STEPS TOWARDS: ENERGY EFFICIENT BUILDING

Garg, Prashant
Lecturer, Civil Engg Department
G.N.E.College, Ludhiana

Daljeet Singh Sidhu
AE ;PWD, B&R, Ludhiana.

INTRODUCTION:

Energy production and consumption is in fact, the basis for growth of civilization and global industrial revolutions witnessed extensive use of energy and gradually the pattern of energy consumption of energy started shifting towards massive dependence on electricity. This led to disproportionate emphasis on the supply side of management of energy. In the last decade, the issue of energy conservation has been receiving greater and greater attention. All aspects of energy conservation are been dissected with a view of finding out the possible area of reductions, conservation and saving, so that without affecting the quality and level of services. Most of Countries have sets out norms for Consumptions for different type of usages.

India has given high priority to the energy sector. Allocation of public funds has risen from 15% to 27% in the last three decades. Despite of best efforts, there exists a wide gap between supply and demand affecting the development process of our economy adversely. The rapid growth of population and economic development have put severe stress on the natural resources, infrastructure and environment of the country. For the projected growth rate of 8% GDP(Gross Domestic Product), the energy demand is expected to grow by about 5% while the power supply demand may grow more than 10% annually.

Energy Conservation Act of 2001 has provided a framework for promoting energy efficiency (EE) in the country. Bureau of Energy Efficiency (BEE) has been set up to facilitate implementation of the provision of the Act. . Bureau of Energy Efficiency (BEE) is in the process of preparing a draft for ECBC (Energy Conservation Building Code) which will be mandatory for all new and old buildings having buildup area more than 1000 sq. m. Or all commercial buildings having a load of 500KWh. As per the Code INDIA is divided into five climatic zones and depending upon the zones, norms are prescribed to use energy efficient building materials, intelligent Gadgets, Domestic appliances. Ludhiana, Delhi fall into Composite climate zone i.e. cold in winter and hot in summer.

NEED FOR CONSERVATION.

The over all energy consumption in India has come down from 3.5% to 1% of GDP since the starting of planning year. In the developed countries, this figure stands between 0.35% to 0.5% of their GDP. It implies that there is enough scope of energy saving through implementation of energy efficiency methods. Cost of generation of power and addition in power generation capacity are quite high. It has been estimated that a single unit of energy saved at the end use point is equal to 2.3 unit of energy produced. If energy efficiency methods are properly implemented, about 25000 Megawatt equivalent capacity of power can be crated through promotion of energy efficiency measures.

POWER SCENARIO

The present power scenario of the country shows a total energy shortage of roughly 8% of the total demand and the peak shortage is about 13% of the peak demand. The peak shortage normally occurs at a time when the residential and commercial sector consumes the maximum power.

NEED FOR ENERGY SAVING IN BUILDINGS

Construction Industry in India is growing at a stunning 30 %. Boom in Real Estate in our Energy starving country is again imposing high power and energy requirements threats.

The residential and commercial sector consumes more than 25% of the total electrical supply

usage of the country and major portion of this is utilized in the buildings. Hence saving in energy is building is an important strategy to combat the problem of energy crisis in the country.

The present day buildings that are designed and used, symbolize un-restrained consumption of energy, be it a five start hotel, commercial establishment, Govt buildings or a residence complex. Thus there is need to design and develop the new buildings on sound concepts of sustainable efficient use of energy and also apply suitable retrofit options to existing buildings that could substantially improve the energy efficiency

ENERGY USE PATTERN IN BUILDING

In - Lighting	-	60%
In Air Conditioning	-	32%
In Other Application	-	8%

In Conventional Indian Building, energy Consumption is 200 kwh per sq. meter and this energy consumptions can be reduced to 120kwh per sq, meter and a saving of about 40% may be achieved.

ENERGY SAVING THROUGH BUILDING DESIGN

An integrated approach to building design involves judicious use and application of

- Bio climatic & solar passive architectural principles.
- Use Energy efficient materials and constructions practices.
- Use of energy efficient systems & equipments.
- Efficient waste and water management practices
- Use of renewable sources of energy to the extent economically feasible.

ORIENTATION OF BUILDING

The first task of the building designer is orientation of the building. The placement of the building in north-south direction, reduces the heat energy input in the building, increases overall ventilation and provide thermal comfort to the building and also make available light energy from the north.

WINDOWS POSITIONING

Use of building walls with transparent glass provides entry of sun light for use. However, glass cannot be made as a universal arrangement since buildings need structural stability and safety. Positioning and sizing of windows in north wall is primarily important with special reference to the type of shades that are provided to control entry of light input inside the building. Proper sizing of windows on the north wall with positioning of dark colored solar chimneys on the south facing of a building create draft for exit of hot air in turn drawing a cool air from the open windows on north ensuring adequate air flow at body level to provide thermal comfort. Thus, designers of today should give greater importance for designing the windows.

