Efficient Energy Consumption and Management Technique

Manika Rastogi
Department of Computer Science & Engineering,
HMRITM,
New Delhi, India.

Harish Kumar
Department of Mechanical & Automation Engineering,
HMRITM,
New Delhi, India.

***Abstract*— 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. Energy efficiency is strongly linked to the operations and control systems, together with the integrated performance of passive and active systems. For reducing cost and increasing efficiency, then use efficient energy consumption and management technique. 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. Energy efficient Consumption 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. In this research paper, the proposed concept is to replace the manual work in public distribution system and to find ways to reduce load, increase efficiency, and utilize renewable fuel resources in facilities of all types.**

Keywords—Conservation, Application area, Efficiency, Management, Techniques, Smart Grid.

I. 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 [1]. 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. India consumes its maximum energy in Residential, commercial and agricultural purposes. It is found that the share of energy consumption in India 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.

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. The reduction of energy use in the built environment through optimizing building energy efficiency is a strategic research challenge. 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.

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.

A. Energy Scenario 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 [1].

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 Noncommercial 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.

II. ENERGY CONSERVATION AND EFFICIENCY

It is seen that there always exist a gap between generation of energy and energy demand of energy. It is quite impossible to bridge this gap by increasing the generation capacity as it is a very capital intensive process. End user sector is a major area of conservation of energy to bridge the short fall between generation and demand. In all the areas, conservation of energy is possible. Through demand side management it is possible to maximizing the end use efficiency.

A. 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.

1) The most significant areas of energy conservation is lighting energy:

Lighting load shares a significant portion in all sectors namely domestic, commercial, industrial etc. It is found that in most of the cases indoor lighting get priority as far as energy efficiency is concern but campus lighting in commercial, domestic building get less importance [1]. There is huge possibility to conserve energy if the inefficient light fittings are replaced by efficient one. Basically it is a demand side management which helps to reduce load on the electrical network. Consumption of energy can be reduced by conservation of energy [2].

It is obvious that higher efficiency of lighting source will definitely reduce the energy consumption. It is seen that the luminous efficacy of the LED (20-60) and CFL (50-80) but LED is much energy efficient due to low power consumption at the driving circuit and negligible loss of power in terms of heat generation. Hence LED for lighting purpose is a good alternative of commonly used light sources.

2) Reduce heating, cooling loads through climate-responsive design and conservation practices:

- Use high-performance building envelopes; select walls, roofs, and other assemblies based on long-term insulation, air barrier performance, and durability requirements.
- Use passive solar design; orient, size, and specify windows; and locate landscape elements with solar geometry and building load requirements in mind [8].
- Consider an integrated landscape design that provides deciduous trees for summer shading, appropriate planting for windbreaks, and attractive outdoor spaces so that occupants wish to be outdoors [3].

3) Employ renewable or high – efficiency energy sources

- Renewable energy sources include solar water heating, photovoltaic (PV), wind, biomass, and geothermal. Use of renewable energy can increase energy security and reduce dependence on imported fuels, while reducing or eliminating greenhouse gas emissions associated with energy use [3][6]. Consider solar thermal for domestic hot water and heating purposes.
- Evaluate the use of building scale to take advantage of on-site renewable energy technologies such as day lighting, solar water heating, and geothermal heat pumps.
- Consider the use of larger scale, on-site renewable energy technologies such as photovoltaic, solar thermal, and wind turbines.
- Evaluate purchasing electricity generated from renewable sources or low polluting sources such as natural gas.

4) Optimize building performance and system control strategies:

- Use sensors to control loads based on occupancy, schedule and/or the availability of natural resources such as daylight or natural ventilation.
- Employ energy modeling programs early in the design process.
- Evaluate the use of modular components such as boilers or chillers to optimize part-load efficiency and maintenance requirements.
- Evaluate the use of Smart Controls that merge building automation systems with information technology (IT) infrastructures.
- Employ an interactive energy management tool that allows you to track and assess energy and water consumption.

- Employ centralized remote meter reading and management to provide accurate analysis of energy use and monitor power quality.
- Use metering to confirm building energy and environmental performance through the life.
- Provide electronic interactive graphic dashboards in prominent locations to educate occupants of their building's energy and water consumption and highlight sustainable building features.

4) Deep energy retrofits

A deep energy retrofit is a whole-building analysis and construction process that achieves much larger energy cost savings than those of simpler energy retrofits such as upgrading lighting and HVAC equipment. In taking a whole-building approach, deep energy retrofits address many systems at once by combining energy efficient measures such as energy-efficient equipment, air sealing, moisture management, controlled ventilation, insulation, and solar control [3].

