Best Practice Guide

Energy Efficiency in Haryana Hospitals

NEW AND RENEWABLE ENERGY DEPARTMENT, HARYANA

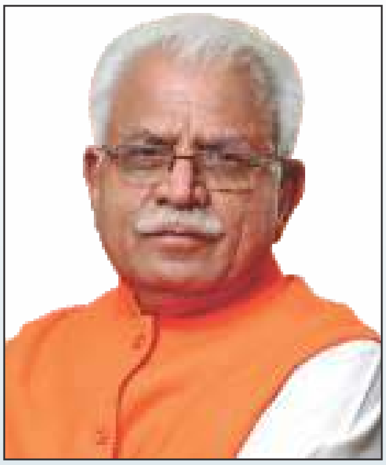
HARYANA RENEWABLE ENERGY DEVELOPMENT AGENCY (HAREDA)


"Renewables make
a Powerful Case as
Hospital Energy Source"

Best Practice Guide

Energy Efficiency in Haryana Hospitals

HAREDA



Shri Manohar Lal

Hon'ble Chief Minister, Haryana

Haryana, the birth place of ancient civilization and culture of India where Vedas and Upanishadas were created, and where the celestial message of holy Gita was delivered, has made rapid strides in several fields.

Haryana has taken several effective initiatives to improve health services, empower women, ensure welfare and upliftment of weaker sections, strengthen and modernize infrastructure, augment power supply, eliminate corruption and establish good governance. The State Govt. is committed to improve the quality of life of people by providing better Health Services in a cost-effective way. In order to provide better health care facilities, enhancement of existing and new healthcare infrastructure is need of the hour.

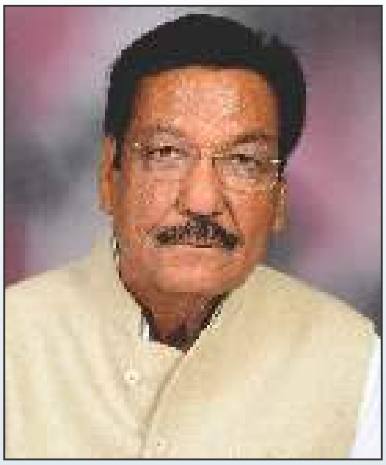
Introducing energy efficiency and green concepts in the healthcare facilities can help to address issues like infection, handling of waste, water efficiency, energy efficiency, reduction in fossil fuel use, consumer waste and in general conservation of natural resources. Most importantly, these concepts can enhance patients' health, recovery and well-being.

The New and Renewable Energy Department has prepared this Best Practice guidebook on Energy Efficiency with a focus on Healthcare sector, which shall be beneficial for energy efficient operation, up-gradation and construction of Hospitals in the State.

I congratulate the Department of New and Renewable Energy, Haryana & HAREDA for preparation of this Guidebook and hope that this endeavor will be instrumental in encouraging efficiency in Haryana healthcare sector and we will be able to provide world class health care facilities to the public.

Manohar Lal

Shri Ranjit Singh
Hon'ble Minister, Power & NRE, Haryana



Buildings are major consumers of energy in their construction, operation and maintenance phase. Energy consuming systems for lighting, air-conditioning and water heating provide comfort to its occupants but consume large quantum of energy. Taking the utilization of consumption into consideration, it is necessary to design a building focusing on energy conservation aspects.

In the past decades, significant attention has been paid to energy analysis and consumption optimization in various industries and buildings. The COVID-19 pandemic has shown the importance of healthcare infrastructure development to maintain health standards of citizens, economic progress, trust in governments, and social cohesion.

The development in healthcare infrastructure is expected to grow several-fold in the next decade. This may continue to challenge and put additional burden on natural energy resources. Fossil fuel are slowly depleting resourced, the world over. On the other hand use of Green resources and adoption of energy efficiency & Green building concepts, will not only potentially reduce Greenhouse Gases emission, but will also be useful for the utilities to manage its future power demand.

The Best Practice guidebook on Energy Efficiency prepared by the New and Renewable Energy Department, Haryana & HAREDA, focuses on Energy Efficiency aspects in Healthcare sector. This guidebook will provide additional guide to the various departments & stakeholders and its officials on various aspects of energy conservation and energy efficiency.

I congratulate the Department of New and Renewable Energy, Haryana/ HAREDA & its officers, for their extensive efforts in bringing this document.

Ranjit Singh

P.K. Das, IAS
Additional Chief Secretary to Govt. Haryana
Power and NRE

Health care is a priority for sustained development interventions both at the individual and community levels. Its accessibility and affordability has to be ensured for good governance. Hospitals worldwide are under mounting pressure to do more with less–to provide superior patient care while controlling costs and eliminating waste. Hospitals and clinics have high energy demands due to 24x7 operations, medical imaging equipment, and special requirements for clean air and disease control. But with escalating energy prices, increasing demand, and the expanding role of power-dependent technologies in the delivery of services, the challenge grows each day.

Energy expenditure is a significant component for healthcare providers after manpower and consumables costs. This clearly signifies the opportunity for hospitals to cut costs and also contribute to reducing India's carbon foot print. There is a pressing need for hospitals, particularly those under construction, to adopt the 'Green Hospital' concept to make maximum use of natural light and renewable/ solar energy, improving indoor air quality, efficient air conditioning & lighting, minimizing the use of paper or recycling paper, recycling kitchen waste, improving water management through efficient plumbing mechanisms,

It is with the idea of analyzing these details in these respects, New and Renewable Energy Department has prepared this guidebook with a focus on Healthcare sector. Cost effective recommendations and best practices have been outlined, demonstrating how management can take action to address their energy inefficiencies and implement energy programs. It has been observed that if energy conservation measures are adopted and coupled with enabling architectural design to harness natural light and ventilation, it should be possible to bring about a reduction of 10-20% in electricity consumption.

P.K. Das

Dr. Hanif Qureshi, IPS
Secretary & Director General, New and Renewable Energy Department, Haryana & HAREDA

The State Governments, large corporate groups and charitable organizations have brought finance and these resources are being invested in developing health infrastructure and modern equipments and technologies leading to the availability of super-specialty hospitals across the Country, especially in big cities. However these developments have led to higher energy-intensiveness in the hospital sector in the State. Many modern hospitals may consume ten to fifteen times more energy per bed as compared to a typical government hospital, and this trend is likely to strain State power sector substantially in the coming years. In fact, many hospitals have been relying heavily on diesel power generation to keep the hospital's critical facilities running in the absence of reliable power supply from the Utilities.

Sample studies in hospital sector have shown number of cost effective energy conservation opportunities, which have remained untapped due to several reasons. The major barriers have been low awareness among the management of the hospitals and limited availability of in-house expertise to identify and implement energy saving projects. Good energy management structure can bring in not only an energy efficient culture within the hospital but also provide substantial reduction in energy expenses without compromising on the quality of health care facilities to the patients. This Energy Efficiency Guide has been prepared to address these issues, and is expected to raise the level of awareness on energy efficiency among the hospital administrators & managers and inspire them to initiate and implement energy conservation program in their facilities.

I am confident this Guide will serve as a valuable reference on energy efficiency for both the existing hospitals as well as the new hospitals which are likely to come up in the next couple of years, and look forward to receiving their valuable comments and suggestions to further enrich the quality of this publication.

Dr. Hanif Qureshi

TABLE OF CONTENT

1. EXECUTIVE SUMMARY

The Department of New and Renewable Energy, Haryana & HAREDA is acting as a State Designated Agency for the implementation of the Energy Conservation Act, 2001 and State Nodal Agency for promotion of Renewable Energy in the State. The Department is also responsible for formulating policies and programmers necessary for popularizing the applications of various non -conventional and renewable sources of energy in the State.

Considering the importance of energy efficiency in Healthcare sector, BEE, GoI in association with UNDP has prepared a Best Practice Guide for Hospitals. Several energy use assessment studies carried out by BEE and other agencies in hospitals indicate high potential for energy savings; nearly 20-30% of existing cost. The Department of New and Renewable Energy, Haryana & HAREDA is replicating various energy saving measures in buildings sector including Hospital buildings and Haryana specific best practice guidebook on Energy Efficiency in Hospitals has been prepared for reference of Engineers, Energy Professionals, Architects and officials working in Healthcare sector.

Scope of Application

This Guide mainly focuses on hospitals and improvements that can be made through the adaptation and implementation of energy efficiency measures. The technical contents represent the best practices and available technologies for energy efficiency and hence can also be applied to new hospitals that are under planning and construction. This Chapter 1 is executive summary of the book. Chapter 2 gives brief outlook on Haryana health care system, while chapter 3 gives basic information about energy conservation and energy efficiency. Energy Conservation Building Code (ECBC) was developed by the Govt. of India for new commercial buildings on May 27, 2007 and was later updated in the year 2017. ECBC sets minimum energy standards for commercial buildings having a connected load of 100kW or contract


HAREDA

demand of 120 KVA and above. In chapter 4, applicability of ECBC and its features has been outlined.

In hospitals, energy brought in, is converted by a number of conversion systems into several internal energy streams to meet heating, cooling and other medical equipment requirements. The energy is being used in hospitals in form of electricity, heat stream, cold stream, compressed air etc. Chapter 5 describes the typical use of energy in Hospitals, its form and type of equipment and services that consumes energy in the hospitals.

Energy benchmarking usually undertaken for comparing the energy use in commercial facilities with a view to compare the energy performance of a building with an established standard or norm. Chapter 6 describes the various benchmarking indicators and their advantages, Sample EPI of Govt. and Pvt. Hospitals. Further, Hospital specific data format has been developed for the purpose of benchmarking.

Hospital Buildings consume energy at different levels in every stage of life cycle. In this respect, we need to know the life cycle of building. Chapter 7 describes the phases of the buildings lifecycle such as the pre-construction, construction phase, post construction phase and end of building life cycle phase and energy efficiency or energy conservation measures that can be implemented in each lifecycle.

In chapter 8, initiatives taken by department/HAREDA for implementation of energy saving measures in existing civil hospitals has been described. The State Govt. has adopted ECBC code published by BEE, GoI for buildings have connected load of 100 kW or above or a contract demand of 120 KVA or above. Further, to assist stakeholder departments for effective implementation of ECBC in the State, ECBC cell has been established at HAREDA with support from BEE, GoI. HAREDA has received building plans of various hospitals for evaluating these hospitals for ECBC compliance. The buildings plans of these hospitals were evaluated by ECBC cell and recommendations have been sent to concerned departments. In case concerned department implements these recommendations, the constructed hospital will definitively comply with the ECBC. In Chapter 9, snapshots of recommendation for energy efficiency / building plan evaluation details in upcoming Govt. hospitals has been discussed. Further, common energy saving measures that can be adopted are included in Chapter 10.

In the development of the Guide, care has been exercised for making it user friendly for the hospital administrators and engineering staff. Good energy management structure can bring in not only an energy efficient culture within the hospital but also provide substantial reduction in energy expenses without compromising on the quality of health care facilities to the patients.

Healthcare System in Haryana at a Glance

Private Hospitals	1,480
Govt. Hospitals / Health Centers	3,399
Civil Hospitals (CH)	70
Community Health Centres (CHC)	118
Sub Centers	2659
Primary Health Centres (PHC)	526
Dispensaries	4
Urban Health Centres	11
Polyclinics	11

2. INTRODUCTION

The health of a nation is an essential component of development and vital to the nation's economic growth. Assuring the required level of health care to the population is a critical constituent of the development process. Since Independence, India has built up a vast health infrastructure and health personnel at primary, secondary and tertiary care in public, voluntary, and private sectors. For producing skilled human resources, a number of medical and paramedical institutions have been set up.

Considerable achievements have been made over the last six decades to improve health standards, including life expectancy, child mortality, infant mortality, and maternal mortality. The Govt. of Haryana is committed to provide quality health care to its all citizens. The State Govt. is continually upgrading health care facilities of the State in terms of infrastructure, human resources, equipment and drugs etc.

During the last few years there has been a great increase in the availability of health care facilities in the State. The number of government hospitals/health centres increased from 840 in 1970 to 3,399 in 2019-20, that is, an increase of 404%. However, these developments have led to higher energy-intensiveness in the hospital sector. Many modern hospitals may consume ten to fifteen times more energy per bed as compared to a typical government hospital, and this trend is likely to strain State power sector substantially in the coming years. There is a pressing need for hospitals, particularly those under construction, to adopt the 'Energy Efficient Hospital' concept to make maximum use of natural light and solar energy. This best practice guidebook will deliberate on the energy efficiency opportunities, benefits & savings associated with the hospitals.

Adopting energy conservation and energy efficient practices will help hospitals not only in reducing their energy bills but will also contribute to reduction in greenhouse gases which are produced as a result of burning of fossil fuels used in producing electricity. In this book, we have made an attempt to identify the avenues where energy efficiency can be achieved. These range from the time of planning the construction of hospital building to the stage where the hospital is fully functional.

Saving energy is producing energy. The growing sector of healthcare facilities is likely to be a major consumer of energy. The savings made here will have a significant impact in reducing energy intensity and consequently achieving the targets India has promised to the international community for climate change.

ENERGY
Efficiency & Conservation

Reduce consumption or stop wastage to save energy

By stopping wastage and using appliances properly

Save Energy

Same output for lesser energy

By buying energy efficient appliances

Save Money

Efficiency
by buying efficient appliances

Conservation
By stopping wastage and using appliances properly

3.
WHAT IS ENERGY CONSERVATION & ENERGY EFFICIENCY?

Energy Conservation and Energy Efficiency are separate, but related concepts.

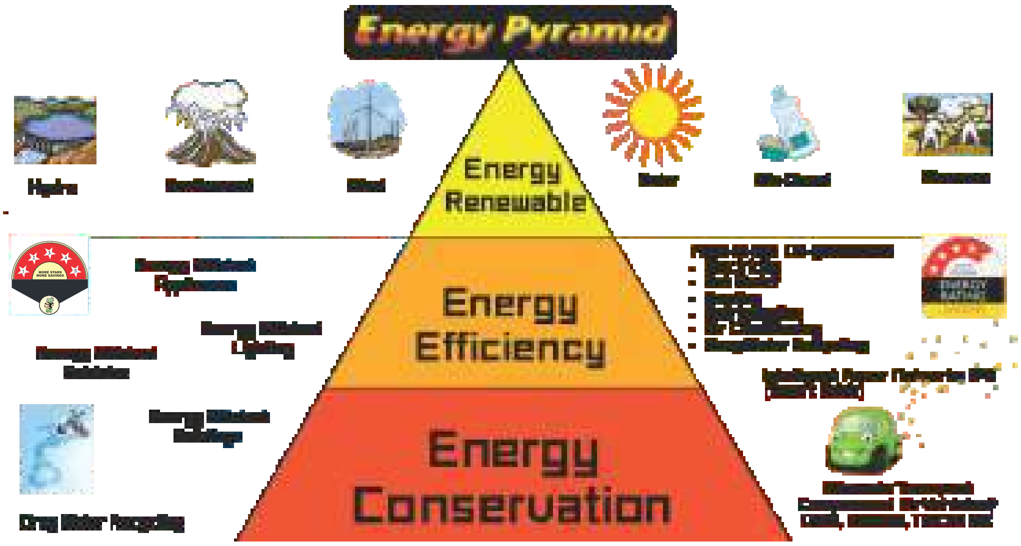
Energy Conservation

- Achieved when growth of energy consumption is reduced, measured in physical terms
- Behavior change that results in not using energy at a time when one might normally
- For example, riding a bike instead of driving a car, unplugging computers and other electronics at night or when not in use, or turning off the lights when you leave a room.

Energy Efficiency

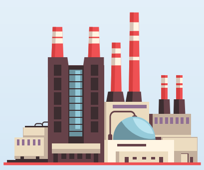
- An improvement in technology that makes an existing use of energy more efficient, i.e. allows us to do more with less.
- Examples of energy efficiency include replacing incandescent light bulbs with LEDs, adding extra insulation to a house, or using Star rated appliances that have power-saving measures installed.