THERMAL INSULATION OF ROOF

Use of over-deck roof insulation using expanded polystyrene slabs/spray applied polyurethane foam topped by reflective broken china mosaic flooring or similar such appropriate building materials and finish, shall result in reduction of cooling/heating load in a composite climate by about 40%.

ROOF FRESTRUTATION

Use of sky light is another aspect by which the sun light is brought into the area at different locations. The building design is so arranged that entry of light is allowed centrally in the building through roof with diffused universal lighting for all the rooms in all the floors through day light which can be provided through glass windows.

TYPE OF GLASS

The type of glass used should be with adequate thermal insulation without loosing the transparent characteristics so that the heat is not allowed inside the building. The type of glass should be such that it should prevent bad effects of the lighting i.e. the glare do not affect the people inside the building.

VESTIBULES

A vestibule is an elegant architectural feature of a building entrance that can also be a practical and effective energy saver. The double set of doors reduces a major portion of the building load attributed

to the envelope: exfiltration and infiltration. These are, respectively, the passage of conditioned air out of the building and the movement of unconditioned air into the envelope. Busy building entrances can lose much energy, approaching losses from a door open to the exterior all the time.
The double set of vestibule doors greatly reduces the flow of air through an entrance. Automatic operation prevents a clear passage for air flow, since one set of doors is always closed. Also, the volume of air trapped between the portals acts as a buffer to the transfer of heat through the vestibule. When there is no traffic the trapped volume or air is an effective insulator that increases the thermal resistance of the passageway. Otherwise the glass vestibule can be a source of high energy loss.

TYPE OF WALL

Use of cavity wall construction with insulation infill for outer walls will reduce ingress of heat/cold and will maximize thermal comfort of a building.

ROOF AND WALL COLORS

The color of the roof and walls can have an impact on the energy use characteristics of a building. In a region with a long and demanding cooling season it is advantageous to have a light colored, reflective roof that reflects solar energy before it is absorbed into the structure and imposes a load on the air conditioning system. The same applies to the walls, especially those facing south and west. The opposite is true of buildings in colder latitudes, which benefit from darker roofs and north facing walls, to enhance the absorption of sunlight in the heating season.

INTERIOR DESIGN ASPECTS

The advantages of daylighting have already been discussed, as beneficial to the morale and attitude of occupants. Having a nice view can also be a boost to productivity. These are not strictly energy saving options, but intangible benefits of a conservation project that should be tallied on the positive side of a project. Spaces with these features can demand a higher lease fee, so the value is not altogether immaterial. Another often unnoticed feature of a room is the wall color. The reflectances of the floor and walls have a great impact upon the ambient light level in a space - the lighter the color and the more reflective the surface the higher the foot-candle level for a given fixture. This means a room with dark paneling will need up to twice the lumens from the lighting than the same room with light colored walls. The same variance applies to the use of dark carpeting versus light, semi-reflective tile or linoleum floor covering

INCREASE USE OF AVAILABLE DAY LIGHTING

The ideal lighting for any visual activity is natural light. It is best for color rendition, and it is a boost to the attitude and performance of the people within a space. Artificial lighting can only approximate the real thing, and then only a narrow band from the whole spectrum. It is always prudent to make the most of available day lighting, since it is not only the most healthy but also the cheapest light source.
Few offices can get by on day lighting alone. A common compromise is the use of multiple level switching. The perimeter offices of a building with outside exposures can have some lamps in each fluorescent ceiling fixture on one switch and the balance on another. For three lamp fixtures this permits four levels of lighting (off, one, two and three lamps) that can be used to supplement the available daylight. In large open offices, exterior hallways or classrooms with perimeter day lighting the outermost row of lights can be switched separately, or turned on by a photocell when the daylight is inadequate. The small additional initial installation cost will be compensated many times over by the savings and the occupant's comfort.

INCREASE INSULATION THICKNESS

Older buildings were designed at a time when energy was inexpensive and it was not economical to provide an effective amount of insulation. A good portion of the envelope losses are through the ceiling and the floor of a building if it not slab on grade. These areas are usually accessible and it is easy to increase the amount of insulation. Areas with colder winters and hotter summers should strive for at least R-10 insulation. A practical way to determine the ideal quantity of insulation is to survey local contractors to determine what they install in new buildings.

INSTALL SHADING DEVICES ON SOUTH & WEST FACING WINDOWS

The highest heat gain of buildings in the northern hemisphere is from the south and west exposures. The energy consumption profile is reduced when windows facing these directions are shaded. Internal shading with curtains or blinds is one method, external shades are another. The application of solar film on the windows is also effective. The solar film has the benefit of reducing the radiation component of the glass - thus a big portion of the heat gain - without blocking the light that is itself often an energy saver. A final solution is solar screens for he south and west windows.