B. Energy efficiency

It involves the use of technology that requires less energy to perform the same function i.e. the goal to reduce the amount of energy required to provide products and services. Reducing energy use reduces energy costs and may result in a financial cost saving to consumers if the energy savings offset any additional costs of implementing an energy efficient technology.

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.

C. Need of Energy Conservation

The earth provides enough to satisfy every man's needs but not every man's greed. We use energy faster than it can be produced - Coal, oil and natural gas - the most utilized sources has taken years to form is on the verge of depleting soon . As Energy resources are limited - India has approximately 1% of world's energy resources but it has 16% of world population and Most of the energy sources we use cannot be reused and renewed - Non renewable energy sources constitute 80% of the fuel use. It is said that our energy resources may last only for another 40 years or so [7].

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. We save the country a lot of money when we save energy - About 75 per cent of our crude oil needs are met from imports which would cost about Rs.1, 50,000 crore a year and We save our money when we save energy - Imagine your savings if your LPG cylinder comes for an extra week or there is a cut in your electricity bills and When we use fuel wood efficiently, our fuel wood requirements are lower and so is our drudgery for its collection

Energy saved is energy generated - When we save one unit of energy, it is equivalent to 2 units of energy produced .we Save energy to reduce pollution - Energy production and use account to large proportion of air pollution and more than 83 percent of greenhouse gas emissions. Energy survey conducted by Ministry of Power in 1992 reveled that there is requirement of improvement in energy generation efficiency, improvement in energy transportation [9] (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.

III. AREA OF APPLICATION OF ENERGY CONSERVATION

Sector wise energy consumption Areas are Domestic: 21%, Commercial: 18.0%, Industrial: 32%, Transportation: 29% [2]. Electrical system is a network in which power is generated using non-renewable sources by conventional method and then transmitted over longer distances at high voltage levels to load centers where it is used for various energy conversion processes. End user sector are identified as three major areas - Power Generating station, Transmission & Distribution systems, and Energy consumers. Consumers are further classified as Domestic, commercial and Industrial consumers.

A. EC in Power generating station

To generate 1MW power generation cost is Rs 4.5 to 5.25 cores and T& D cost is Rs.2 cores .But cost of saved power is Rs.1Crores/MW important note is time period to set a power plant is 5 years, to set up transmission line 1 year and to plan energy conservation is only 1 month. We have less opportunity for EC in generating area but we can improve the performance efficiency of generators by optimization of load, optimal distribution of load among different units, periodical maintenance and also increasing the capacity by adopting advanced technology using renewable energy sources.

B. EC in Transmission & Distribution

In India the power transmission and distribution (T&D) system is a three tire structure comprising of state grids, regional grids and distribution network. To meet the energy demand power system networks are interconnected through Intraregional Link [1][4]. The inter-regional power transmission capacity of India at end of 2007 was 14000 MW. T&D system in India is characterized by heavy losses of about 34.54% according to statistics of 2005-06, as compared to 10-15% in developed countries Power losses in T&D system can be classified as Technical losses and Commercial losses.

1) Technical Losses In T&D System:

Power losses occurring in T&D sector due to imperfection in technical aspect which indirectly cause loss of investment in this sector, are technical losses. These technical losses are due to inadequate system planning, improper voltage and also due to poor power factor etc.

2) Commercial Losses:

Commercial losses are those, which are directly responsible for wastage of money invested in transmission and distribution system. These losses are effects of inefficient management, improper maintenance etc. Corruption is also the main reason contributing to the Commercial losses. Metering losses includes loss due to inadequate billings, faulty metering, overuse, because of meters not working properly and outright theft. Many of the domestic energy meters fail because of poor quality of the equipment.

IV. ENERGY CONSERVATION TECHNIQUES

A. EC Techniques in Transformers

1) 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) [7], 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

2) 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.

B. EC 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.

1) 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.

2) *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.

3)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.

4) 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.

5) 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.

6) 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 it can be programmed to switch on /off as per the month wise, year wise and even season wise working schedule.