Energy conservation is achieved when growth of energy consumption is reduced, measured in physical terms. Energy Conservation can, therefore, is 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



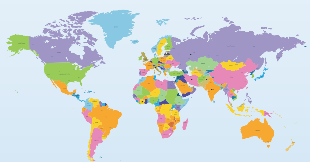
ENERGY EFFICIENCY BENEFITS

INDUSTRY



- Reduced energy bills
- Increased competitiveness
- Increased productivity
- Improved quality
- Increased profits

COUNTRIES

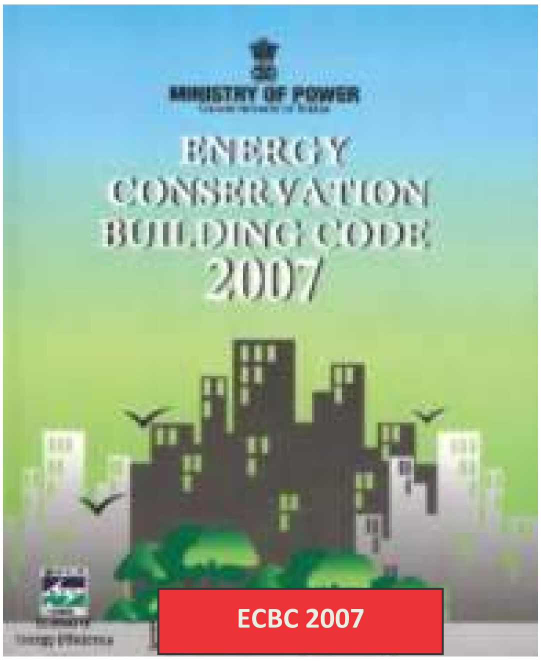


- Reduced energy imports
- Avoided costs can be used for poverty reduction
- Conservation of limited resources
- Improved energy security

WORLD

- Reduced GHG and other emissions
- Maintains a sustainable environment

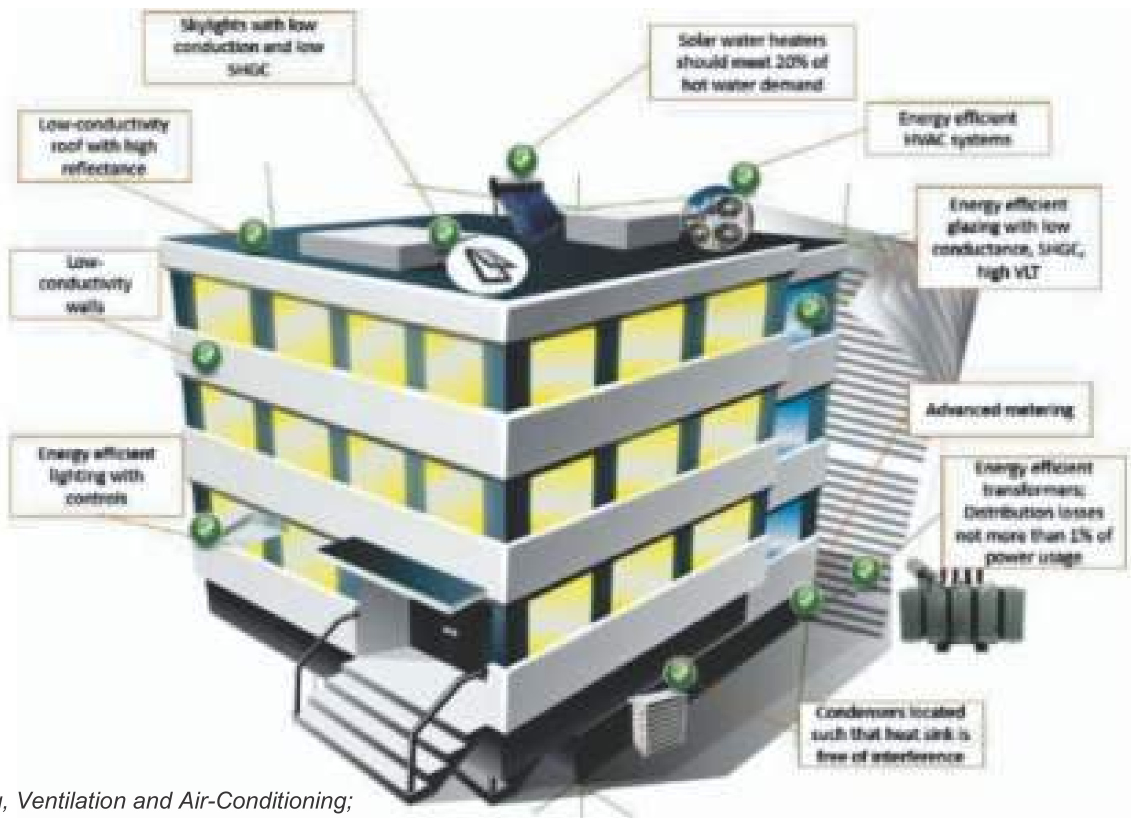
Energy
Conservation Act 2001



Energy Conservation Building Code (ECBC)

ABOUT ECBC 2017

Applicable Building Systems



HVAC *–Heating, Ventilation and Air-Conditioning;*
SHGC *–Solar Heat Gain Coefficient;*
VLT *–Visible Light Transmittance*

4.
ENERGY CONSERVATION BUILDING CODES

Energy Conservation Building Code (ECBC) was developed by the Govt. of India for new commercial buildings on May 27, 2007 and was later updated in the year 2017. ECBC sets minimum energy standards for commercial buildings having a connected load of 100kW or contract demand of 120 KVA and above.

- ECBC encourages energy efficient design or retrofit of buildings so without affecting the building function, comfort, health, or the productivity of the occupants. It has appropriate regard for economic considerations.
- Addresses local design conditions and helps improve existing construction practices.
- Emphasis on Integrated Building Design approach.

Applicable Building Systems

- Building Envelope
- Mechanical systems and equipment, including HVAC, service hot water heating
- Interior and exterior lighting
- Electrical power and motors and Renewable Energy Systems

Exemptions

- Buildings that do not use either electricity or fossil fuels
- Equipment and portions of building systems that use energy primarily for manufacturing processes
- Safety, health and environmental codes take precedence

- ECBC 2017 provides climate zone data for major Indian cities.
- The better the insulation of the wall, the higher the energy savings
- Adequate day lighting can result in 20-30% of energy savings;
- Specific norms for Hospitals
- Compliance approaches
  - Mandatory Requirements
  - Prescriptive Method
  - Whole Building Performance Method


OUTPATIENT

5.
ENERGY USAGE IN HOSPITALS

Hospitals consist of large buildings, and careful control of their internal climate is considered necessary. Substantial amount of heat is normally generated internally by the occupants and operating equipment. An effective cooling (and heating depending upon the external weather conditions.) and ventilation systems combined with good insulation of hospital building, usually reduce hospital's sensitivity to the outside weather. Hospitals also require stand by electricity generators to ensure a continuous supply of power in emergencies and critical operations.

The typical hospital building is designed for long-term use and, in practice, is often used for longer periods than its builders ever intended. During this period, the building is retrofitted and renovated many times. Reasons for this include the shorter life of technical equipment, the development of new types of equipment and healthcare facilities, new regulations, new energy-saving technologies and the ageing of the building itself.

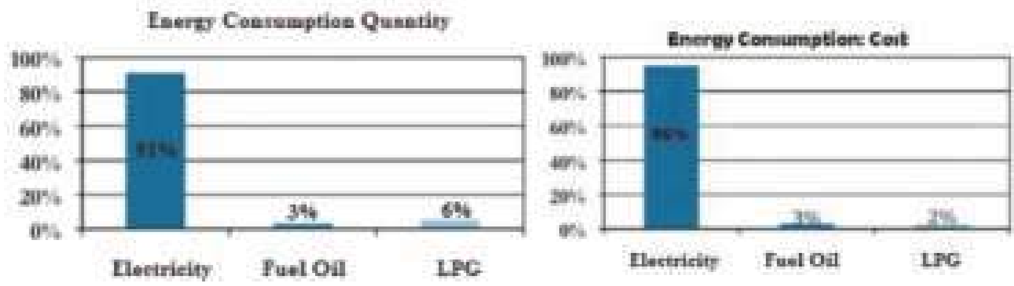
When considering energy-efficiency in hospitals, it is important to keep in mind that it is not the end-use of energy alone, but also the need to control the indoor climate, that is one of the principal requirements. The indoor climatic requirements are determined by the hospital activities in the building. Once these are established, it is necessary to provide the required climate, ideally in the most economical way. In practice, energy efficiency is increasingly becoming important requirement, but medical considerations remain the top priority in the hospitals.

It is generally true that newer hospitals consume more energy than older hospitals. This is mostly due to the more sophisticated type and extent of the services provided by more modern hospitals, as a result of which their buildings may at times offer greater scope for energy and cost savings. Energy efficiency and availability of newer technologies can assist in developing efficient hospital design.

The hospitals, as large consumers of energy, have high bills for electricity and fuels, although they may represent a small proportion of the hospital's total operating cost.

Hospitals purchase energy from outside in the form of fuels and electricity. Furnace oil /LPG/LDO/Gas is used for steam and hot water generation and other thermal applications such as catering and laundry facilities. In most of the hospitals, fuel oil (mainly high speed diesel) is mainly used for standby power generation sets, which are used for considerable period due to inadequate power supply from the Utilities in many states of India. Figure below provides the tentative energy consumption and cost breakup in a typical hospital.

The electricity consumption depends upon the extent and complexity of equipment and services provided in the hospitals. New hospitals often have proportionately more air conditioning, with its associated chiller plant, and more extensive ventilation systems to maintain health care facilities and standards.



Tentative Energy Consumption in Hospitals

In hospitals, energy brought in, is converted by a number of conversion systems into several internal energy streams to meet heating, cooling and other medical equipment requirements, and there are energy saving opportunities in all the energy streams categorized as under:

- Electricity is used for a wide variety of purposes. Major electricity consumers in a hospital are cooling/heating equipment, lighting, air compressors, water pumps, fans and ventilation. Other applications include laundry equipment; kitchen and canteen equipment; ovens and geysers and medical equipment including autoclaves, office facilities such as computers and photocopiers, utilities such as lifts, refrigerators, water coolers, etc.

- Heat Stream is used in the form of steam and hot water. Steam is used in the kitchens and for humidification in HVAC and sterilization process. In addition steam is used to transport heat over longer distances. In many cases heat is transported from the heat generating station in the form of steam and then converted locally into central heating or hot water. Oil/Gas-fired boilers are used to generate steam and hot water.

- Compressed air can be divided into two main categories, namely medical air and technical air. Medical compressed air refers to the direct treatment and care of patients. Examples include breathing apparatus and surgical tools driven by the compressed air. The medical compressed air is subjected to very high standards for availability and quality. The technical compressed air is used for HVAC control systems, workshop applications or keeping containers under pressure.

- Cold Stream mainly takes the form of chilled water and is used for in-door climate control systems, for cooling and drying the ventilation air. In many cases cold stream is generated centrally by means of compression coolers. In combination with cogeneration, absorption-cooling machines are used to supplement compression coolers.

Major Electricity End-Users in Hospitals

HVAC System

In many large and centrally air-conditioned hospitals, HVAC systems may consume 40% of total electricity consumption. Air Conditioning and Ventilation system in hospitals is required for:

- Maintaining the requisite indoor temperature, air distribution and humidity levels for thermal comfort.
- Maintaining indoor air quality, particularly in areas requiring prevention of infection
- Building envelope design plays a very important role in the determination of HVAC capacity in the hospital.

Lighting

Lighting is a major electricity consumer next only to HVAC systems. Requirement of lights in a hospital varies widely depending upon the activity, time of day and the occupancy level. The complexity can be well understood from the simple fact that National Building Code (NBC)2005 recommends illuminance level varying from one lux for night lighting in some areas to 750 lux in operation theaters for general requirements. At times special lights are used with illuminance of 10,000-50,000 lux in operation theaters.

Water Pumps

Water is consumed in different sections of the hospitals for various requirements. In most hospitals, water pumping systems may account for 5-15% of total electricity consumption and offer scope for reducing energy consumption.

6. ENERGY BASELINE AND BENCHMARKING IN HOSPITALS

Energy benchmarking usually undertaken for comparing the energy use in commercial facilities in a few countries with a view to compare the energy performance of a building with an established standard or norm. In fact, it can be used as a first step towards implementing an energy management program in the hospital.

Benchmarking Indicators

Two indicators most commonly used internationally for bench marking in hospitals are (Leonardo Energy, 2008):

a) Annual energy consumption per square meter of the hospital's building area

b) Annual energy consumption per inpatient bed in the hospital

Both indicators have their own particular disadvantages:

- When taking the built-up area into consideration, the hospital management need to decide which areas of the hospital building are included in the benchmark or not (e.g. outdoor gardening, car parks, roads, corridors and equipment floors). Secondly how much of the hospital's built-up or the carpet area is air conditioned or non-conditioned in real situation.

- When taking beds into consideration, hospitals built-up or carpet area per bed is the critical factor. This factor is determined by the type of hospital and by the design criteria of its construction. One needs to take into account, the trend towards higher quality of health care and greater privacy for patients, which may lead to a lower number of beds per room and thus a greater number of square meters per bed. Secondly, many hospitals have combined metering of energy consumption of out-patient department and in-patient department. Therefore for an effective benchmarking, independent sub-metering of the two may be essential.

Another method of benchmarking is the one normally used in process industries, namely benchmarking on the basis of "production" by the hospital. The parameters used for "production" in hospitals could be the number of patient overnights or the number of bed-days actually used annually. From this, one can determine the energy consumption per overnight.

However, this depends to a large degree on the type of hospital, and on trends in healthcare facilities. For instance, the number of overnights per treatment has fallen sharply in recent years, because the number of treatments has risen considerably for the same number of beds. There is also a possibility that with increasing load of inpatients and scarcity of room space in the hospitals, lesser area per patient is provided. Climate conditions also greatly affect energy consumption in hospitals, and thus climate based benchmarks could be more meaningful or alternatively they need to be normalized sufficiently for an effective comparison.

Benchmarking Approaches

In practice, two following approaches for benchmarking are adopted.

- **Internal Benchmarking**; where energy performance of a building is compared against it own previous performance over a period of time. This approach is typically used to compare performance before and after retrofit measures have been implemented for energy savings.
- **External Benchmarking**; involves comparison of energy performance of similar buildings against an established standard or baseline. This is typically used to set performance targets for the future.

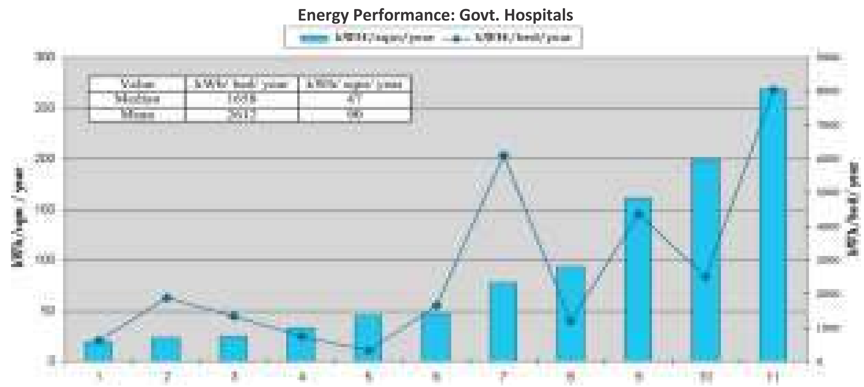
The Bench marking offers following advantages:

- It assists in initiating an in-house energy saving program or a macro level energy efficiency program.
- It determines how a building's energy use compares with others; this immediately helps the management in identifying savings potential.
- It facilitates the management to set targets for improved performance and monitoring them on a continuing basis.
- It facilitates the building owners gaining recognition for exemplary achievement in energy performance
- It assists the Service Providers to communicate energy performance of buildings in terms of "typical" vs. "best practice" benchmark
- It helps utility companies to compile energy data from various buildings and track energy use and its growth trends.

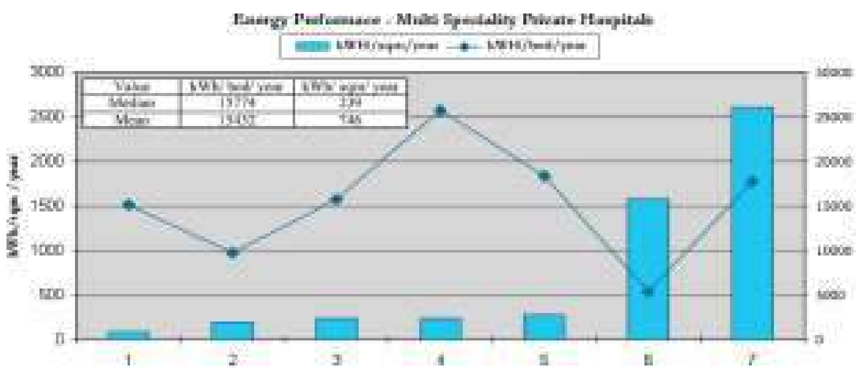
Looking at the advantages and disadvantages into consideration, it is useful for the hospital management to analyze the above-mentioned indicators for establishing the energy benchmarks in the hospitals.

BEE, GOI carried out survey in six hospitals Energy use benchmarks represented as kWh/bed/year varies significantly from 749 to 1833.

Sample EPI of Govt. and Pvt. Hospitals



Sample EPI / Energy consumption performance of 11 nos. Government Hospitals



Sample EPI / Energy consumption performance of Multi-Specialty Private Hospitals

Source: BEE, GoI and UNDP Guidebook for Hospitals

Hospital Building Information and Energy Data Collection format for the purpose of benchmarking: The Department / HAREDA has prepared a format which will help hospital to analyze the performance of their buildings. The format may be referred in annexure A.

Portion of Total Carpet Area (e.g. auditorium, seminar halls, large conference rooms, etc.) which is not used actively on daily/regular basis, and normally AC systems and lights are kept switched off.

7. ENERGY EFFICIENCY OPPORTUNITIES IN HOSPITALS

- Hospital Buildings consume energy at different levels in every stage of life cycle.
- Construction has a major impact on the environment in its consumption of energy.
- A large part of the energy (35–60%) is used for heating, air-conditioning, ventilation, and artificial lighting at this stage.

Hospital Buildings consume energy at different levels in every stage of life cycle. Contemporary human civilization depends on buildings and what they contain for its continued existence, and yet our planet cannot support the current level of resource consumption associated with them.

Construction also has a major impact on the environment in its consumption of energy. For example, building materials occupy a great share of this consumption. The large bulk of materials used consume a great deal of energy for transport.

There is a growing concern about energy consumption in buildings and its possible adverse impacts on the environment. These are issues that the building professions in the whole world have to address.

In an operating phase, a Hospital building with at least a 50-year lifespan, energy used for production of materials, transportation, and construction, "at least five times" as is required in the amount of energy use and operating phases. A large part of the energy

Traditional buildings were designed climatic responsive architecture and passive heating/cooling techniques

Modern buildings emphasize more on western modern architecture and are more energy intensive.

(35–60%) is used for heating, air-conditioning, ventilation, and artificial lighting at this stage.

There are very different applications targeting the decrease of energy consumption of hospital buildings. Considering energy consumption in each phase of structuring is achieved with the analysis of building life cycle. In this respect, we need to know the life cycle of building. Building life cycle is divided into four main phases such as the pre-construction, construction phase, post construction phase and end of building life cycle phase.

Hospital building life cycle main phases

Construction Phase

Post construction phase (operational phase)

Pre-construction

End of building Life Cycle

Energy-efficient Pre-construction Phase

The preconstruction phase includes the choice of the space where construction is to be built, the design of the building, the choice of building materials, obtaining raw materials for building material, manufacturing, and transporting them.