UNDERGROUND EARTH TUNNEL

The thermal storage capacity of earth is very high. The daily and annual temperature fluctuations decrease with increasing depth of the earth. At a depth of about 4m below the ground, the temperature remains constant round the year and is equal to the average annual temperature of a place. The average annual temperature of most part of India is around 26 Deg C. Thus we can use the principle of underground earth tunnel in which air forced through underground pipes or tunnel which are at a depth of 4m and then the air circulated in the room. This system can be used to pre-cool the fresh air input to the air handling units in buildings with central air conditioning systems. This system is widely used in Australia and other developed countries where the temperature fluctuations are high. In India this concept is used by TERI in Green Buildings.

PLAN LANDSCAPE SHADING WITH FAST GROWING TREES

The critical exposures of a building in the northern hemisphere are those facing south and west. They receive the most direct sunlight in the summer and account for a majority of the building's heating load. Shading of windows with blinds or awnings will reduce this heat gain somewhat, but trees will do this and more: they can shade the walls and even the roof of small structures. Deciduous trees, in addition, will lose their leaves in the winter to expose the building to the warming sunlight. Landscaping has another benefit. A portion of the heat striking the lower walls of a building arrives indirectly, reflected from rocks, sidewalks and parking lots or re-radiated from these surfaces. Shrubs, grass and ground cover reduce this heat gain by blocking the heat transfer path or dissipating the thermal flow. Shrubs are quite effective if they shed their leaves in the winter or can be trimmed to open the thermal path to the south and west facing building walls.

FIBER TUBE LIGHTING

Lighting pipes, which make use of fiber tube lighting, are new way of achieving the same purpose with greater flexibility. Light pipes will not only bring light into otherwise inaccessible or dimly lit places, but also improve the internal environment without generating excessive heat. Light pipes have been seen to be proficient devices for introducing daylight into the buildings. The most effective light pipes being straight and short.

INNOVATIVE & ADVANCED LIGHT SYSTEMS

More innovative and advanced day lighting systems are also available and are being developed such as the Prismatic Systems i.e. glazing with one side flat glass and the other side faceted in form of a parallel long prism, redirecting the diffused light from near the zenith of sky to the rear/back of the room where no sky light reaches; Electro chromic Glass system, using coating on glass which controls the flow of light or heat; Chromomeric glazing, which uses LCD technology to quickly switch the glass from a transparent state to diffused white state, thus eliminating requirement of conventional shading devices etc., which can be used for designing buildings.

ENERGY EFFICIENT AIR CONDITIONING SYSTEM

Use of natural air cooling systems integrated with conventional HVAC systems incorporating use of energy efficient chillers and other energy efficient equipments such as air handling units, pumps, cooling towers, etc with use of various variable speed drives for chillers, pumps and AHUs make it possible to reduce energy consumption by about 40% over conventionally designed HVAC Systems.

ENERGY EFFICIENT LIGHTING SYSTEM

Use of energy efficient lighting system in a building makes it possible to reduce energy consumption of a building by 30-40% over the buildings having conventional lighting system.

ENERGY EFFICIENT LIGHT SOURCES

Various energy efficient light sources have come in the market during the last two decades.
Fluorescent tube lights is the first major invention in energy efficient light sources. CFL is the further development of fluorescent tube light technology and is primarily best for replacement of GLS lamps.
Sodium vapor lamps and metal halide lamps are energy efficient light sources which are primarily used for public area lighting.
Light Emitting Diodes are in research stage and at present their application is only in small quantities. Sulphur lamps and induction lamps are also under introduction.
Thus variety of energy efficient light sources have come in the market, giving importance for lighting engineers to select proper energy efficient light source for the task concerned.

FLUORESCENT TUBE LIGHTS

A 40-watt fluorescent tube emits 2,150 lumens as compared to 455 lumens by a standard incandescent 40-watt bulb. In addition, fluorescent tubes typically last longer and create much less heat than incandescent lamps. The newer generation in fluorescent tube are T-8 and T-5 tube lights especially with triband phosphor and are highly energy efficient.

COMPACT FLUORESCENT LAMPS

Compact fluorescent lamp (CFL) is energy efficient as most of the electric energy used is converted into light rather than heat. CFL are simply small fluorescent tubes with attached electronic ballast. When compared to standard incandescent bulbs, they consume 80% less electricity and last ten times longer.

LIGHT EMITTING DIODES (LEDS)

LEDs are new entrant to the field of lighting and are causing lighting revolution in areas where lighting intensity required is not very high. These LEDs have about 11 years of life, a real advance in lighting technology. This small light has no element to break, no glass to shatter and is not affected by heat or cold and can be lit up using ordinary batteries or very low voltages. These are at present used in a big way in automobile industry and for traffic lights. Research is going on to improve upon the quality of LED for its use in lighting applications.