C. Smart Grid:

A smart grid delivers electricity from suppliers to consumers using two-way digital technology to control appliances at consumers' homes to save energy, reduce cost and increase reliability and transparency. It includes an intelligent monitoring system that keeps track of all electricity flowing in the system. It also incorporates the use of superconductive transmission lines for less power loss, as well as the capability of integrating renewable electricity such as solar and wind. When power is least expensive the user can allow the smart grid to turn on selected home appliances such as washing machines or factory processes that can run at arbitrary hours [5]. At peak times it could turn off selected appliances to reduce demand.

It is a system that optimizes power supply and delivery, minimizes losses, is self-healing, and enables next-generation energy efficiency and demand response applications. From a utility's perspective, a Smart Grid can be viewed as a means to further five primary goals:

(1) Enhance Customer Service.
(2) Improve Operational Efficiency.
(3) Enhance Demand Response and Load Control.
(4) Transform Customer Energy Use Behavior.
(5) Support More Utility Energy Efficiency Investment.

A smart grid is an umbrella term that covers modernization of both the transmission and distribution grids [5]. The modernization is directed at a disparate set of goals including facilitating greater competition between providers, enabling greater use of variable energy sources, establishing the automation and monitoring capabilities needed for bulk transmission at cross continent distances, and enabling the use of market forces to drive energy conservation.

V. ENERGY AND ENVIRONMENT

The usage of energy resources in industry leads to environmental damages by polluting the atmosphere. Few of

examples of air pollution are sulphur dioxide (SO2), nitrous oxide (NOX) and carbon monoxide (CO) emissions from boilers and furnaces, chloro-fluro carbons (CFC) emissions from refrigerants use, etc. [1].

A. Evolutionary Trends in Pollution Problems:

In both developed and rapidly industrializing countries, the major historic air pollution problem has typically been high levels of smoke and SO2 arising from the combustion of sulphur containing fossil fuels such as coal for domestic and industrial purposes.

Smog's resulting from the combined effects of black smoke, sulphate / acid aerosol and fog have been seen in European cities until few decades ago and still occur in many cities in developing world [9].

Traffic pollution problems are worsening world-wide. The problem may be particularly severe in developing countries with dramatically increasing vehicle population, infrastructural limitations, and poor engine/emission control technologies and limited provision for maintenance or vehicle regulation.

B. Energy Management:

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.

1) The objective of Energy Management:

- To achieve and maintain optimum energy procurement and utilization, throughout the organization.
- To minimize energy costs / waste without affecting production & quality.
- To minimize environmental effects.

CONCLUSION

In order to reduce energy use and to alert the drivers about the utilization limits for safe usage an effective solution is provided to develop the intelligent utilization, which will operates on safest use at critical zones and monitor various parameters of energy utilization in-between constant time period. Controlling the energy utilization automatically in real time is very difficult. So, in order to avoid those difficulties, this research paper succeeded in alerting the driver about the energy limits, detecting the critical area and proposed renewable energy.

Everything what happens in the world is the expression of flow of energy (Electrical) in one of its forms. In development process to cope with increasing energy demands, conservation and energy efficiency measures are two parallel paths.

It is found that the improvement of end user efficiency with proposed higher efficient LED light fixture provide significant result for campus lighting system. It is also found that in spite of higher initial investment, the operating life of the LED system is reasonably high which results 50% savings on initial investment on long term basis as compared to existing fluorescent lamp (T12) fixture.

REFERENCES

[1] Shradha Chandrakant Deshmukh, Varsha Arjun Patil," Energy Conservation and Audit", 8 August 2013.
[2] Biswajit Biswas, Sujoy Mukherjee ," Conservation of Energy: a Case Study on Energy Conservation in Campus Lighting in an Institution",4july2013
[3] WBDG Sustainable Committee, "Optimize Energy Use", 27 October 2015.
[4] Tildy Bayar," Virtual Power Plants: A New Model for Renewables Integration", 30 September 2013.
[5] N. V. Vader, M. M. Dixit," Latest Techniques in Energy Conservation for Power System", 20th Aug.2011.
[6] Renewable energy sources & conservation technology-N.K.Bansal.
[7] Shradha Chandrakant Deshmukh, Varsha Arjun Patil," Energy Conservation and Audit", 8 August 2013 Financial and economic aspects of energy saving within the framework of the csrc approach" workshop: "transnational energy saving networks"14 December 2005 vilnius, Lithuania.
[8] Fifth of Global Energy Could Come from Biomass Without Damaging Food Production, Report Suggests, 31 January 2012WBDG Sustainable committee, "Optimize Energy Use",27 October 2015.
[9] Vikas Negi, "Conservation Energy"3 August, 2013.