Pre-construction / Pre-building phase

- Appropriate site selection
- Site planning
- Building form
- Building plan and appropriate space organization
- Building envelope design choosing energy-efficient building materials
- Energy-efficient landscape design
- Obtaining raw materials for building material

Appropriate Site Selection

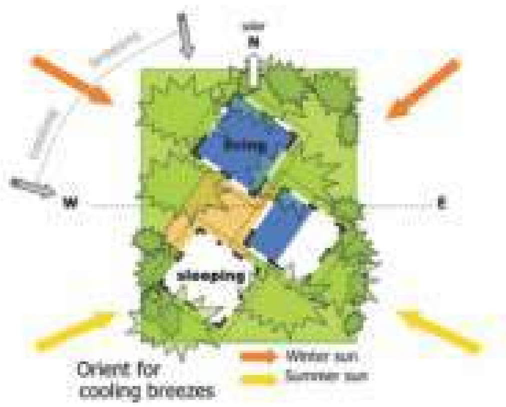
Location of the building determines the microclimate conditions which has very important role in building energy efficiency, as it is important for learning, climatic values such as sun radiation, air temperature, air circulation, and humidity, which effect energy costs. In order to provide adequate protection from the prevailing wind and sun, the orientation of buildings on the land needs to be appropriate to the climatic conditions of the region. In cold regions, lower overnight temperatures cause colder, denser air to accumulate in hollows and valleys. Therefore, in cold regions it is advisable to position buildings on hillsides rather than in valleys.

It is well known that a south slope is warmer and has the longest growing season in the northern hemisphere. When a choice of site is available, a south slope is still the best for most building types. In the winter, the south slope is the warmest land due to two reasons: the south slope receives the most solar energy on each square foot of land because it most directly faces the winter sun. The south slope will also experience the least shading because objects cast their shortest shadows on south slopes.

The south slope gets the most sun and is the warmest in the winter while the west slope is the hottest in the summer. The north slope is the shadiest and coldest, while the hilltop is the windiest location. Low areas tend to be cooler than slopes.

As we go above the sea level, we get an increase in solar radiation values. The reason for this increase is dealt with atmospheric conditions, clarity of the atmosphere and shortening of the distance taken. In return, for the increase in solar radiation values, as we go above the sea level, we get a decline in the air temperature. With the increase of altitude, gale force also increases, which leads to the increase of heat loss in the building

Site Planning



In the design of buildings, distance between buildings is an important designing parameter that affects utilization of solar energy, wind direction, and speed concerning artificial environment. In the design process, building should be handled as a whole with its environment. The distances between buildings highly affect the energy performance in the usage phase of building. The fact that a building remains within the shading space of other buildings influences the utilization of solar rays and will raise the consumption of energy. In order to utilize solar radiation, building spaces must not be less than the tallest shade height of other buildings. Besides, the position and distance of other buildings affect the speed and direction of wind on building, and this impacts the energy performance of building.

Orientation of building affects the ratio of the solar radiation gain of building sides, consequently the total solar radiation gain of building. In addition, the side of buildings affects wind amount, consequently, affecting natural ventilation possibility and heat loss amount by convection and air lack. For this reason, according to the necessities of that region, buildings must be oriented for avoid of or benefit from the sun and wind according to the conditions.

Choosing the best orientation

Local climate research should study:

- temperature ranges, both seasonal and diurnal (day–night)
- humidity ranges
- direction of cooling breezes, hot winds, cold winds, wet winds
- seasonal characteristics, including extremes
- impact of local geographic features on climatic conditions (see Choosing a site)
- impact of adjacent buildings and existing landscape.

Energy-efficient Construction Phase

The building phase includes the construction and usage processes of the building.

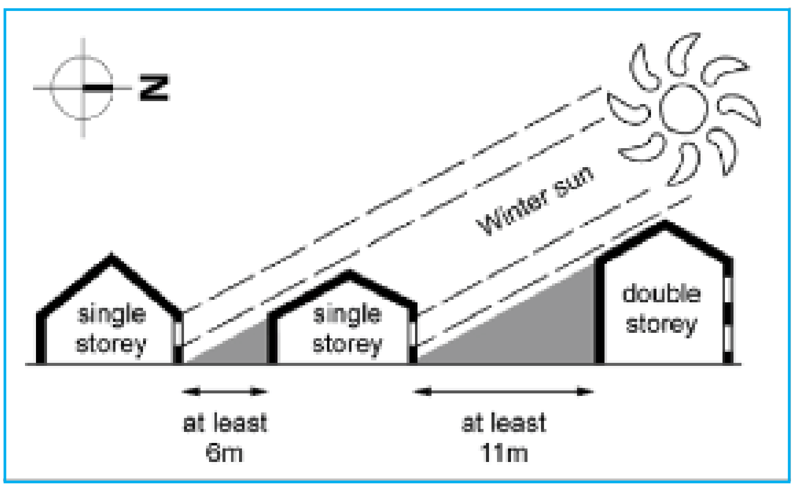
Building Form / Shapes

The shape of building which is a considerable factor affecting heat loss and gain can be defined through geometrical variables making up building such as the proportion of building length to building depth of the building in the plan, building height, type of roof & its gradient and front gradient. Heat loss-gain of building may rise and decline depending upon the proportion of the surfaces constituting environment to volume.

In cold climate regions, compact forms should be used which minimize the heat loss part. In hot-dry climate regions, compact forms and courtyards should be used which minimize heat gain and helps to provide shaded and cool living spaces. In hot-humid climate region, long and thin forms whose long side oriented to the direction of prevailing wind makes possible maximum cross-ventilation. In mild climates, compact forms, which are flexible more than the forms used in cold climate regions, should be used.

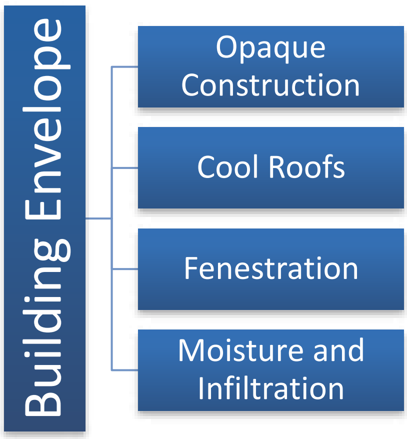
Building Plan and Appropriate Space Organization

Building plan and shapes should be effective in energy conservation. Therefore, buildings should be formed to ensure minimum heat gain in warm seasons and maximum in cold. Due to simple plan types such as square or rectangle having a reduced surface area, their heat-loss and -gain are also reduced. Smaller buildings, where internal space has been used efficiently, use less energy as they can be heated, cooled, and illuminated more efficiently than larger buildings. In the building design, stratification can perform zoning depending on buffer zone, sanitary spaces, noise level, lighting level, and heating need. Therefore, areas with many users and which are used throughout the day should face southerly direction.



Building envelope

Building envelope is the components such as wall, ceiling, ground, window, and door which separate building (conditioned space) from outdoor and let heat energy transfer into inside or outside. As an indoor and outdoor reagent, it has a vital impact



Design Considerations

Building Envelope Component Design

- Area, orientation and tilt of the building envelope components
- Roof form design, choice of shading devices, fenestration size, placement of windows, construction specifications etc.

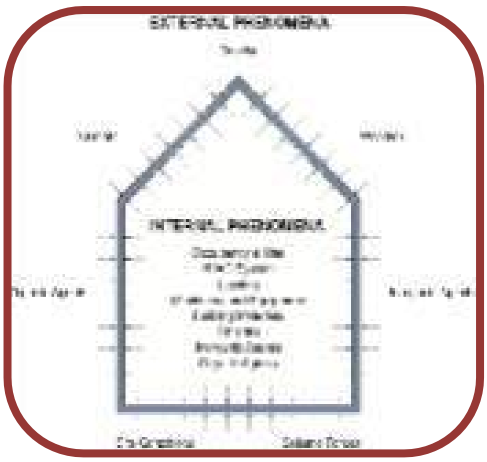
Building Material Specification

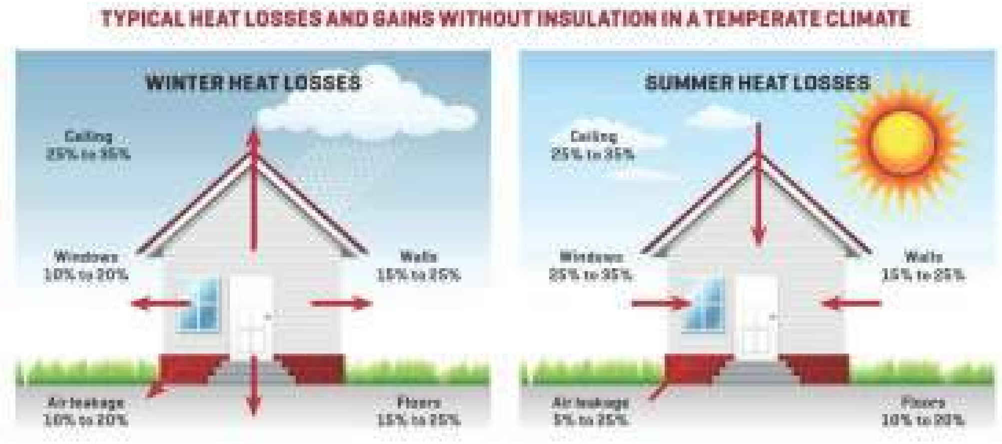
- Insulating Properties (U–values, SHGC), emissivity & colour / texture

on energy consumption. While the cost of constructing a building envelope makes up 15–40 of the total constructional cost, its contribution to life cycle costs especially to energy cost is around 60%. The skin of building performs the role of a filter between indoor and outdoor conditions, to control the intake of air, heat, cold, and light. Building envelope should minimize the heat loss in the winter and the heat gain in the summer.

Outer Walls

Thermal and massive characteristics of outer walls are related to building material constituting them and the characteristics of building element layers and how they are sorted. The walls that will minimize heat loss and gain are well-isolated massive walls with high heat-storing capacity. The formation of outer surfaces that can get most solar radiation or be protected from radiation in terms of heat gain should be handled depending upon the characteristic of climatic zones. External phenomena and building insulation plays vital role in energy consumption of the building. To keep sunlight as much as possible in winter, wall-to-window ratio is desired not to exceed 15% with the use of dark and high-density materials in the parts exposed to the sun.





Source: SEAV 2002
Source: http://www.yourhome.gov.au/passive-design/insulation

Benefits of Building Insulation

- Reduces energy costs
- Prevents moisture condensation
- Better thermal comfort
- Reduces capacity and size of new mechanical equipment
- Enhances process performance
- Better R-Value
- Reduces emissions of pollutants
- Safety and protection of personnel
- Acoustical performance: Reduces noise levels
- Maximizes Return on Investment (ROI)
- Improves Appearance
- Fire Protection

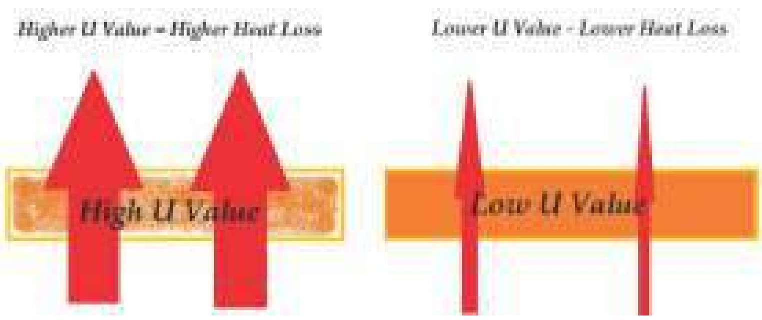
R-Value or Thermal Resistance

- Resistance to conductive heat flow
- Reciprocal of Thermal Conductance (U)
- Higher the R-Value the better the performance of insulation

$$R = \frac{\text{Thickness of the material(d) m}}{\text{Thermal conductivity of the material(k) W/mK}}$$

Thermal Conductance – U Value

- Conductance to heat flow
- Reciprocal of Thermal Resistance (R)
- Lower the U-Value the better the performance of insulation
- Measures heat transfer through the envelope due to a temperature difference between the indoors and outdoors (Unit = W/m2·K)



Heat Gains/ Loss from Building Envelope (roof, walls and windows)

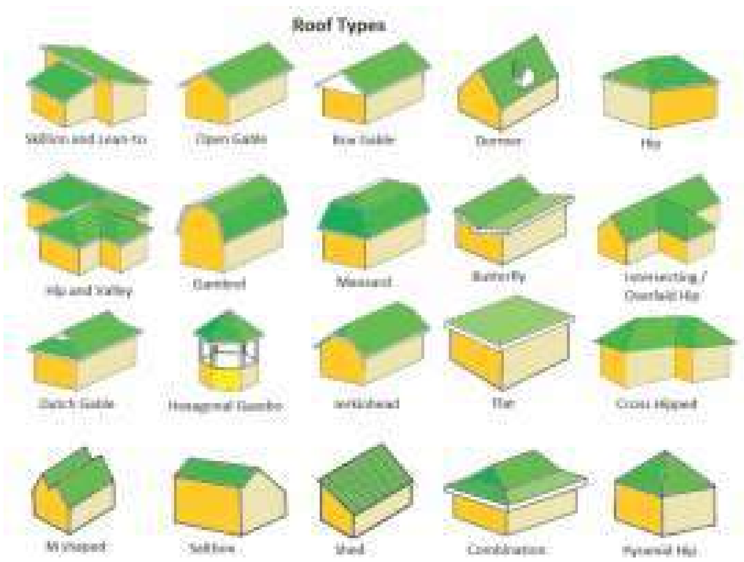
Natural Ventilation

Day Lighting

Roofs

In commercial and institutional buildings, roofs are generally flat, and the insulation can be resting on the suspending ceiling. In gabled roof construction where the attic is not used, the insulation is generally in the ceiling. The shape, material, gradient, orientation, outer surface color, and insulating qualities of the roof determine the thermal performance of the buildings. Therefore, roofs need to be designed in such a way to suit the climatic conditions.

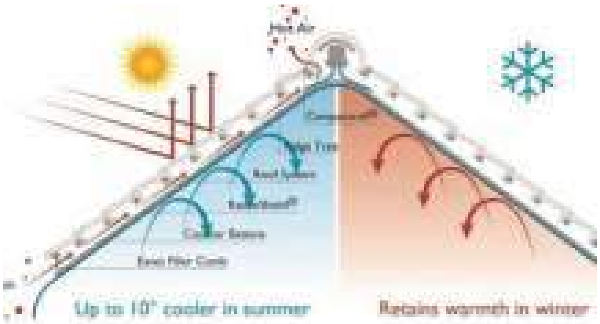
Thermal insulation qualities of roofs, their gradient and facade should be chosen properly to climatic character, their outer surface color and stratification order should, however, be chosen taking heat gain and loss into account. In temperate dry and temperate humid climatic zone and cold climatic zones, the well-isolated gradient roofs should be preferred. In hot and dry climate zones, flat roofs should be preferred to reduce the impact of solar radiation; in hot and humid climates that allow air flow, raised or sloping roof should be arranged.

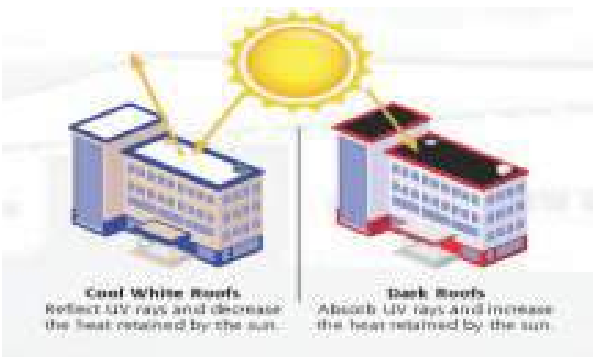


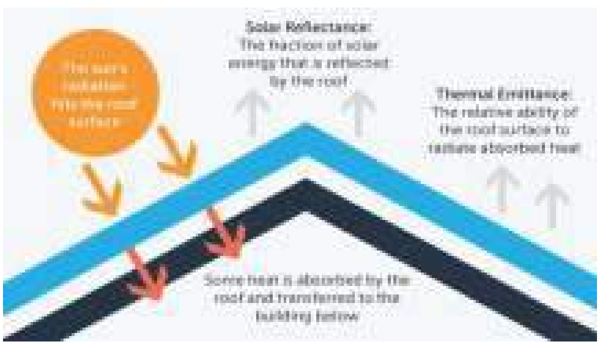
Cool Roofs : All roofs that are not covered by solar photovoltaic, or solar hot water, or any other renewable energy system, or utilities and services that render it unsuitable for the purpose, shall be either cool roofs or vegetated roofs. For qualifying as a cool roof, roofs with slopes less than 20° shall have an initial solar reflectance of no less than 0.60 and an initial emittance no less than 0.90.Solar reflectance shall be determined in accordance with ASTM E903-96 and emittance shall be determined in accordance with ASTM E408-71 (RA 1996). For qualifying as a vegetated roof, roof areas shall be covered by living vegetation.

Advantages

- Reduced peak cooling demand by 10-15%
- Reducing energy bills by decreasing air conditioning needs
- Better thermal comfort
- Reduce local air temperatures
- Lower peak electricity demand







Low Slope Roofs

- White colored roofing materials
- Coatings
- Applied using rollers, sprays, or brushes
- Single Ply Materials
- Mechanically fastened over the existing roof and sealed at the seams

High Slope Roofs or roofs visible from ground

- Non–White, high reflectance materials (Glare control)
- Concrete Tile
- Clay Tiles

Common Indian Cool Roofing Products

- Lime coats
- White tiles grouted with white cement
- Special paints

Windows/ Fenestration

Windows affect energy efficiency in buildings via heat loss or gain, natural ventilation, and illumination. The most appropriate direction is south in terms of heat gain, after the east and west side. Large windows reduce the need for artificial lighting while improving daylight.

Windows should be designed in the magnitude that is sufficient to provide natural lighting. For example, window magnitude should be at least 15% of the room's floor area.

While taking a decision on the transparency rates in building envelope, in which climatic zone the building is placed should be ascertained in advance. Since protection from solar radiation and wind is the basic purpose in hot and arid climatic zones, small and few windows should be used. In hot and humid climatic zones, by taking necessary precautions, large openings should be used in order to raise indoor air circulations. In cold climatic zones, to minimize the heat losses stemming from windows, again small and few windows should be used. Yet, so as to utilize the beneficial effect of solar radiations, the window openings in the southern front should be kept more than the ones in other fronts. In temperate climatic zones, however, it should be given to openings that would enable sufficient air circulation.

