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Guidebook to Train the Trainer on Energy Efficient and Thermally Comfortable Buildings

BEEP
BUILDING ENERGY EFFICIENCY PROJECT

CMS
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About the Manual

The manual has been developed as a toolkit for journalists interested in writing stories on different aspects of Building Energy Efficiency. It has been designed as a resource for media persons as well as journalism students. It has been developed by the Centre for Media Studies (CMS), New Delhi for Indo-Swiss BEEP.

Preface

We track local weather forecasts daily, observe unseasonal or unusual trends in weather patterns, and are reminded how the weather is impacted by climate change, whenever we face or read about rising drought or floods.

However, how and what does the weather or climate outside got to do with the buildings we live in, with our lights and air-conditioners that make life comfortable for us inside? There are plenty of links. For example, the buildings and building construction sectors combined are responsible for over one-third of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions.

The topic requires more focused attention given India's rapid urbanization, the new government programs for buildings, and a general rise in construction. India's stock of buildings is projected to increase by three times by 2030, of which 60% is yet to be built. Buildings, therefore, are projected to become the single largest consumer of electricity in India by then. The Government of India has undertaken several initiatives for designing buildings that minimize energy consumption – called 'energy efficient buildings'.

One such key initiative is the Indo-Swiss Building Energy Efficiency Project (BEEP), bilateral cooperation between the Ministry of Power (MoP) under the Government of India, and the Federal Department of Foreign Affairs (FDA) of the Swiss Confederation. One of the objectives of the BEEP program is to raise awareness on environment-friendly or 'green' buildings that consume less energy through media under Media Engagement Program, as media plays an important role in flagging the topic, informing, and raising awareness.

For the BEEP Media Program on Energy Efficient Buildings, CMS has developed two manuals on the subject one for the media persons and the other for trainers of journalists. The aim of developing this manual for media persons especially journalists writing on the environment; science and energy sectors is to report on energy-efficient buildings with more insights, accuracy, and understanding. The overall Media Program on Energy Efficient Buildings includes training workshops and fellowship grants for media professionals.

This manual has been designed to cover the major aspects like the need and importance of conserving energy in the construction of housing and commercial buildings, the role of buildings in climate change. It also includes a section to provide the tools and techniques of reporting on the subject.

We acknowledge the strategic guidance and support received from Dr. Jonathan Demenge, Head and Counsellor, SDC, Dr. Anand Shukla, Senior Thematic Advisor, SDC, Mr Abhay Bakre, DG-BEE and Mr. Saurabh Diddi, Director, Bureau of Energy Efficiency. The manual could not have taken this shape without the technical inputs received from Dr. Sameer Maithel, Head, Indian Project Management & Technical Unit; Indo-Swiss Building Energy Efficiency Project (BEEP) and Ms. Vernica Prakash, program officer, BEEP.

The efforts of CMS team Ms. Annu Anand, Mr. Alok Srivastava and Mr. Prabhakar to provide constant editorial inputs to develop the final product are well appreciated.

We hope that this manual proves to be a useful tool for the journalists covering environment, energy and building sector which otherwise is considered to be a niche and somewhat technical subject.

