the financial audit.
6. A comprehensive Act may be passed by the Parliament without further loss of time. The act should be simple in interpretation and effective in implementation.
7. Energy efficiency is to be given due importance at the planning stage itself of the new industries. The Financial institutions may be asked to insist on this aspect before sanctioning loans.
8. The government should provide more attractive incentives in terms of soft loans for purchasing energyefficient machinery and subsidies for employing energy conserving measures. There should be a realistic tariff particularly for agricultural sector.

9. Last but not the least, the energy conservation should be developed as a mass movement like family planning, literacy drive etc.

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