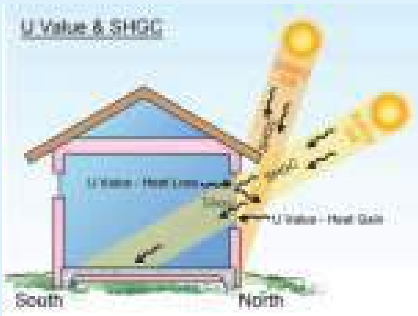
The use of windows also serves a number of essential purposes such as ventilation, natural lighting, and opening to scenery; it does not bring much load on constructional cost. In the climatic zones having cold winters, positioning window openings in the north should not be preferred due to the fact that heat gain from the sun is too little to be considered and air penetrations increase because winter winds usually blow from the north and thus heat losses grow.

It is possible to obtain a certain amount of sun gain from the openings placed in the east and west, even if it is less in winter than the southern front. However, since the summer sun comes horizontally in the morning and afternoon hours, it is very difficult to protect these openings and we may face the problem of overheating. The windows looking toward south, however, may utilize solar rays coming horizontally in winter almost the whole day; in summer, they may be easily protected from the rays coming more vertically.

Because of all of these components, southern windows are the systems which can be very commonly used in utilizing sun passively. Yet, compared with wall, due to their weak isolation qualities they are much more open to heat-loss and gain; therefore, it is needed to take precautions for winter and summer. In this case, the application of double-glazing gains a high

Solar Heat Gain Coefficient – SHGC

- In hot climates, SHGC is more significant than U–factor
- Depends upon glazing specifications and window operability
- Lower SHGC = Lesser Heat Transfer

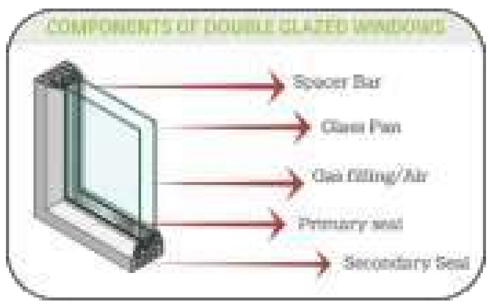


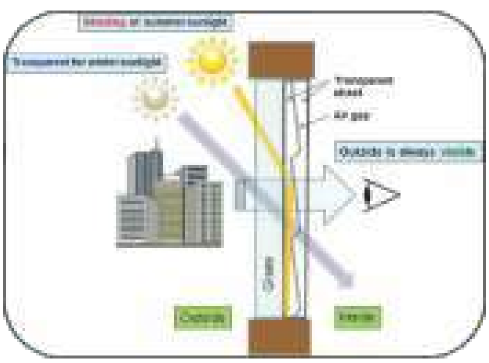
Visible Light Transmittance – VLT

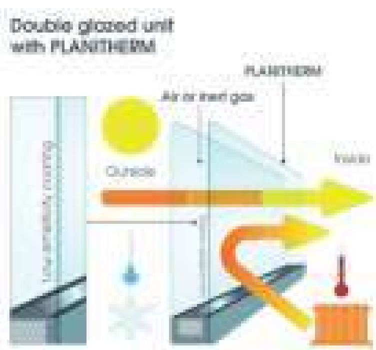
- Percentage of visible light that passes through a window or other glazing unit
- Influenced by colour of glass, no. of glazing and coatings
- Usually Lower VLT = Lesser SHGC
- Balance is needed between daylight requirements & heat gain through windows.

importance. Night isolation applications, however, are necessary to dismiss the heat losses that may occur after sunset. These isolation elements may be shutter, roller blind, or jalousie fixed either from inside or outside. Or, losses should be reduced through at least bringing curtains strictly down. In summer days, windows may be easily protected by the help of eaves, sunshade, or curtain.

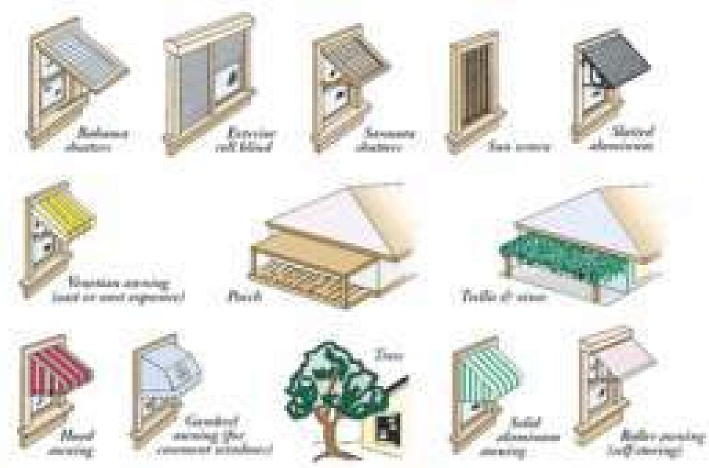
In the front, high performance glass that has the most suitable thermal and light transmittance coefficient for the desired qualities depending on climate, sun direction, and the usage purpose of building should be used. Energy can be efficiently used thanks to isolated joineries, low-E covered glasses, argon or krypton-filled double-glazing and air proof detailing and montage.





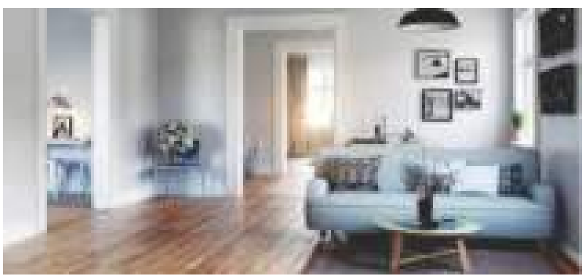


External Shading:



Doors: The position of outer doors should be chosen considering wind effects, heat gain, and losses. In cold climatic zones, windbreak is suggested in order to be protected from the wind effect increasing heat losses. In hot-arid and temperate climatic zones, as wind does not have a restorative impact on comfort, surfaces closed to wind should be preferred.

Floors: Floorings grounded on soil should be arranged in a way to enable the desired performance in terms of heat and moisture. In cold and temperate climatic zones, well-isolated floorings should be preferred. In warm-humid climatic zones, however,



heightened floorings can be preferred since air streams become important. In the volumes getting sunlight, floor laying can be used as a thermal heat store. In floor laying, dark color materials having a high heat-storing capacity should be preferred. Not laying carpets on floor and leaving it open increase its capacity of heat absorption.

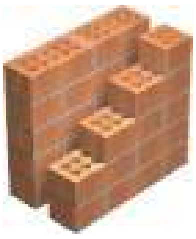
Choosing energy-efficient building materials

Building materials both in the production phase should have energy-efficient features in the use phase. Energy-efficient building material properties are highlighted as below.

- Local material
- Recycled resources
- Materials manufactured through low density industrial processes
- Natural materials are quickly obtained from renewable resources
- Labor intensive materials
- Materials consuming less energy during the worksite process
- Use of durable building materials
- Building materials with high thermal insulation capacity

Material and Envelop Construction

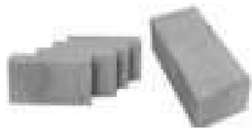
Autoclaved Aerated Concrete is a Lightweight, Load-bearing, High-insulating, Durable building product, which is produced in a wide range of sizes and strengths. AAC Blocks is lightweight and compare to the red bricks AAC blocks are three times lighter.


Double Brick Wall


AAC Blocks


Hollow Concrete Block


Solid Concrete Block


Fly-ash Brick


Hollow Brick


(Burnt Clay Brick)


Hollow Clay Brick


Hollow Clay Brick

Roof Material


Hollow Roof Tiles


Broken China

Heat Resistance Tiles


SRI Paints

Insulation Material for Roof


Expanded


Glass Wool

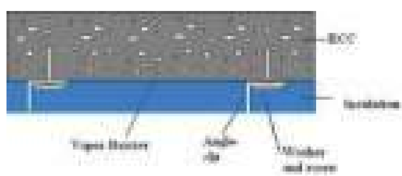

Spray Foam


Polyurethane Slab


Brick Batt Coba


Extruded Polystyrene Slabs


Roof Over Deck Insulation


Roof Under Deck Insulation

Energy-efficient Landscape Design

Through an accurate and conscious energy protected landscape design, it is possible to reduce the energy cost spent for heating and cooling during summer and winter seasons at 30%.The ground flooring of outdoor and grass has a cooling impact via vapor transportation. The materials harboring heat in its body such as asphalt continue to expand heat following sun and they increase night time radiations. So as to reduce the cooling costs spent, using such materials that store heat and reflect lights little or shading them against direct solar rays are among the precautions to be taken.

Energy Efficient Post Construction / Operational Phase

This phase includes the post construction and usage processes of building. Hospital Building operational phase is possible with preferring building techniques consuming less energy and using energy-efficient equipment. The energy used in construction changes according to building systems.

Building Envelope

Considering the age and outdated design of many hospital buildings, it is not surprising that some can be inefficient.

Identifying and repairing problems quickly can help avoid expensive problems later on.

Typically, two thirds of Energy (for cooling/heating) from a hospital is lost through the building envelope, with the remaining third being lost through air infiltration and ventilation. The rate at which energy is lost depends on:

- The temperature difference between inside and outside
- The insulation properties of the building envelope
- The amount of fresh air entering the building either by controlled ventilation or through poorly fitting windows, doors or joins in walls

Improving building envelope in a hospital makes good sense for many reasons:

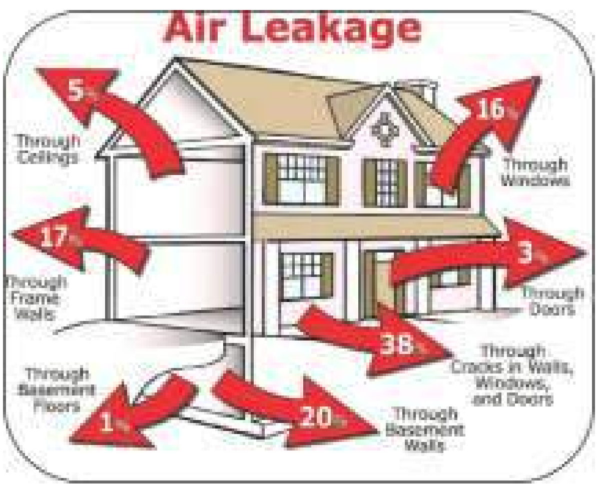
- Better temperature control—it can lower cooling and ventilation costs and prevent over heating
- Enhanced patient comfort—a more comfortable ward gives patients the best conditions for a faster recovery
- Improved productivity — staff morale and output can be enhanced by providing a

more comfortable working environment through reducing draughts, solar glare, overheating and noise

- Lower capital expenditure—a more efficient, well insulated hospital needs smaller heating and cooling plant
- A brighter, cleaner environment—this may help increase patients' confidence in the care unit.

Low Air Leakage Rate: Airtight construction and controlling air leakage is the primary key to the performance of an energy efficient building. It is also one of the most elusive features to identify. It is an excellent investment to have a professional blower door test done to identify air leakage areas and to determine how tight your building is. Building for air-tightness entails a variety of materials, techniques, proper testing, and an appropriate design. In general, all joints, seams and penetrations should be sealed with either caulk, two part foam, gaskets or polyethylene

> **DID YOU KNOW?**
> Fan power requirements are high in buildings that are poorly insulated and draughty because of the need to distribute larger volumes of air. Improving insulation can help to reduce this need.



ADVANTAGES OF AIR SEALING

Improved thermal integrity of envelope & improved thermal comfort

- Improved performance of insulation
- Minimized temperature differences between rooms
- Reduction in unconditioned air, drafts, noise, and moisture

Reduction of unwanted condensation

- Reduction of insulation R–value, degradation of building materials

Improved indoor air quality

- Reduced pollution, dust, mold and moisture.

Reduced energy loss and heating / cooling costs

- Infiltration loads can add up to 20–40% heating/cooling loads

Regularly Check the Building for Dampness and Moisture Damage: Moisture can cause significant damage to the building structure and reduce its insulating properties. It is also unsightly and even though it may not reflect the quality of the healthcare offered, patients could be concerned by what appears to be dirty and unkempt premises.

Prolonged dampness can lead of mould growth, which can be very dangerous for the health of patients and hospital staff.

Repair split down-pipes, faulty gutters and leaky roof tiles as soon as an issue becomes apparent. Do not just opt for a quick fix — repair the cause and save time on expensive work later on.

Regularly check for signs of damp and condensation at least once a year, preferably prior to winter months.

Check and Maintain Insulation: Ensure that hot water and heating pipes are insulated. Similarly, check accessible loft spaces to make sure that insulation is in good condition and replace if required. As well as saving energy by reducing heat loss from the pipe, insulation can also improve internal comfort by reducing the risk of overheating.

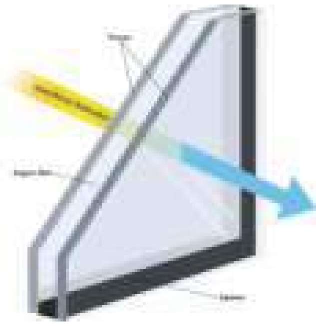
BUILDING ENVELOPE

- Install high-efficiency, secularly - selective glazing carefully chosen for sun exposure on each facade and other variables.
- Install interior or exterior shading devices.
- Install insulation in strategic locations.
- Under take air sealing, including ductwork.

Make the Most of Curtains and Blinds: As well as providing privacy for patients, curtains and blinds play an important role in protecting the building. If correctly chosen, they can reduce draughts and help rooms retain more of their residual heat overnight during winter months. Close curtains and blinds at the end of the day to keep the heat in. The same process can help in summer to reduce heat in rooms that receive direct sunlight. Blinds can also be an effective way of controlling direct day light and glare.

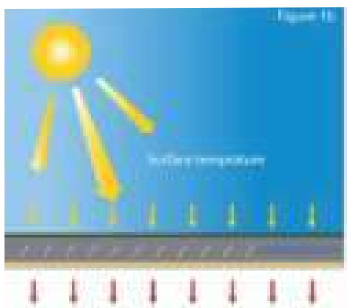
Improve Glazing: Double glazing should be considered when replacing windows. Not only does it offers improve thermal and optical properties to improve building performance, it can also help reduce the noise levels inside the hospitals providing better acoustical comfort for patients. Some window units even have integrated blinds and/or allow for secure night opening, which can provide additional ventilation and cooling benefits.

High performance glass has a coating that improves its insulation properties. Coatings that allow day light through but block or reduce heat (infrared component of solar radiation) can be particularly effective at reducing overheating from direct sunlight, therefore lowering mechanical cooling requirements.



In highly glazed spaces such as waiting rooms and atria, it may be more effective to replace some of the glazing with insulated blank panels. This will reduce the amount of light entering the space but provide better insulation and reduce heat and glare problems associated with a large area of windows.

Install More Insulation during Refurbishment: Large amount of heat can enter the building through an un-insulated roof, which increase the energy consumption for cooling the space below the roof. Insulating roof and unfilled external cavity walls is an effective and inexpensive way of saving energy. Energy Conservation Building Code (Ministry of Power, 2017) prescribes U- factor for roof and opaque walls of hospitals (operating 24 hours). The Table below highlights the same.



Composite zone Prescriptive Values of Maximum U–factor(W/m^2·K) for Hospitals (24-hour use buildings), Energy Conservation Building Code 2017

Building compliance level	Roof Assembly (Max. U – factor(W/m^2·C))	Opaque Wall Assembly (Max. U – factor(W/m^2·C)
ECBC	0.33	0.40
ECBC +	0.20	0.34
Super ECBC	0.20	0.22

Source: Energy Conservation Building Code 2017

Many hospital buildings have flat roof sand single external walls making insulation measures more difficult, disruptive and costly. Improvements to these are most cost effective during refurbishment projects and should always be considered when the opportunity arises.

Under take Regular Maintenance: Identify potential building envelope problems as part of routine maintenance and deal with them promptly. In particular, repair gaps or holes in walls, windows, doors and skylights immediately. Preventing the loss of heated or cooled air provides instant savings and also improves the appearance of a hospital. It is more comfortable for staff and patients too.

Establish a Housekeeping Schedule: Compile a regular checklist to address areas where energy is lost via the building structure. If the hospital is large, it would be worth delegating this to several members of staff, all of whom can work from the same checklist. A comprehensive schedule includes checking walls, floors, roofs and skylights, doors and windows, including frames and panes.

Keep windows and external doors closed as much as possible when cooling/heating is on and consider sealing unused doors or windows to further reduce draughts.

Space Cooling and Heating: Most managers recognize the importance of having an effective cooling and heating systems to keep patients and staff comfortable. It is often possible to reduce energy wastage while improving internal comfort conditions at the same time. Setting appropriate temperatures, ensuring that cooling and heating equipment and controls are operated and managed correctly can help reduce costs. Infact, it is possible in many hospitals to save upto 30% on cooling and heating costs through the implementation of energy saving measures.

Obtain Feedback: Encourage staff to report any areas that are too hot, cold or draughty. Investigating problem areas can help to identify operation and maintenance issues. If these issues are addressed, the hospital staff and patients are less likely to adjust the temperatures by opening windows while heating or cooling is on, or bringing in portable electric heaters or fans. Therefore in order to maintain appropriate internal temperatures, the temperature settings should be in accordance to the activity taking place in the area. A good starting point is to know NBC(2005) recommended temperatures for specific areas in hospitals.

Recommended temperatures for specific areas in hospitals

Room type	Temperature °C	Relative Humidity
Operation theatres	17–27	45–55%
Recovery Rooms	24–26	45–55%
Patients Rooms	24–26	45–55%

Source: National Building Code of India (2005)

Check Controls: Some signs of poor control in hospitals include:

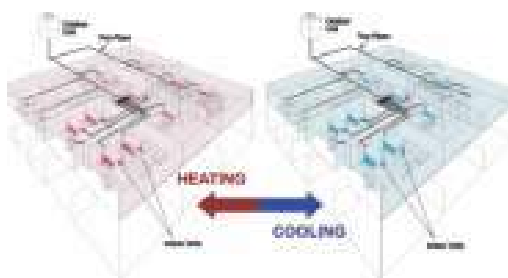
- Cooling/Heating being too high or not high enough, because the thermostat is located where sunlight, draughts, radiators or equipment affect the reading.
- Thermostats beings et to minimum level for cooling (or maximum level for heating), because staff believes this will make the space cool up (heat up) faster. It does not; it simply results in overcooled (or overheated) space.