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ENERGY SAVING
ON
OFF


LIVING ROOM
17,0 M²
BEDROOM
11,4
7,0 M²


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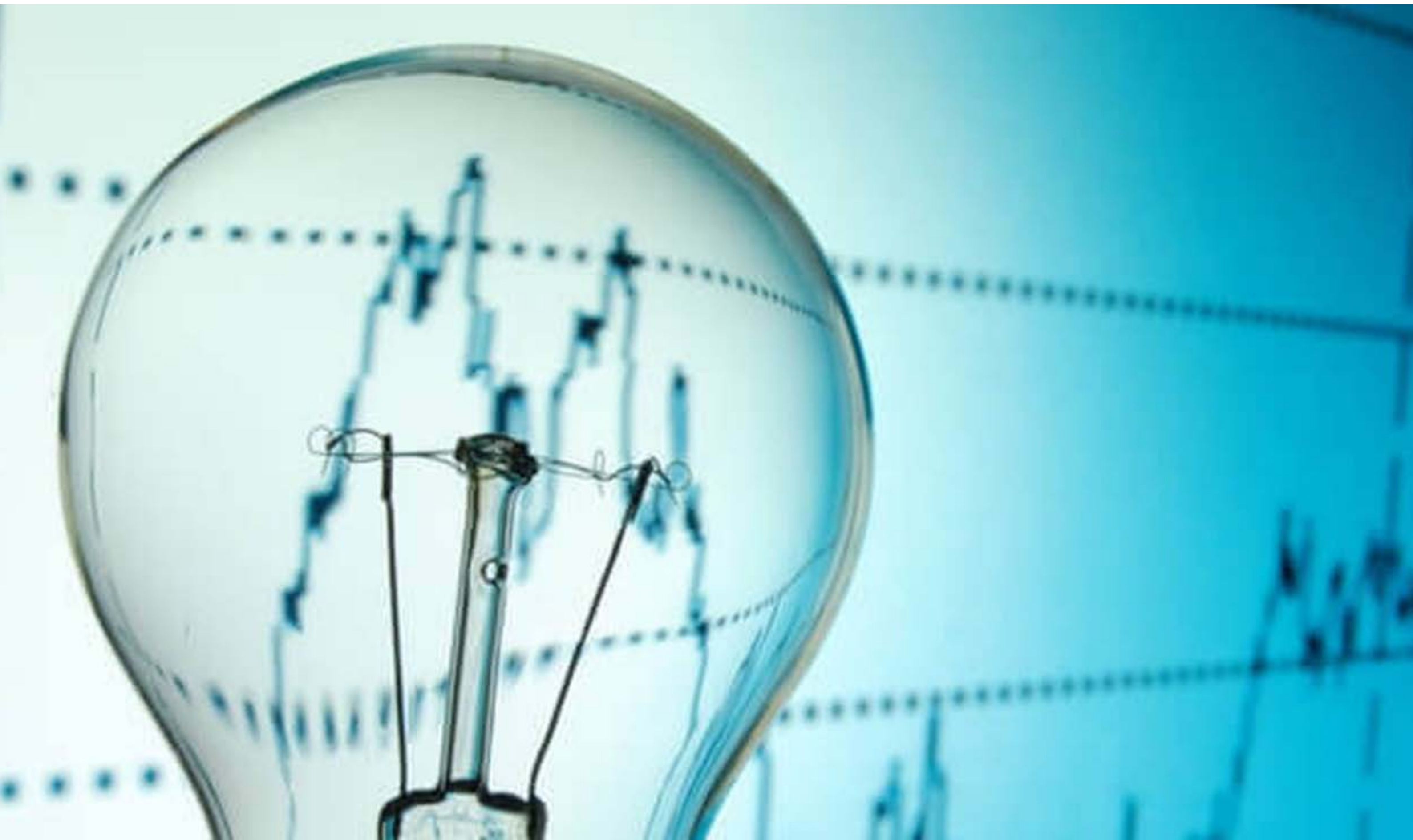

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Introduction

On a hot summer evening, returning from school, office or other workplaces, you switch on the air cooler/air conditioner and fans. Pulling the curtains down, you also switch on the lights. Later, cooking dinner, the fridge, microwave and other equipment are used. You are among those millions consuming electricity or energy.

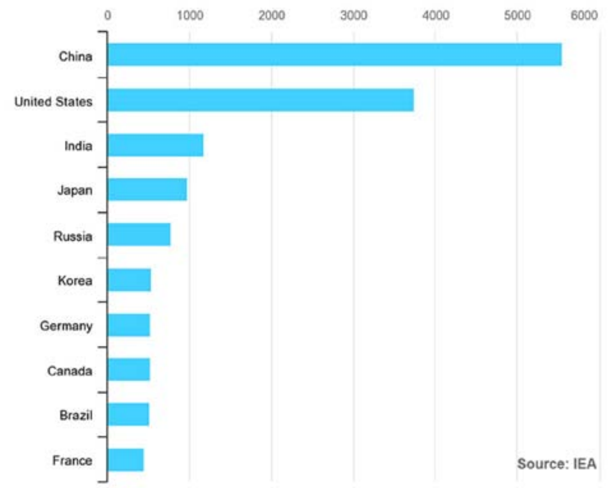
Globally, while energy acts as a stimulant in the economic growth and social development of every nation, its usage represents the largest source of greenhouse gas emissions (GHG) from human activities. About two-thirds of global GHG are linked to burning fossil fuels for energy to be used for heating, electricity, transport and industry.

Buildings are responsible for more than 40% of global energy use and one-third of GHG emissions. Buildings are also major emitters of other non-CO_2 greenhouse emissions such as halocarbons--mostly man-made gases consisting of both carbon and at least one of the halogens (fluorine, chlorine, iodine, and bromine).

Given the massive growth in new construction in economies in transition, and the inefficiencies of existing building stock worldwide, GHG emissions from buildings will more than double in the next 20 years, if nothing is done. Thus, buildings have a deep and possible adverse impact on the environment.