ENERGY EFFICIENT CONTROLS

The various type of energy efficient control available are :

- Dimmer switch
- Timer
- Motion detectors or occupancy sensors
- Photo-sensors or photocells
- combination of above

The successful working of these controls depend on the environmental conditions and hence are being used only on selective basis.

QUALITY OF LIGHT AND RETROFIT APPLICATION

The quality of light produced by a compact fluorescent lamp is comparable to that of the incandescent lamp. There is no flicker or hum the annoying characteristics that are generally associated with fluorescent lamps. CFL are available in various wattages starting from 5 W and can conveniently replace incandescent lamps at all wattages. Thus Compact fluorescents lamps can replace the two common types of incandescent lamps - the pear shaped bulbs and the flood lamps.

At present in Office Buildings and residential building, T-12/T-8 lamps are being used very widely. These can be replaced with T-5 lamps of 28 watt at a cost of about Rs. 800/- with retro fitting arrangement which is easily available. The normal life of 28 watt T-5 lamps is 15000 hours and replacement cost of tube is about Rs. 180/- as against the cost of Rs. 32/- for T-12/T-8 lamps whose life is about 5000 hours. With the use of fl. Tubes widely in office buildings, replacement of these fluorescent tubes with T-5 lamps will result in immediate saving of about 40% in energy consumption due to lighting.
Basic `On` and `Off` control with use of PIR sensors can be used in big halls and in individual rooms so that they “switch off and switch on” lights in the

event when nobody is available in the specified room. These sensors work on the principle of the heat of the individuals and accordingly a have reasonably good performance and their life expectancy is around 10 years. The cost of such sensors is Rs. 6000/- each. The use of sensors is expected to produce energy saving of about 15-20%. The pay back period is likely to be longer since they will have to be installed in a fairly large quantity.

Use of "switch on and switch off" control with PIR sensors and microwave sensors with photocell for corridor will result in savings of about 40% on the consumption of corridor lights.

Above energy methods can be adopted both in the existing as well as in the new buildings without much increase in the cost of lighting per sqmt and they will bring savings due to lighting by about 40%.

PEAK LOAD SHIFTING

Some systems accomplish demand limiting by shifting the building load to off peak hours. One way to do this is to run the chillers during the night to chill water that is stored in large tanks on the premises. Then during the peak building load the following day the chillers are turned off and the ready-made chilled water is circulated to the building loop. Other systems make ice in the night and melt it later to chill the loop water. Keep in mind that the peak load that the system is designed to handle typically lasts only a couple of hours. Use of the aforementioned dynamic elements, eg letting the temperature and humidity drift upward in the process, will greatly reduce the daily peak load. Also, since this load is usually at the end of the work day the entire system will be shut down soon and no additional energy will have to be input to make up for the excesses permitted, since the building will equalize with its environment through the night, possibly aided by artificial circulation of outside air.

USE OF RENEWABLE SOURCES OF ENERGY

Solar panels can be used on the roof of buildings for power generation to meet the peak demands of power and also for hot water generation for heating applications. Even though the capital cost for installing the panels is higher the energy available is free of cost. The captive power generation facilities of the buildings must be designed in combined cycle mode wherein the waste heat of the flue gases of the generating units is recovered for the production of chilled water. This heat energy can be utilized either in the form of steam or can be directly fired in the Vapor absorption machines to produce chilled water which in turn can be used for air-conditioning. This not only increases the efficiency of the power plant but also cuts down the overall electrical energy requirement of the facility. This way we can effectively deal with the shortage of energy available in the form of power, heating, ventilation, air-conditioning etc.

IMPLEMENTATION OF ECBC

Bureau Energy Effiecency is in the process to formulate a Energy Conservation building Code for which a draft has been prepared with the consultation of energy experts of India and outside. The code is to be implemented in 2007 in which norms regarding energy saving in new and existing buildings for residential and commercial is given and will be mandatory for all building with electric connection more than 500Kw and residential building having an area more than 1000 sq. meter.

A few states also notified some norms regarding energy efficency in all residential, commercial and agricultural field

After implimenting ECBC and other efforts by State Government, A saving of 20-30% may be expected. But general public, contractors, builders, architects, Civil enginers, technical Colleges has to be involved in this energy saving compain.

OTHER METHODS

Efficient waste and water management practices need to be considered while designing major complexes.

Use of renewable energy forms may be considered after optimizing energy saving opportunities in a building.

CONCLUSION

Use of energy efficient building design with energy efficient systems for lighting and Central Air Conditioning system shall result in a saving of 60-70% of energy consumption of a conventionally designed building. Retrofitting arrangements

suggested for lighting and air conditioning shall result in a saving of about 50% of the present consumption in existing buildings.

REFRENCES:

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