- Cooling/Heating being on in unoccupied areas, because timers and thermostats are not set correctly.

Check controls thoroughly and regularly. Ensure system operating hours match the times when heating, ventilation and cooling are required, as needs vary throughout the day. Fit simple times witches in smaller spaces, such as treatment and consulting rooms, to automate this process.

It is important to ensure time settings are reviewed every month or so to check that they are correct. Many systems function inefficiently because someone made a short-term adjustment and then forgot about it — for example, in waiting areas of specialist wards with occasional extended hours. Although heating or cooling may be required during these extra hours, building services (such as heating, ventilation and lighting) should be set so that they revert back to normal operating times outside these periods to minimize energy wastage.

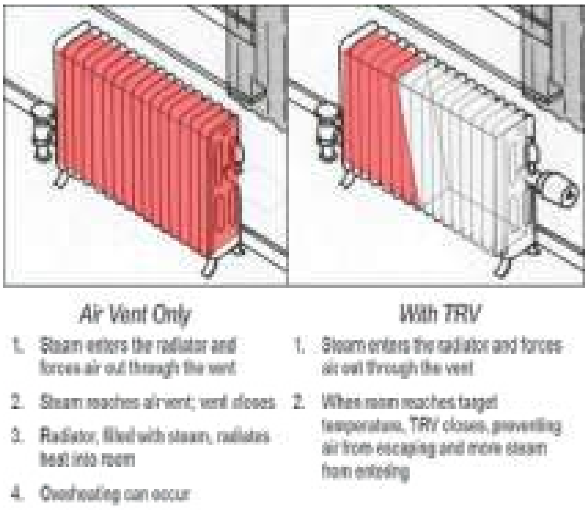
Zoning: Hospital buildings frequently have areas with different time and temperature requirements such as in waiting areas or individual private rooms. This can be problematic where only one overall heating or cooling control system exists. In this instance, consider dividing the area into zones with separate controls for cooling/heating (other systems such as lighting can also be zoned in a similar way). The extra control often results in increased comfort for patients and staff, and saves money as well.



Keep the Conditioned Air in: Easy access to hospitals is imperative at any time of day or night. However, during summer months open doors allow cooled conditioned air to escape and hot air to enter. The thermostat then senses a temperature decrease and automatically switches on cooling which may be unnecessary. The same happens with heated air in winter months. Try to keep external doors open only when absolutely necessary. Alternatively, install automatic doors or a draught lobby, particularly in frequently used building entrances. Lobbies should be large enough to provide unrestricted access and enable one set of doors to be closed before the other is opened. Where possible, the two sets of doors should have automatic control to increase ease of access and help keep the conditioned air in.

Keep Systems Clear and Unobstructed: Make sure that the conditioned air is not obstructed by furniture or equipment and also keep filters clean. This ensures better circulation of air into the space and reduces the energy required to meet the cooling and heating demand.

Localize Control: A thermostatic radiator valve (TRV) is a simple control valve with an air temperature sensor, used to control the heat output from a radiator by adjusting



water flow. Correctly fitted and operated, TRVs can provide efficient temperature control in areas, which have different usage patterns, such as treatment and consulting rooms.

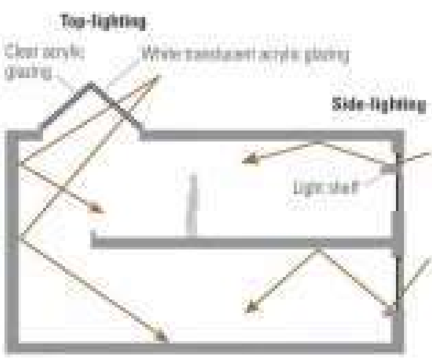
> **Capture Daylight**
> Reducing cooling load (daylight contributes less heat to a space per given amount of light – efficiency of daylight is significantly higher than most forms of electrical lighting)

Upgrade ControlsCapture Daylight : Reducing cooling load (daylight contributes less heat to a space per given amount of light – efficiency of daylight is significantly higher than most forms of electrical lighting) Many existing systems have old, inefficient time and temperature controls. Upgrading them is worthwhile as they can pay for themselves very quickly through savings on energy bills.

Sophisticated cooling/ heating systems can adjust themselves in line with the changeable weather conditioned. A compensator is a form of control for heating systems that automatically regulates the cooling/heating temperature based on the weather. An optimum start controller learns how quickly the building reaches the desired temperature and brings the cooling/heating on at the optimum time prior to building occupancy, again depending on the weather.

Lighting

Lighting is a major energy consumer in Hospital buildings. Effective lighting is essential for health care staff to carry out their work properly, yet it is possible to achieve significant savings in this area and improve the quality of the lit environment.



LED bulbs are upto 90% efficient as compared to ICL.

Heat generated from electric lighting contributes significantly to the energy needed for cooling of buildings. Each kilowatt–hour (kWh) reduction in lighting energy approximately saves 0.4 kWh in cooling energy.

The light-emitting diode (LED) is one of today's most energy-efficient and rapidly developing lighting technologies

Lighting controls: Lighting requirements reply to a building design. The need for lighting, when during daytime, will depend on the window size and placement, and the position of buildings. The need for lighting is decreased by the use of automatic controls, which depend on the orientation of building windows, the supply of daylight, and usage of the room.

Use of lighting controls

- **On–off controls**
  - Manual switches
  - Elapsed–time switches
  - Clock switches
- **EMS (Energy Management Systems) controls**
  - Photocell controls
  - Occupancy controls
  - Switched power strips
- **Dimming controls**
  - Power reducers
  - Stepped–dimming controls
  - Continuous–dimming

ECBC Mandatory requirement for Automatic Lighting Control:

- Interior lighting systems in buildings larger than 300 m2 shall be equipped with an automatic control device for 90% of interior lighting fittings.
- Occupancy sensors shall be provided in all building greater than 20,000 m2 BUA (Built up Area).
- Each space enclosed by ceiling-height partitions shall have at least one control device to independently control the general lighting within the space.
- Lighting for all exterior applications (provided not exempted) shall be controlled by a photo sensor or astronomical time switch that is capable of automatically turning off the exterior lighting when daylight is available or the lighting is not required.
- Internally-illuminated exit signs shall not exceed 5 Watts per face.

Occupancy Sensors: Occupancy sensors ensure lights only operate when there is somebody there to require them. These are especially useful in, for example, the following spaces:

- Intermittently used office areas
- Toilets and wash room facilities
- Store rooms
- Areas where lighting is zoned.

TOP TIP
Always make the most of natural daylight. Research indicates that increased daylighting in patient rooms may ease post-surgical pain, decrease the use of pain medication and reduce the length of stay in the hospital.

REMEMBER
Lighting design is complex and many of the examples given here are general guidelines, appropriate for reception areas and other common rooms in healthcare units. Some tips will not be appropriate for specialist areas, so always seek advice before making any changes to the lighting in your hospital.

Occupancy sensors can also be used to lower light levels in corridors at night time, which can be an effective cost-saving measure. However, it is imperative to maintain minimum light levels so as not to compromise health and safety standards.

Occupancy sensors may not be appropriate for wards and inpatient rooms where people may not be moving frequently enough to be detected.

Switch Off' Policy: Involve all staff in making energy and cost savings. As part of an awareness campaign, conduct regular meetings, place suitable stickers above light switches and put posters up in the staff areas.

Make a member of staff responsible for going around at set times during the day to check lighting. For example, a morning check would include making sure that external lights are switched off, if there is sufficient daylight.

Label Light Switches: Help staff to select only those lights they need, by labeling light switches suitably. As part of general policy, lights in unoccupied areas should be switched off but remember to consider health and safety implications, particularly in corridors and stairwells. Key areas for security lighting include pharmacy drug stores, laboratories and residential accommodation.

Maintenance: Without regular maintenance, light level scan fall by 30% in 2–3 years. Keep windows, sky lights and light fittings clean. Replace old, dim or flickering lamps and keep controls in good working order by ensuring timers are set correctly and that any occupancy sensors are clean. Encourage staff to report maintenance issues. This will help maintain the desired light output and, in turn, provide more attractive environment for both staff and patients.

Install Low-Energy Lighting: Upgrade lights to the most efficient suitable options. For example, at many locations in the hospitals, any 'standard' tungsten light bulbs can be upgraded directly to energy saving LED lights which use 90% less energy, produce less unwanted heat and last 10-12 times longer. Replace blackened, flickering, dim or failed fluorescent tubes with LED lights.

High frequency tubes reduce energy use and heat output, eliminate flicker and hum, extend lamp life (by upto 50%) and can allow dimming—all of which can make award more comfortable.

Always consult a qualified lighting specialist before upgrading lighting systems and refer to BEE Star labeled lamps to ensure it is efficient.

LIGHTING

- Install LED bulbs in place of incandescent in hospital rooms, halls, and elevators.
- Install energy-efficient lighting in all other spaces, being sure to replace T-12 fixtures, T-8 or T-5 fixtures with LED Tube lights.
- Install and calibrate automatic lighting controls in conjunction with skylights and clere stories in open areas to dim lights in response today light.
- Install LED exit signs.
- Upgrade parking lot lighting to save energy.

Switching in Parallel: Hospitals tend to have a lot of windows, particularly on wards and in consulting areas. This provides a good opportunity to maximize daylight. Wire lights so that those closer to the windows can be switched off, while the rest remain on with separate controls. This is called 'switching in parallel' and enables staff and patients to make the most of natural day light, which is usually preferred. As a result, less lighting is used, reducing energy consumption and additional heat generated by the lights, which, in turn, means that less cooling is required.

High-efficiency heating, ventilation, and cooling (HVAC) equipment

Heating ventilating air conditioning (HVAC) systems extremely influence energy consumption in buildings. The relationship between building specifications and HVAC systems are: highly efficient building envelopes reduce the need for heating and cooling systems. Good and intelligent designed buildings can reduce the need for HVAC systems. Efficiency improvements in HVAC systems can lead to substantial savings. If, for instance, energy efficiency is improved in a heating boiler or an air-conditioner, total savings will depend on the total need for heating or cooling in the building. In a well-insulated building envelope, the energy needs of the HVAC system are reduced. The building can be separated into thermal zones at suitable dimensions, reducing the need for heating, cooling and ventilation with careful building planning

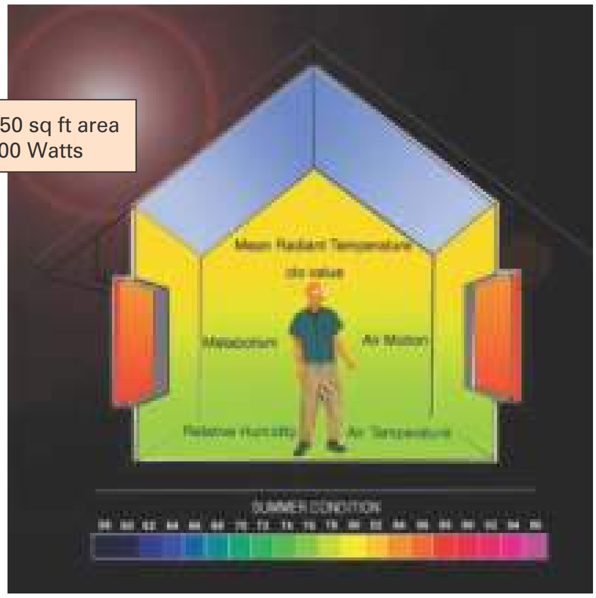
Factors for thermal comforts

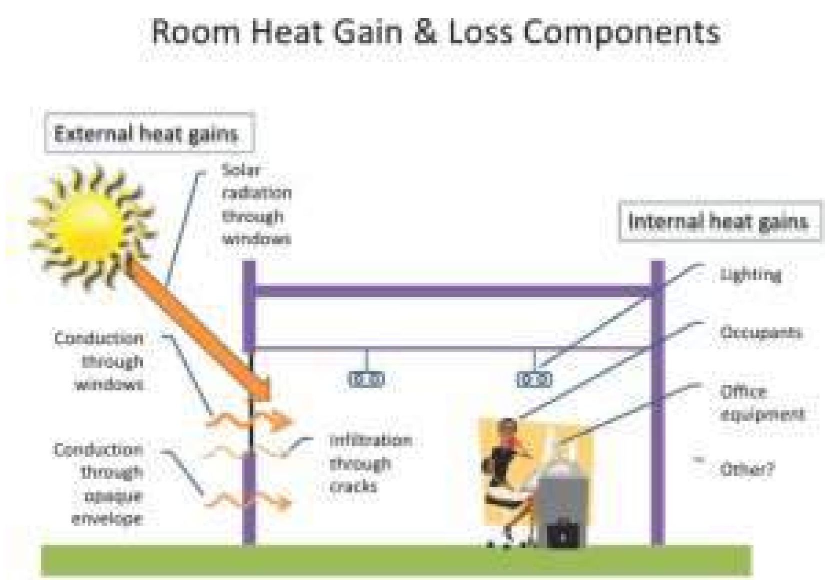
- Air Temperature
- Room Size
- Air Motion
- Relative Humidity
- Radiant temperature
- Metabolic rate
- Clothing type
- Objects and appliances in Room
- State of Mind

Conventional AC Design

- 24+ 2 deg. C
- 30% to 70% RH
- Air speeds: 0.3 m/s

1 ton AC per 150 sq ft area
1 ton = 1000 Watts

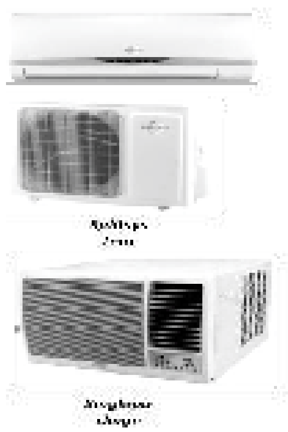


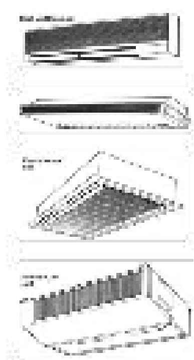


HVAC System Types

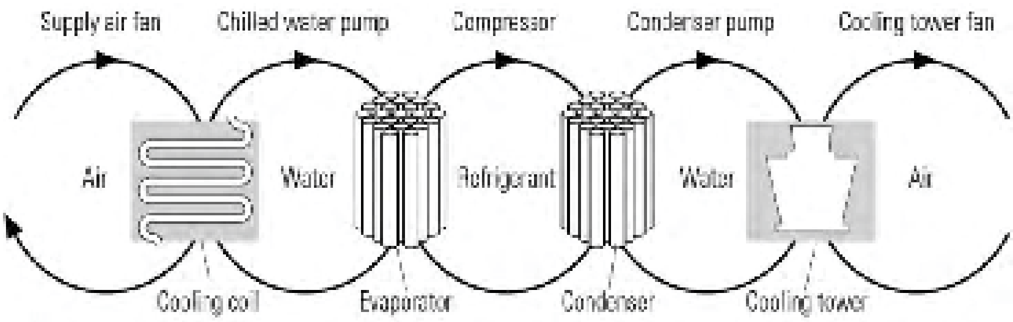
Room Air Conditioners

- Split systems – separate indoor (evaporator) and outdoor (condenser + compressor)
- Window systems- All functions in one outdoor package





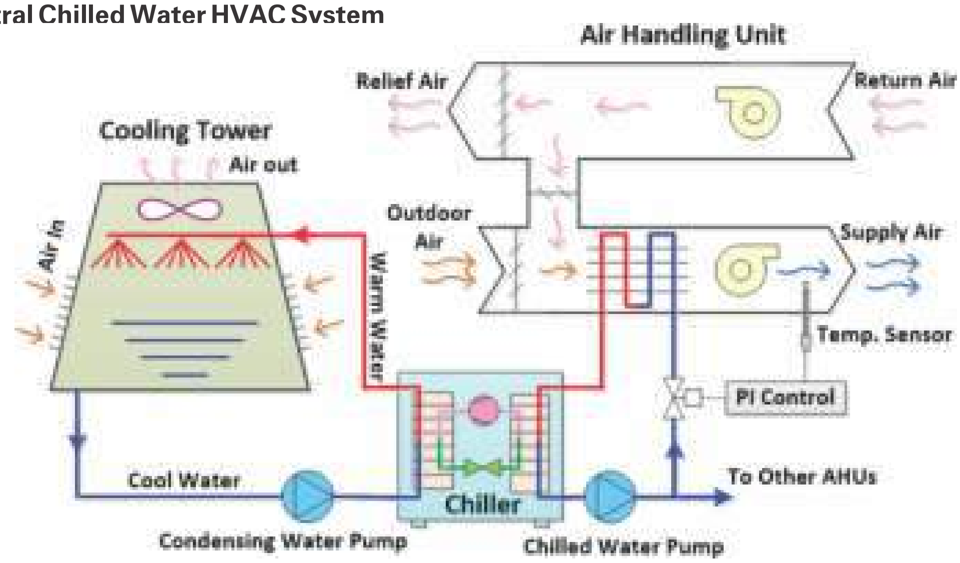
Central Air Conditioners



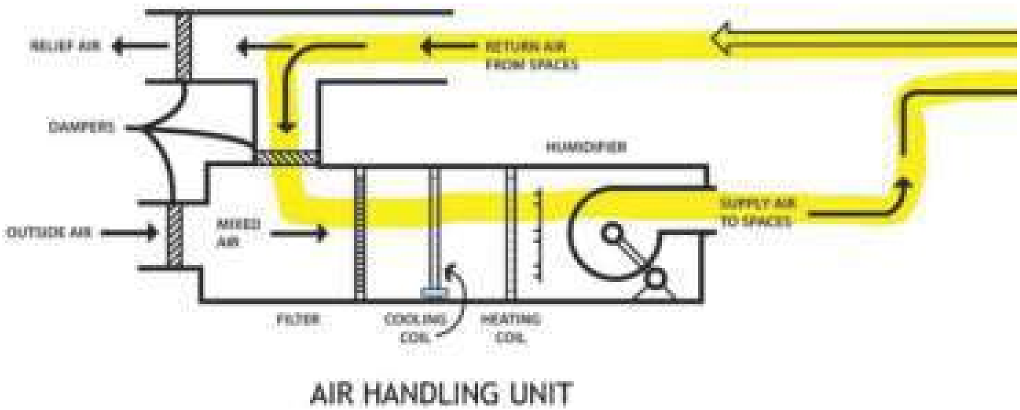
Variable Refrigerant Flow System

- High flexibility, Modular, Better Capacity utilisation, High efficiency (depends on size and application)
- Suitable for buildings with variably loaded Zones
- Generally installed for areas less than 1 lakh sqft

Central Chilled Water HVAC System

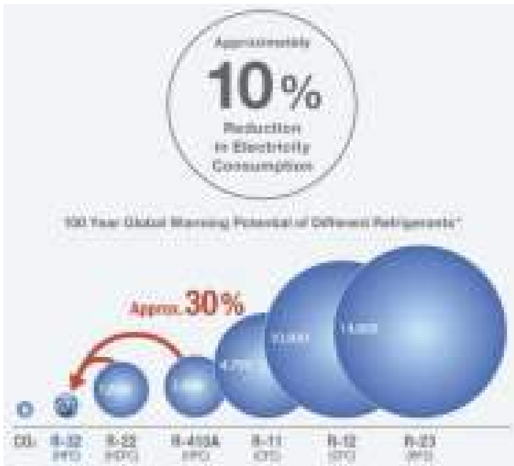


AHU with Economiser

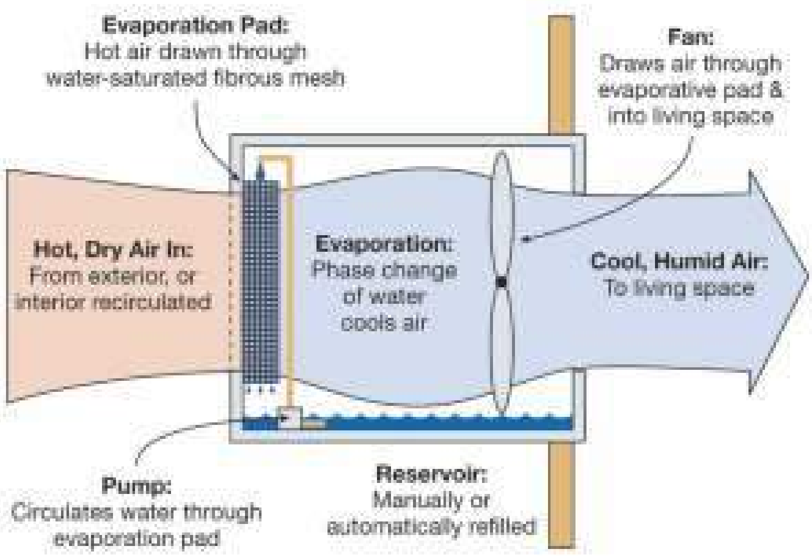


Energy Conservation options

- Reduce Heat Loads
- Expand Comfort Range
- Optimize the delivery systems (reducing velocity, pressure and friction in ducts and piping)
- Apply non-refrigerative cooling techniques
- Improve controls



Evaporative Cooling



Window and split air conditioners shall be certified under BEE's Star Labeling Program.

In modern hospitals, ventilation can account for large energy consumption. Although an integral part of hospital design, it is possible to reduce the amount of energy that ventilation systems consume by focusing on some key energy saving opportunities.

Ventilation is required not just to combat heat gains from lighting, staff, patients and specialist equipment but, more importantly, to provide high air change rates in operating theatres and on the wards to help eliminate airborne bacteria. It is important to remember that a certain level of ventilation for infection control is vital in healthcare buildings. Always seek advice from a technical specialist or microbiology department before implementing any major changes.

Take Advantage of Natural Ventilation: As simple as it sounds, natural ventilation and cooling relies on natural airflow between openings on opposite sides of a room or building — or rising warm air being replaced with air sucked in through windows or vents. It may be possible to use windows and doors to provide good levels of natural ventilation in some areas within a hospital, allowing mechanical ventilation to be switched off or turned down to save energy. When opening vents, doors and windows, always consider security implications. It is also advisable to check the quality of outside air before letting it in.

Set a Temperature 'Dead Band': Do not let heating and cooling operate at the same time. This can be avoided by setting a temperature 'dead band' — a wide gap between the temperatures at which heating and cooling cut in. For example, in a hospital ward, the heating may be set to switch off when a temperature of 19ºC has been reached and cooling would not come on until the temperature exceeds 24°C.

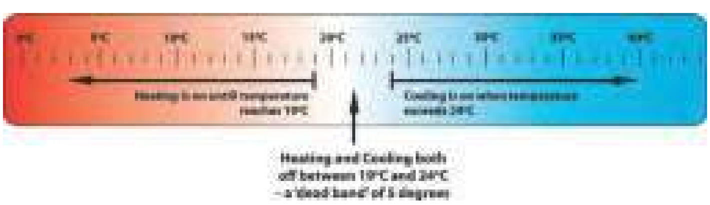


Diagram of 'dead band' control providing recommended temperatures in hospitals wards

TOP TIP

To save energy and increase comfort, it is better to reduce the amount of heat produced in an area than to raise ventilation rates. If you are concerned that your system is not operating correctly, or if staff or patients complain about draughts from ventilation fans, talk to your maintenance specialist.

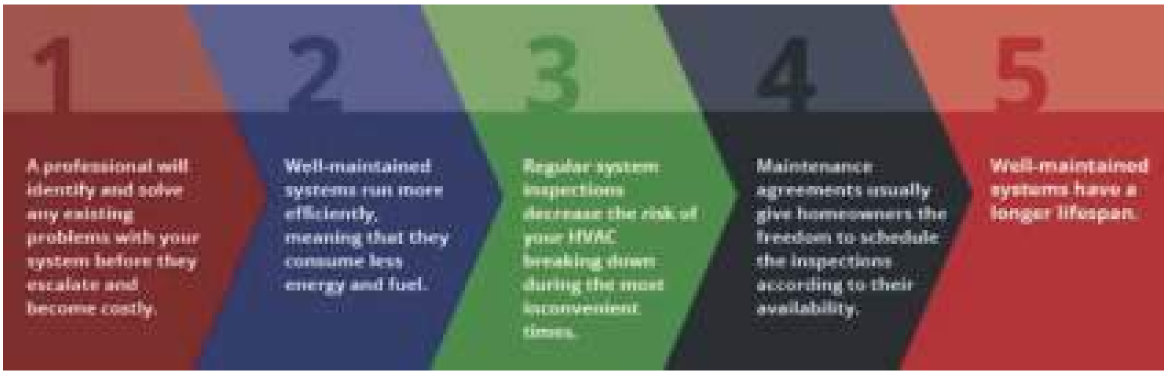
SAFETY FIRST - VENTILATION SYSTEMS

The use of ventilation for infection control is paramount so always seek professional advice before making alterations to systems.

Ventilation systems for clinical areas in hospitals differ from those in most commercial buildings I none critical respect: they need to use full fresh air with no recirculation. This can create very high energy demands and is expensive to operate.

It is therefore important to distinguish between separate non-clinical areas such as administrative rooms, which do not have this constraint, as some further energy efficiency measures may apply to these. In general, air should flow from clean to neutral to dirty areas within a hospital, and outlet grilles should be sited at locations that do not present a health and safety risk.

Maintain System Components: Energy consumption in HVAC system can increase substantially if regular maintenance is not undertaken. Dirty or faulty fans, air filters, air ducts and components directly affect system efficiency and increase running costs and risk of breakdown. The performance of the whole system should be reviewed annually and replacement parts ordered as necessary. Always consult a maintenance specialist



Mixed Mode Systems: Some hospitals use what is known as a 'mixed mode' system, which uses a combination of both natural and mechanical systems. The building uses natural ventilation, heating and cooling where possible, with mechanical systems being used only when needed. There are various advantages to such a system.

- The building becomes more adaptable to a wide range of requirements
- The occupants have more control over their environment
- Hospitals can cut down on energy spend.

MYTH - Turning air conditioning thermostats as low as they can go, cools the building more quickly.

REALITY - The temperature drops at the same rate but then overshoots, using more energy than necessary and creating discomfort for staff and patients. If controls are not coordinated, the temperature could even go low enough for the heating system to be switched on. Both systems then operate at the same time.

REMEDY - Set thermostats correctly and educate staff to dispel this myth. As a last resort, protect thermostats to prevent tampering, where possible.

Variable Speed Drives

Fans do not need to operate at full speed all of the time and variable speed drives (VSDs) can help to reduce costs by enabling the output speed of the fans to match requirements at different times of the day. This reduction in speed saves energy and there are corresponding heating and cooling cost savings too.

Building Energy Management Systems

A Building Energy Management System (BMS or BEMS) is based on a network of controllers and offers closer control and monitoring of building services performance, including cooling, heating, ventilation and air conditioning. This is shown on a computer screen in real time and allows settings to be changed quickly and easily. BEMS can reduce total energy costs by 10% or more so they are well worth considering.

Energy Management Systems (EMS) has been installed in a number of hospitals in India. These systems offer advantages of monitoring and optimization of operation of chiller compressors, air handling units, pumps, fans, etc. They can also facilitate in continuous monitoring of energy consumption indifferent departments of the hospital.

Hot Water

Water costs within a hospital can be considerable and this is made worse when hot water is wasted, as the energy used to heat water has been wasted too. However, water is a metered and controllable resource and it is possible to save a significant amount of water simply by implementing some inexpensive efficiency measures. Conservation of water also reduces the pumping requirement, which saves energy. Solar water heating system may also be used in case of high usage of Hot water and availability of excess rooftop space.

ECBC Provisions for Solar Water Heating systems: To comply with the Code, Hospitals in all climatic zones and all buildings in cold climate zone with a hot water system, shall have solar water heating equipment installed to provide for:

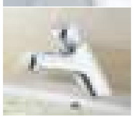
a) at least 20% of the total hot water design capacity if above grade floor area of the building is less than 20,000 m2
b) at least 40% of the total hot water design capacity if above grade floor area of the building is greater than or equal to 20,000 m2

For compliance with ECBC+ and Super ECBC, Hospitals in all climatic zones and all buildings in cold climate zone with a hot water system, shall have solar water heating equipment installed to provide at least 40% and 60% respectively of the total hot water design capacity

Consider Water-Saving Devices

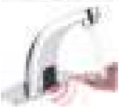
The largest area for potential savings is through the installation of water-conserving devices such as:

Tap retractors - these provide equal flow at a number of taps in a washroom and can reduce water flow by 15%.



Push taps - these only operate when pressed, turn off after a brief time period and are ideal for areas where taps may be left running.

Shower regulators and water-efficient shower heads - these decrease the volume of water coming out of a tap or shower and can reduce water flow by 20%.



Infrared controllers - these provide water only when required, switch off automatically and can save between 5 and 15%ofwater per tap per year.

> **TOP TIP**
> Taps and toilet flush mechanisms fitted with infrared controllers are a particularly good idea because they also reduce the opportunity for the spread of infection.

Supply Efficiently

It is inefficient to supply isolated and infrequently used hot water taps from a central hot water storage tank because of heat loss from long pipe runs. Consider installing a point of- use instantaneous water heater in such cases. These can be extremely economical where hot water demand is intermittent, yet essential such as for hand washing.

Regular Maintenance for Optimum Performance

Maintain water services including taps, storage facilities and pipe work on a regular basis and ensure all drips are fixed immediately. Check for water vapour, flooded ducts and corrosion around joints or fittings on pipe-work to identify water leakage and present water wastage.

Run an Awareness Campaign

Encourage staff, possibly even the visitors to the hospitals, to report any issues such as dripping taps, overflowing cisterns and inefficient water-saving/flushing devices in toilets so they can be repaired before the problem escalates.

Maintain Boilers and Pipe-work

It is important to ensure boilers are required to be serviced regularly by a reputable firm or maintenance contractor. A regularly serviced boiler can save as much as 10% on annual heating costs. Boilers, hot water tanks, pipes and valves should be insulated to prevent heat loss. Payback can usually be expected within a few months of installation, with additional savings in subsequent years.

Office and Small Power Equipment

Office and small power electrical equipment may account for more than10% of total electricity use within, the hospital.

Office and IT equipment is widely used in hospitals, particularly in administration section and reception areas. Other common small power appliances include equipment such as kettles, electric cookers, toasters, microwaves and other electrical appliances including vending machines, televisions , vacuum cleaners, etc.

Seven-day timers

These only cost little but reduce the likelihood of machines being left on out of hours. They can be fitted to photocopiers, printers, drinks and vending machines. Check with your equipment supplier first about any service agreements particularly in vending machines.

Maintain Equipment

Check and clean all heat-emitting equipment regularly, including keeping filters free of dust. This is not just to improve cleanliness and appearance; dirt can reduce the effectiveness of equipment and affect it's cooling down process. Seek advice from the manufacturer on servicing schedules in order to maintain optimum efficiency.

Reduce the Risk of an Area Overheating

Place heat-emitting equipment such as printers and photo copiers in a separate, ventilated area with good airflow. This helps prevent overheating, removes potential emissions from the equipment and reduces noise.

Purchase for Your Requirements

With health care units under increasing pressure to spend budgets wisely, it makes sense to workout the whole life cycle cost of the item, that is the capital cost plus the running costs in energy over the lifetime of the equipment. Slightly higher costs of some energy efficient equipment can often pay back very quickly. This could be an important policy point for the hospital's procurement department, which may only consider the capital outlay in its decisions.

Catering

Water and energy usage in catering department are areas that can offer major energy savings without compromising hygiene or resources.

Efficient catering facilities can reduce the energy requirement per meal significantly. Energy consumption in kitchens can represent more than 10% of total hospital energy usage. This is equivalent to 1-2 kWh/bed/day.2 Managing consumption can have additional benefits of improving the quality of the food produced as well as the working environment for kitchen staff.

Raise Awareness Amongst Kitchen Staff

- Do not switch on too soon — most modern catering equipment reaches optimum temperature quickly. Label equipment with its preheat time and educate staff to switch on only when required
- Avoid using catering equipment to warm the kitchen space on staff arrival in winter months
- Switch off heating and cooking equipment immediately after use
- Avoid over filling saucepans and kettles, and use lids where possible
- Keep fridge and freezer doors closed and defrost at manufacturers' recommended intervals to save energy and prolong equipment lifetime
- Switch off equipment, lights and exhaust fans when they are not being used.

Purchase Equipment with running costs in Mind

Although gas-fired equipment is often more expensive to buy than electrical or steam equivalents, savings made on running costs make it an attractive option. Equipment that automatically switches off, such as pan sensors on hobs, can save on energy costs. Select ovens with large, double-glazed viewing window store duce the need to open doors to inspect contents.

When purchasing any domestic-sized catering equipment such as fridges, freezers or dish washers refer to BEE efficiency label and always look for the most efficient rated models.

Consider Heat Recovery

Large volumes of warm air are expelled from kitchens. Many managers do not realize that heat can be recovered using heat recovery devices, which can significantly reduce energy costs. An air-to-water recovery device is often the most effective method of recovering heat because it can then preheat hot water, providing a year-round use for the recovered heat.

Monitor with Sub-Meters

Sub-metering kitchen areas can provide an extra incentive for staff to be efficient, by showing how energy is used in this facility and how subsequent efforts have paid off. Catering in hospitals is at times outsourced so there is the additional benefit of allowing for budget allocation and charging to take place.

Laundry

Laundry facilities are extremely energy-intensive. With an average of three kg of dry laundry per bed per day, laundries are big consumers of steam. They may account for as much as10-15% of a hospital's total energy consumption in large modern hospitals. Water usage is also an important issue. Make sure that laundries are targeted in the site-wide energy strategy. Some actions to consider are listed below:

- Most steam-heated laundries will generate excess low-grade heat that can be conveniently re-used elsewhere across the site.
- Water recovery by recycling the rinse water from was her extractors is a proven means of reducing water usage
- Total water recovery is becoming more acceptable and should be investigated
- Heat recovery via heat exchangers from hot effluent is standard practice and can be used on all types of machine
- Consider combined heat and power (CHP) or Co-generation systems, which might be viable for many sites (if reliable gas supply is available) that incorporate a laundry.

Specialist Equipment

The specialist nature of a hospital environment means that there is a significant amount of energy-intensive equipment, such as medical fridges, mortuary and pharmacy cold stores, laboratory equipment, X-ray, CAT-Scan, MRI machines, etc.

Each specialty area will have a wide range of equipment. Since each item requires careful evaluation, and because of the potential risks to the welfare of the patients, this Guide does not provide in-depth guidance on this topic. However, careful purchasing, along with maintaining good housekeeping practices can generally keep consumption to a minimum, as detailed in the action points below.

Portable Medical Equipment

While being both convenient and cost-effective, portable medical equipment can cost hospitals in terms of energy use. Fortunately, energy performance can be tackled in several ways:

- **Establish a purchasing policy** - choosing the most efficient equipment will reduce energy use and heat gains.
- **Raise awareness of energy management techniques** - encourage staff to switch off devices when they are not being used, or to make use of built-in standby or power-down modes.
- **Building design** - deal with heat gains generated by medical equipment in the context of the building's overall design strategy. For example, instead of installing air conditioning for an entire department, consider local comfort cooling that can be used as required.

REMEMBER
Always check with an expert before switching off or altering controls on specialist equipment.

Refrigeration Equipment

The energy consumption of refrigeration equipment can be reduced by:

- **Defrosting** - follow the manufacturer's recommendations to save energy and prolong the lifetime of equipment.
- **Maintenance** - check door seals on cold rooms, fridges and frozen stores and replace if damaged. Keep condensers and evaporator coils clean and free of dust and check systems have the correct amount of refrigerant.
- **Temperatures control** - maintain correct temperatures on cooling equipment and avoid over-cooling. Keeping refrigerated equipment at the correct temperature is better for the stored contents and for energy savings. Energy

consumption by refrigeration equipment can be reduced by 2–4% if the set cooling temperature can be increased by1ºC. Set the temperature based on manufacturer's recommendations.

TOP TIP:
Ensure X-ray machines, film processors and other significant, individual pieces of equipment are switched off when not required.

Medical Gases

Where medical gases are supplied in bottles or other storage vessels and connected to manifold systems, they have a negligible impact on energy use. However, medical compressed air, medical vacuums and anesthetic gas scavenging, all use pumps and compressors, which consume a significant amount of energy. Consider the following actions:

- Selecting plant and equipment using whole-life costing techniques
- Monitoring(but not controlling) plant operation via a Building Management System to identify unexpected usage and highlight possible problems
- Providing localized systems for applications such as dentistry, medical physics, laundry and sterilizers to minimize distribution energy and potential leakage.

Sterilization and Disinfection

To operate effectively, sterilization and disinfection departments require equipment that is particularly energy intensive. As packing are as need to be kept particularly clean, the ventilation to this department is filtered by high-efficiency particulate air (HEPA) filters and usually air-conditioned. In order to minimize energy consumption, consider:

- Using cascade systems where conditioned air from the cleanest space (packing) flows to neutral then to dirty areas
- Using heat recovery in these areas as heat is often emitted 24 hours per day
- Choosing sterilizing and disinfecting equipment on the basis of energy usage as well as performance—energy usage and whole-lifecycle costs can differ widely between manufacturers
- Insulating sterilizer bodies and pipe-work connections ,valves, flanges and so forth, to minimize stand by losses
- Metering the department for each utility and specifying individual energy metering for each major washer and sterilizer.

Motors and Drives

Motors are generally running out of sight, sometimes constantly, everyday of the year. The value of the electricity consumed by an electric motor over its life is typically 100 times the purchase price of the motor itself. It is therefore important to ensure that motors (and their associated drives) are as efficient as possible.

Considerable energy savings can be achieved by good system design to minimize the motor load. A small increase in duct or pipe size can significantly reduce system losses and thus greatly reduce the fan or pump power required.

Low-loss motors, variable-speed controls and effective control can realize substantial savings.


exit

8.
IMPLEMENTATION OF ENERGY SAVING MEASURES IN EXISTING CIVIL HOSPITALS

The Department of New and Renewable Energy, Haryana/HAREDA has provided financial assistance of Rs 1.0 lakh to each District for implementation of Energy Saving measures in District Civil Hospitals from BEE, GoI financial support. Apart from this, Energy Saving measures are being implemented by conducting detailed survey of Hospitals

Civil Hospital , Panchkula

- Located in Sector 6, Panchkula.
- Hospital is equipped with advance health care facilities and well qualified & specialized team of Doctors.
- Connected load of the Hospital is 2,391 kW.
- Energy saving measures were implemented at District Civil Hospital Panchkula , for which financial assistance of Rs 6.33 lakh was provided by HAREDA from BEE, GoI Financial support.
- 1165 nos. of inefficient tube-lights have been replaced with LED tube-lights.
- 340 nos. of inefficient fans have been replaced with BEE five star rated fans.
- Avoided Generation capacity through these measures is approx. 50.44 kW and annual energy saving potential is approx. one lakh units.

Government Civil Hospital , Bhiwani

- Located at Krishna Colony, Bhiwani, Haryana

- Hospital is equipped with advance health care facilities and well qualified & specialized team of Doctors.
- Connected load of the Hospital is 1,268 kW
- HAREDA has implemented energy saving measures at Govt. Civil Hospital Bhiwani with expenditure of Rs 6.0 Lakh from BEE, GoI Financial support.
- 2,000 nos. of CFL have been replaced with LED lights.

- 305 nos. of inefficient tube-lights have been replaced with LED tube-lights.
- 340 nos of inefficient fans have been replaced with BEE five star rated fans.
- Avoided Generation capacity through these measures is approx. 48 kW and annual energy saving potential is approx. one lakh units.

Government Civil Hospital, Karnal

- Connected load of the Hospital is 557.5 kW
- Energy saving measures were implemented at District Civil Hospital Karnal , for which financial assistance of Rs 3.22 lakh was provided by HAREDA from BEE, GoI Financial support.
- 390 nos. inefficient fans have been replaced with BEE five star rated fans.
- Avoided Generation capacity through these measures is approx. 10 kW and annual energy saving potential is approx. 30 thousand units.

Government Civil Hospital , Faridabad

- Connected load of the Hospital is 700 kW
- Energy saving measures were implemented at District Civil Hospital Faridabad , for which financial assistance of Rs 6.0 lakh was provided by HAREDA from BEE, GoI Financial support.
- 351 nos. inefficient fans have been replaced with BEE five star rated fans. 495 nos conventional Tubelights were replaced with LED lights. 1150 nos CFL replaced with LED lights

- Avoided Generation capacity through these measures is approx. 43 kW and annual energy saving potential is approx. one lakh units.

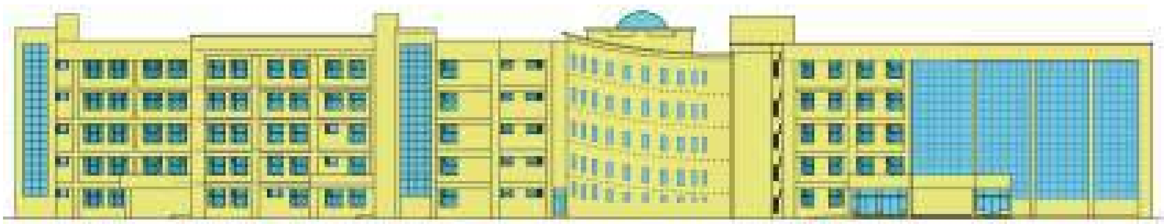
9. RECOMMENDATIONS FOR ENERGY EFFICIENCY IN UPCOMING GOVT. HOSPITALS

The Department of New and Renewable Energy, Haryana / HAREDA has received plans of four nos. new hospitals from stakeholder Departments for their evaluation for ECBC compliance. The plans were evaluated by ECBC cell established at HAREDA with support from BEE, GoI. The Details of these hospitals are as under:

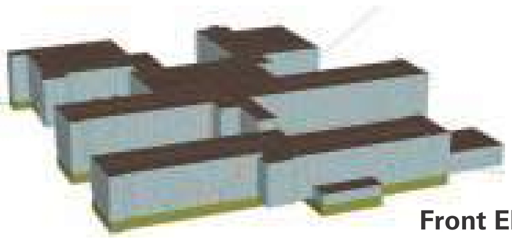
1. Civil Hospital, Fatehabad
2. Mother and Child hospital, Panipat
3. 100 Bed hospital, Panipat
4. 200 Bed hospital, Gurugram
5. 500 Bed Cancer Hospital, Gurugram

Civil Hospital, Fatehabad

The plans of Civil Hospital Fatehabad were evaluated by ECBC cell established at HAREDA, for ECBC compliance and evaluation report was submitted to Architect Department, Haryana and key highlights are as under:



2D View

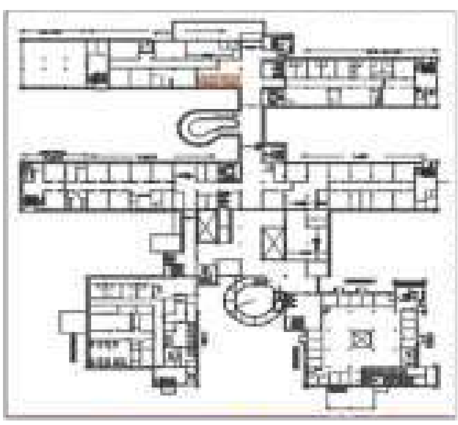


Front Elevation

Building Plans

BasementPlan

Ground Floor Plan



Typical Floor Plan (1st, 2nd, 3rd

4th Floor Plan

Whole Building Energy Performance Analysis

The Proposed Hospital as evaluated for ECBC compliance as per Whole Building Energy Performance Analysis.

- Hospital has been modelled using the e-QUEST energy simulation software which is able to model energy flows on hourly basis for the entire year.
- This simulation tool has the capability to model hourly variations, lighting, HVAC equipment, daylight control and thermal zones.
- The SLD has been created so that the single line rests on the interior side of the external walls and in the middle of the interior walls.
- For representing the weather conditions, the ISHRAE weather file database has been used to represent the external weather conditions.
- Provided below the chart indicating the steps flow of 'Whole Building Energy Performance Process.

Summary of recommendations is as under:

- Whole Building Performance Method has been used to show compliance of project with ECBC.
- Project achieves EPI ratio of 0.974 when compared with ECBC baseline case. Thereby, project is meeting the ECBC compliance by 'Whole Building Performance' approach.

Input Parameter	Baseline	Proposed	Units
Wall material	As per ECBC	230mm AAC Block Wall	
Wall U-value	0.0704	0.126	Btu/hrsqft F
Roof material	As per ECBC	150 mm RCC + 150 mm Brick Bat Coba	
Roof U-value	0.0581	0.215	Btu/hrsqft F
Glazing U Value	0.328	0.282	Btu/hrsqft F
SHGC	0.27	0.21	
Window Shading	No	As per Architectural Drawings	
Cooling Sizing Ratio	1.15	1	
Heating Sizing Ratio	1.25	1	
HVAC System	Water Cooled Chiller	Water Cooled Chiller	
Chiller Efficiency (COP)	6.3	6.1	
LPD has been taken as per ECBC Building Area Method (section 6.3.2)			
Lighting Power Density	Hospital- 0.9	Hospital- 0.63	W/ ft²
	Parking – 0.28	Parking – 0.2	W/ ft²
External Light Load	20.3	14.34	KW
Outdoor Air Changes	General Ward- 2 ACH ICU/OT- 20 ACH	General Ward- 2 ACH ICU/OT- 20 ACH	
Zone Cooling set point	75	75	deg F
Zone Heating set point	70	70	deg F

- Project achieves EPI ratio of 0.974 when compared with ECBC baseline case.
- Thereby, project will meet the ECBC compliance by 'Whole Building Performance' approach.

Description	Energy Consumption/ Generation
FAR AREA (m2) including parking	47765.86
Basement Parking area (m2)	3218.16
FAR area (m2) excluding basement parking	44547.7
Baseline case energy consumption (kWh)	12282341.3
Proposed case energy consumption (kWh)	11970631
Proposed case energy EPI (kWh/m^2/yr)	268.71
Base case energy EPI (kWh/m2/yr)	275.71
ENERGY SAVING ACHIEVED, kWh/ YEAR	311710.25
EPI Ratio that can be achieved	0.974

Mother & Child Hospital, Panipat

100 Bedded Hospital is planned to be constructed in Gurugram. This is an office building with 24 hrs. occupancy schedule. The building has 7 floors (G+7). The total building built-up area is 10772 m2 with peak occupancy type of Healthcare.

2D View

Energy Efficiency Measures recommended

- High reflective, furniture and wall surfaces increase UDI.
- Energy Efficient Glass with advanced thermal insulation.
- Insulating the envelope with better materials.

- LED Lights to meet exact lux levels and reduce lighting loads.
- Maintain air-tightness of conditioned spaces to avoid excessive thermal loads and infiltration.

4.3%	86.19
Energy saving over Standard Design (%)	Proposed Energy Performance Index(EPI)

100 Bed Hospital, Panipat

Project Name : 100 Bed Hospital4.30%
Location : Panipat
Building Type : Healthcare
Owner : Health Department, Haryana
Climatic Zone : Composite
Number of Floors : G+7
Built-Up Area (m2): 10772

Energy saving potential over standard design

4.30%

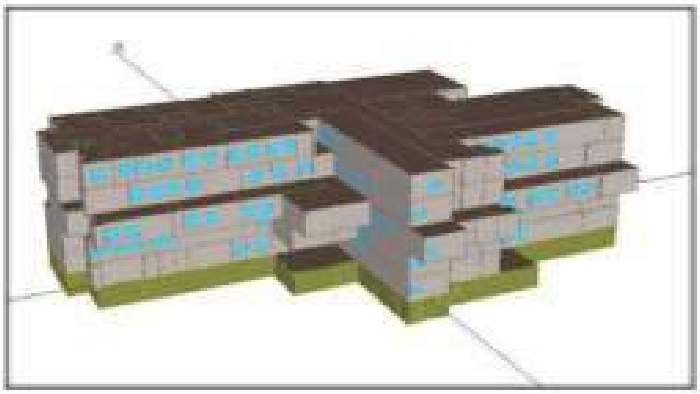
Parameter	As Designed	Proposed
AnnualEnergyConsumption(kWh)	1871982	1791467
EPI (kWh/m²/year)	90.0	86.19
EnergySavingsover StandardDesign(%)	-	4.30

Technical Prescription

200 Bed Hospital, Gurugram

The proposed Hospital building is planned to be constructed in Gurugram, Haryana. This upcoming facility will have B+G+4 above grade floors. A Standard Building as per the requirements of ECBC 2017 is modeled.

The average base case energy consumption has been considered without modeling any shades and overhangs in the building as envisaged by the architects.



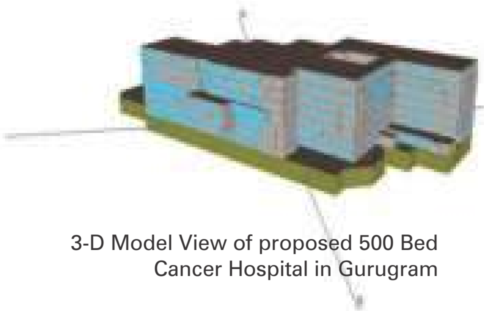
3-D Model View of proposed 200 Bed Hospital in Gurugram

Building Name	Proposed 200 Bed hospital, Gurugram
Building Type	Healthcare
Location	Gurugram, Haryana
Climatic Zone	Composite
Built-up Area (excluding parking), m^2	15,178
Occupancy Type	Healthcare
Total Proposed Case Annual Consumption(kWh/year)	1581780
Total Baseline Case Annual Consumption (kWh/year)	1745680
ECBC compliance achieved	ECBC 2017
EPI (Baseline Case), KWh/m^2/year	115.01
EPI (Proposed Case), KWh/m^2/year	104.21
EPI Ratio (EPI Proposed / EPI Baseline)	0.90
Energy Saving Achieved, kWh/ YEAR	163900

To meet the ECBC 2017 compliance through Whole Building Performance method, a thermally well performing building opaque envelope as provided in below Table is suggested.

Opaque Assembly	Construction Layers	Specification
Ext. Wall Assembly	Assembly layers: • (Innermost) 20 mm Cement Plaster • 230 mm AAC block • (Outermost) 20 mm Cement Plaster	U-value –0.13 Btu/hr.ft.^{2}°F
Roof Assembly	Assembly layers: • RCC roof with insulation (150 mm thick) • 50 mm thick XPS • Cement Sand Screed + Brick Batt Cobra	U-value – 0.07 Btu/hr.ft.^{2}°F
Ext. Wall Assembly	• Maximum U-factor considered -0.4 W/m2K (as per table 4.7 ECBC-2017)	U-value–0.07 Btu/hr.ft.2°F
Roof Assembly	• Maximum U-factor considered -0.20 W/m2K	U-value – 0.03 Btu/hr.ft.2°F

500 Bed Cancer Hospital, Gurugram



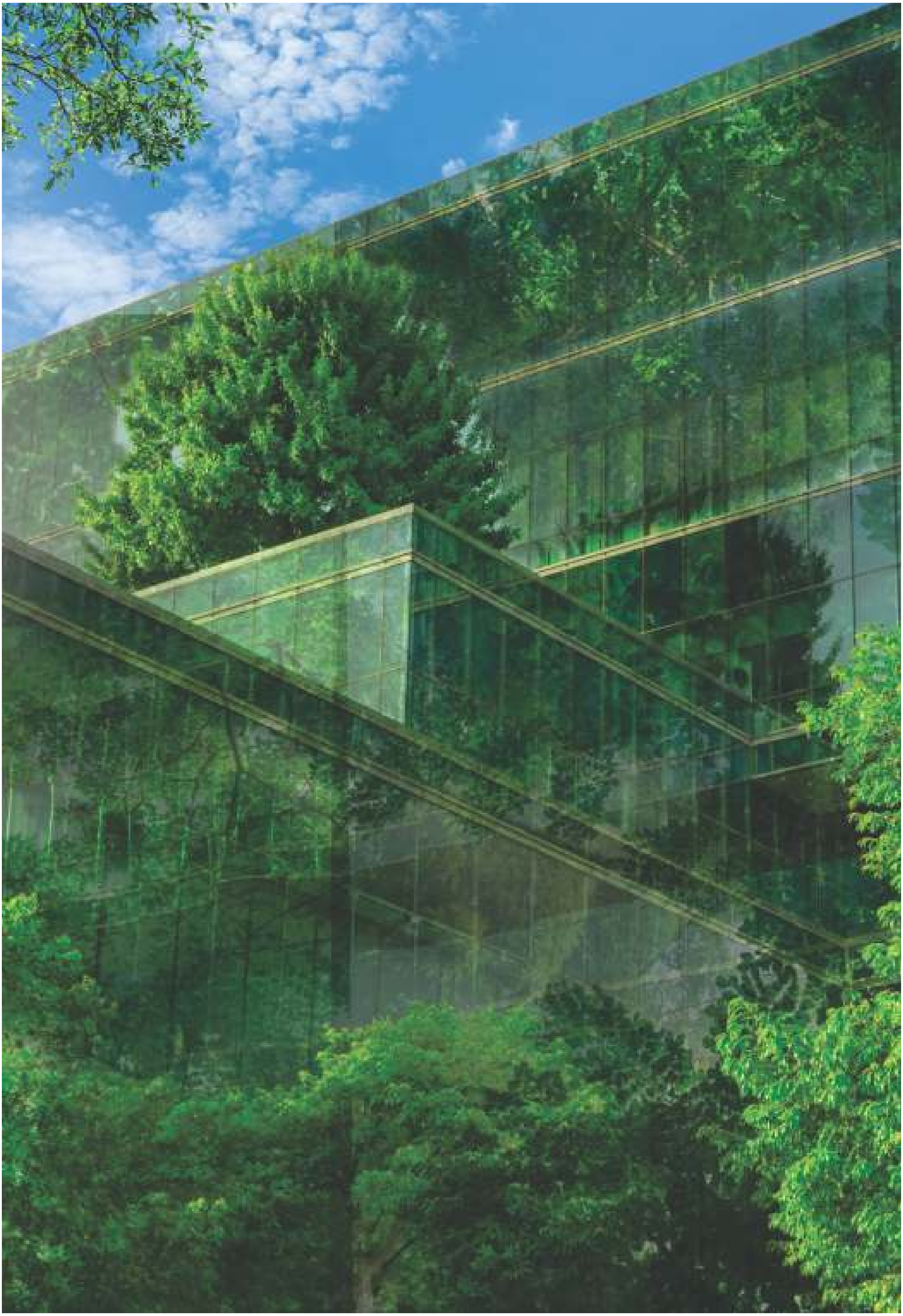
3-D Model View of proposed 500 Bed Cancer Hospital in Gurugram

The proposed Hospital building is planned to be constructed in Gurugram, Haryana. This upcoming facility will have B+G+6 above grade floors. A zoning plan was developed for each space and entered into the simulation model. Each zone was assigned a set of properties including lighting power density, equipment power density, occupancy rate, etc. Each zone was also assigned physical properties of floor-to- floor height, material conductivity and fenestration area etc. A Standard Building as per the requirements of ECBC 2017 is modeled. The average base case energy consumption has been considered without modeling any shades and overhangs in the building as envisaged by the architects

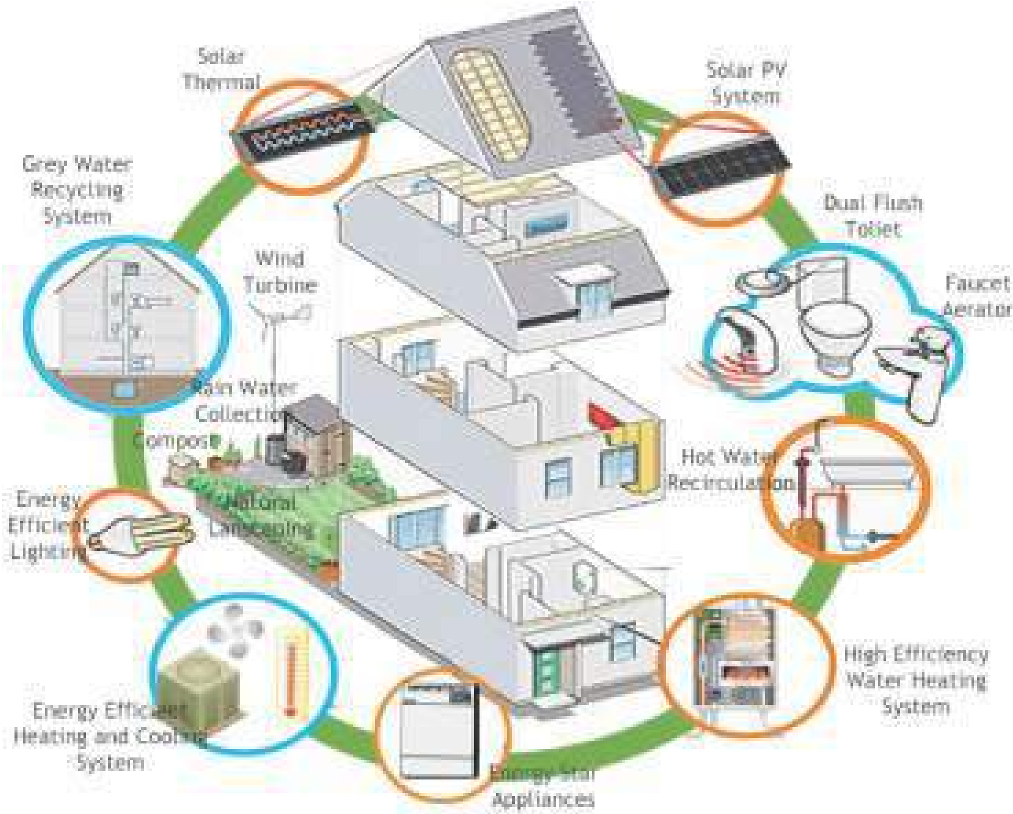
6,88,817 nos. Units can be saved annually by implementing Energy saving measures as per ECBC	**Base case Consumption**: 5398036 kWh **Proposed case Consumption**: 4709219 kWh
The EPI of the proposed facility is **116.7 kWh/m2/year** which is better than the ECBC benchmark of 133.77 kWh/m2/year.	■ 55.3% daylight illuminance levels of minimum 110 lux at the working plane. ■ 30% reduction from ECBC 2017 has been considered in the exterior lighting.

Summary of major recommendations:

- Use BEE 5 star rated appliances and LED lights
- UPS (of sanctioned capacity) shall be installed at the project site and shall have energy efficiency at 100% load as per ECBC requirements.
- IE-3 High Efficiency Motors has been recommended as per ECBC 2017.
- APFC panel shall be installed for Power Factor Correction of 0.99.
- Power cabling shall be sized so that the distribution losses do not exceed 2% of the total power usage as recommended in ECBC 2017
- Project shall install occupancy sensors for all public toilets more than 25 m^2 area and corridors controlling at least 80% of the lighting fitted in the toilets and corridors.
- Use energy efficient building material and low VoC paint.
- Project shall install Solar water system and Solar Rooftop Power plant as per space availability.



Snap Shots of various Green Building features



10.
ENERGY SAVING TIPS

Lighting System

- One of the best energy-saving devices is the light switch. Turn off lights when not required.
- Many automatic devices can help in saving energy used in lighting. Consider employing infrared sensors, motion sensors, automatic timers, dimmers and solar cells wherever applicable, to switch on/off lighting circuits.
- As far as possible use task lighting, which focuses light where it's needed. A reading lamp, for example, lights only reading material rather than the whole room.
- Dirty tube lights and bulbs reflect less light and can absorb 50 percent of the light; dust your tube lights and lamps regularly.
- Use artificial lighting only when there is inadequate natural light in a space
- Don't replace tube lights (line source) which light over a larger linear spread with a bulb (point source) that emits light from a single point.
- Don't use dark-colored surface in workrooms. These reduce the reflected light levels and increase the number of lamps required to illuminate the space.
- Children are advised to study in one room and with individual table lamps. Children shall utilize morning hours & broad day light for studies rather than using artificial light.
- Switch off alternate tube Lights/lamps in common areas and staircases during late hours in the night.

Energy Saving Potential by using LED Lights

Conventional lighting system	**Approx. equivalent upgrade system by using LED lights**	**Potential saving in energy consumption**
Florescent Lamp TL40 W	LED 16-18 W TL	55-60 %
Sodium Vapor 70W	LED 30 W TL	57%
Sodium Vapor 150 W	LED 60 W TL	60 %
Sodium / Metal Halide 250 W	LED 120 W TL	52 %
Sodium 400 W	LED 240 W	40 %
CFL 20 W	LED Bulb 10 W	50 %
CFL 11W	LED Bulb 7W	57 %
T5 (28W)	LED Bulb 18 W	35 %
Manual switching	Automatic Switching System for Dust to Dawn operation	10-15%

Air Conditioners

- Use ceiling or table fan as first line of defense against summer heat.
- Use BEE star labeled products.
- You can reduce air-conditioning energy use by as much as 40 percent by shading your home's windows and walls. Plant trees and shrubs to keep the day's hottest sun off your house.
- One will use 3 to 5 percent less energy for each degree air conditioner is set above 22°C (71.5°F), so set the thermostat of room air conditioner at 25°C (77°F) to provide the most comfort at the least cost.
- Using ceiling or room fans allows you to set the thermostat higher because the air movement will cool the room.
- A good air conditioner will cool and dehumidify a room in about 30 minutes, so use a timer and leave the unit off for some time.
- Keep doors to air-conditioned rooms closed as often as possible.
- Clean the air-conditioner filter every month. A dirty air filter reduces airflow and may damage the unit. Clean filters enable the unit to cool down quickly and use less energy.
- If room air conditioner is older and needs repair, it's likely to be very inefficient. It may work out cheaper on life cycle costing to buy a new energy-efficient air conditioner.
- Have your air conditioning unit checked every 6 months. If the Freon level is not correct, you will waste a lot of energy and your home will never be as cool as you want it.
- The gaps around the windows and doors leads to AC loss. You can use a candle to look for drafts. It the flame flickers or dances, found the place to seal.
- Use electronic devices with occupancy sensors which switch on or off automatically by sensing if the room is occupied.
- Buy split ACs instead of window ACs. They cost more, but they are more energy efficient and consume lesser electricity.
- Do not install AC units on the west and south walls as these are exposed to direct sunlight through a major part of the day during summers.
- Do not apply dark colors on the external surfaces (roof and walls) of the house. Dark colors absorb more heat than light colors, leading to increased use of the AC.
- Ensure that the condenser of the unit must have enough space around it for air to circulate and help the refrigerant dissipate its heat easily.

Refrigerators

- Make sure that refrigerator is kept away from all sources of heat, including direct sunlight, radiators and appliances such as the oven, and cooking range. When it's dark, place a lit flashlight inside the refrigerator and close the door. If light around the door is seen, the seals need to be replaced.

- Refrigerator motors and compressors generate heat, so allow enough space for continuous airflow around refrigerator. If the heat can't escape, the refrigerator's cooling system will work harder and use more energy.
- A full refrigerator is a fine thing, but be sure to allow adequate air circulation inside.
- Think about what you need before opening refrigerator door. You'll reduce the amount of time the door remains open.
- Allow hot and warm foods to cool and cover them well before putting them in refrigerator. Refrigerator will use less energy and condensation will reduced.
- Make sure that refrigerator's rubber door seals are clean and tight. They should hold a slip of paper snugly. If paper slips out easily, replace the door seals.
- When dust builds up on refrigerator's condenser coils, the motor works harder and uses more electricity. Clean the coils regularly to make sure that air can circulate freely.
- For manual defrost refrigerator, accumulation of ice reduces the cooling power by acting as unwanted insulation. Defrost freezer compartment regularly for a manual defrost refrigerator.
- Use BEE star labeled products.
- Keep your refrigerator and freezer at the right temperature. If they are only 2-3 degrees colder than necessary, energy consumption may go up by approx 25%.
- Make sure that the refrigerator is not place against outside facing wall or walls exposed to the direct sunlight.
- Make sure that you are using a refrigerator that is approximately sized for your needs. If your fridge is too small, you may be overworking. If it is too large, then you are potentially wasting energy and home space.

Water Heater

- To help reduce heat loss, always insulate hot water pipes, especially where they run through unheated areas. Never insulate plastic pipes.
- By reducing the temperature setting of water heater from 60 degrees to 50 degrees C, one could save over 18 percent of the energy used at the higher setting.
- Install Solar Water Heating System.
- A dripping faucet wastes water and if it's dripping hot water, its wasting energy too. Often requiring nothing more than a new washer, fixing leaks is one of the quickest and least expensive ways of reducing the energy and water bills.
- Using less hot water may be easier than you think. Water conserving shower heads and faucet aerators can cut hot water usage half. To see if this will work for you, first determine what your faucet and shower flow rates are now.
- To select the right water heater for your home, you need to consider family size and whether your usage would be considered high or low demand. It is assumed that you know your family size, so all you have to determine is your usage profile.

Computers

- Turn off your home office equipment when not in use. A computer that runs 24 hours a day, for instance, uses - more power than an energy-efficient refrigerator.
- If your computer must be left on, turn off the monitor; this device alone uses more than half the system's energy.
- Setting computers, monitors, and copiers to use sleep-mode when not in use helps cut energy costs by approximately 40%.
- Battery chargers, such as those for laptops, cell phones and digital cameras, draw power whenever they are plugged in and are very inefficient. Pull the plug and save.
- Screen savers save computer screens, not energy. Start-ups and shutdowns do not use any extra energy, nor are they hard on your computer components. In fact, shutting computers down when you are finished using them actually reduces system wear - and saves energy.

Ovens / Microwave Oven

- Microwaves use around 50% less energy than conventional ovens: they are more efficient for small portions or defrosting.
- Check the seal on your oven door to see if there are cracks or tears in it.
- Develop the habit of cooking to permit lower temperature settings.
- Carefully measure water used for cooking to avoid having to heat more than is needed.
- Begin cooking on highest heat until liquid begins to boil. Then lower the heat control settings and allow food to simmer until fully cooked.
- When preheating an oven for baking, time the preheat period carefully. Five to eight minutes should be sufficient.

Washing Machines

- Washing machines can account for as much as 20% of the electricity you use.
- Set the washing machine temperature to cold or warm and the rinse temperature to cold as often as possible.
- Each was cycle uses up to 60 to 90 liters of water. Use washing machine on full load and plan washing periodicity to save on water too.
- Adding too much detergent actually hampers effective washing action and may require more energy in the form of extra rinses.
- Wash only full loads of clothing-but do not overload machine. Sort laundry and schedule washes so that a complete job can be done with a few cycles of the machine carrying its full capacity, rather than a greater number of cycle with light loads.
- Soak or pre-wash the cloths for effective cleaning.

Ceiling Fan

- Use BEE five Star rated fans or BLDC Fans.
- Replace conventional regulators with electronic regulators for ceiling fans.
- Ensure proper height of the fan relative to the ceiling. If fan is too close to the ceiling, the airflow is restricted; that is, the fan will not be able to draw as much air through its blade as it has the potential to do. The distance that a fan should be mounted form the ceiling is directly correlated with its air moving potential; no fan should be mounted with its blade closer than 24 inches to the ceiling.
- Rewinding of fan motors decreases fan efficiency and hence increases the electricity consumption.

11. Annexure

Hospital Level Data Format Template	
Name of Hospital	
Address	
Contact Person and Mobile No	
District	
Type of Establishment	
Sector (Govt. / Pvt.)	
Mandatory Data	
Built up area (Sq meter)	
Annual Electricity Consumption (kWh)	
Connected Load (kW)	

Detailed Data			
Primary Data			**Year**
Sr. No.	**Item**		**Value**
1	Connected Load (kW) or Contract Demand (kVA)		
2	No. of Beds		
3	Installed capacity: DG/GG Sets (kVA or kW)		
4	Installed Capacity (Solar PV) kWp		
5	Installed Capacity (Solar Water heating system) LPD		
6	Annual Electricity Consumption, purchased from Utilities (kWh)		
	Annual Electricity Consumption, through Stand by Diesel Generating (DG)/Gas Generating (GG) Set(s) (kWh)		
	Annual Electricity Consumption, through Solar Power Plant (kWh)		
	Total Annual Electricity Consumption, Utilities + Solar+DG/GG Sets (kWh)		
7	a) Annual Cost of Electricity, purchased from Utilities (Rs.)		
	b) Annual Cost of Electricity generated through DG/GG Sets (Rs.)		
	c) Total Annual Electricity Cost, Utilities + DG/GG Sets (Rs.)		
8	Fuel used for generating steam & water heating	FO/LDO, etc in appropriate units	
		LPG/N Gas, etc. in appropriate units	
9	Fuel used for in-house power generation in appropriate units	HSD (or any other fuel oil) (KL) N gas/LPG, any other (Cu. m)	

10	Area of the Hospital (exclude area used for students' education, staff residences, hostels, parking, lawn, roads, etc.)	a) Total Built Up Area (sq. ft. or sq. m.)	
		b) Total Carpet Area (sq. ft. or sq. m.)	
		• Conditioned Area	
		• Non Conditioned Area	
		c) Non-active Carpet Area* (sq. ft. or sq. m.)	
11	Major Buildings Blocks in the Hospital (Specify below)		
	a) Blocks	No. of Floors and rooms	
	b) Blocks	No. of Floors and rooms	
	c) Blocks	No. of Floors and rooms	
12	Hospital	Total no. of Employees	
		Total no. of Out-Patients serviced annually	
		Total no. of Patient Beds in the hospital	
		In-patient Overnights (% Occupancy)	
13	Installed capacity of Air Conditioning (AC) System in the Hospital	Centralized AC Plant (TR)	
		Package ACs (TR)	
		Window & Split ACs (TR)	
		Total AC Load (TR) a) + b) + c)	
14	Installed Lighting load (kW) in the Hospital		
15	Installed Water Pumping load (kW) in the Hospital		
16	Installed Plug Loads (Medical equipment, Computers and others) (kW)		
17	Water consumption in the hospital (exclude garden, hostels, residences, students' education areas, etc.) (kilo liters)		
18	Estimated Hot water consumption in the hospital (kilo liters)		
19	Hospital Services	Catering (whether in-house or out-sourced)	
		Laundry (whether in-house or out-sourced)	
20	Whether sub-metering of electricity consumption for Air Conditioning, Lighting, Water pumping, Plug Loads, etc. done: Yes/No		

Other Data			
Sr. No.	**Item**	**Response**	
1	No. of operation theatres		
2	ICU		
3	Emergency (Y/N)		
4	No. of Ambulance		
5	Lab		
6	No of Lifts		
7	Appliances Details		
	Component	Rating (W)	Quantity
	Indoor		
	LED Lights		
	CFL		
	T5	28 W	
	T8/ other Tube Lights		
	Out Door		
	LED Street light		
	Halogen light		
	Other Conventional lights		
	Fans		
	70 W & above		
	Below 70 W		
	AC	TR and BEE Star rating	Total Nos.
	Window		
	Split		
	Details of Other Appliances		
a			
b			
c			
d			

AKSHAYA URJA BHAWAN

(Office Building of New and Renewable Energy Department, Haryana & HAREDA)

Salient Features

- First building in Government Sector in Haryana having 5 Star GRIHA Rating.
- Compliant with Energy Conservation Building Code (ECBC) and Solar Passive Architectural concepts
- Total covered area – 55000 Sq.ft.
- Autoclaved Aerated Concrete blocks used on East and West sides of building to act as insulation.
- Cavity walls on East and West sides filled with XPS foam to act as insulation.
- Fly ash bricks
- UPVC framed double glazed windows.
- South side glazed to have winter sun.
- Tapered windows on East and West sides to avoid sun rays in summer months.
- Heat resistance roof insulation tiles.
- Aluminium Composite Panel (ACP) louvers to have direct sun in winter in courtyard
- Misting system for cooling through evaporation
- Grey water used for landscaping using drip irrigation system.
- Solar Chimneys for natural flow of hot air
- 42.5 kW Solar Power Plant for internal electricity requirement.
- Recycled cellulose fiber sheets for training hall.
- Water saving faucets having flow controllers.
- Solar water heating system
- Variable Refrigeration Volume(VRV) air-conditioning system
- Furniture made of recycled agro waste
- Rain water harvesting

NEW AND RENEWABLE ENERGY DEPARTMENT, HARYANA
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