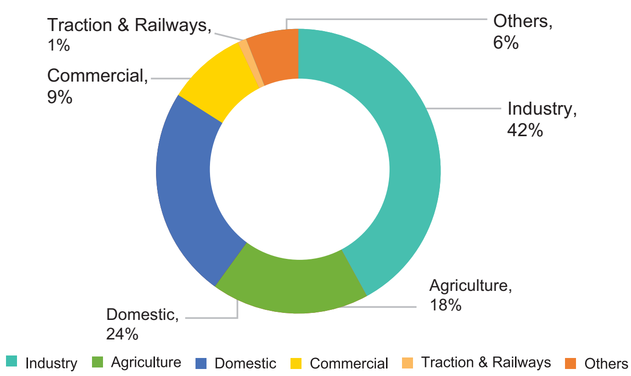
Electricity consumption in India

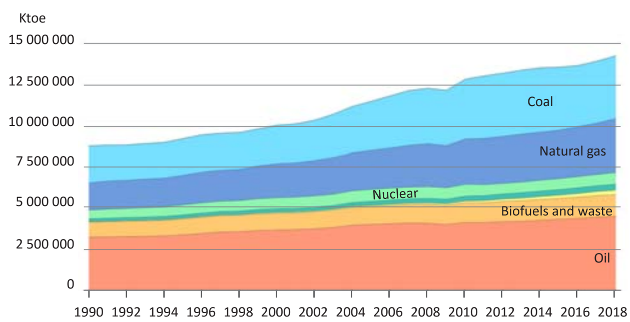
India is among the top 10 electricity consuming countries globally. It was ranked third with 1,164 TWh in November 2019, according to IEA. China was on top with 5,537 TWh, followed by the United States with 3,738 TWh.



The industrial and service sectors are the largest users of electricity in India, accounting for 74% of total final consumption (TFC) together, roughly half each (Figure 1).

Electricity Consumption by Sectors in India, 2017-18





Source: IEA

Energy consumption in buildings

In India, rapid economic growth, rising income, increasing population and urbanisation are leading to a surge in energy demand, and building energy consumption. Residential and commercial buildings account for nearly 30% of total electricity consumption today. This share is expected to increase to 48% – nearly half of electricity consumption – by 2047.[1]

We spend more than 90% of our time in buildings, either in the office or at home. Energy used in buildings (residential and commercial) accounts for a significant percentage of a country's total energy consumption. This percentage depends largely on the degree of electrification, the level of urbanisation, the amount of building area per capita, the prevailing climate, as well as national and local policies to promote efficiency.[2] Patterns of energy use differ between rural and urban populations.

Electricity consumption in the commercial building space has been growing rapidly at 11-12% annually, while in the residential building sector it is rising by 9.76% annually.

The key factor for the rapid increase of energy consumption in the buildings sector has been rising ownership levels for appliances such as air conditioners to provide comfortable indoor temperatures in urban areas in recent years. Water heating and refrigeration each account for significant shares of building energy use since they are constantly active.

The building sector, both residential and commercial, covers a diverse set of end use activities, which have different energy use implications. Building designs and materials have a significant effect on the energy consumed for a select set of end uses. Space heating, space cooling and lighting together account for a majority of building energy use. These depend not only on the energy efficiency of temperature control and lighting systems, but also on the efficiency of the buildings in which they operate.

Higher income levels have allowed households to purchase more appliances almost 40% of Indian households now own a refrigerator, compared to 25% in 2010. Cooling systems are also a major driver of increasing electricity demand. The number of households owning an air conditioner has increased by 50%. Yet, India still has one of the lowest appliance penetration rates in the world, according to 'India 2020: Energy Policy Review 2020', a report by the IEA.[3]

Despite a growth in residential electricity use, India's average monthly household consumption is low, at 90kWh—enough to run four tubelights, four ceiling fans, a TV, a small refrigerator and small kitchen appliances.

Government's endeavour

Household electrification has been a strong driver of India's electricity demand growth, reflecting a strong policy push: over half a billion people have gained electricity access since 2000.

The government has been addressing the problem of electricity access with improvement in its availability over years. The average duration of power available is 20-24 hours in cities and 18-20 hours in villages. The government launched the Saubhagya Scheme--Pradhan Mantri Sahaj Bijli Har Ghar Yojana--in 2017 to provide 24x7 affordable and quality power to all households. More than 26.2 million households were electrified under the scheme. The government achieved 100% household electrification by March 2019.

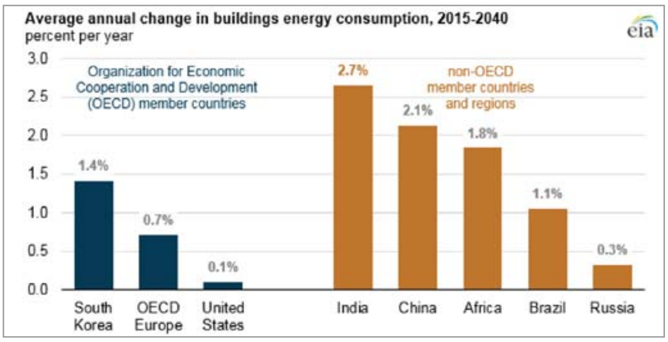
India is potentially on the tip of a rapid increase in energy consumption. It is poised to witness a number of transitions: in urbanisation, demographics, infrastructure and energy systems. Indian cities will be home to one of the largest historical influxes of people over the next few decades. It is estimated that two-thirds of the buildings that will exist in 2030 have not been built yet. Managing these transitions is a challenge, complicated by the need to address their immense energy implications.

Investing in energy efficiency across India's urban areas is, thus, essential to saving energy while meeting the demands of the growing building market, reducing air pollution, and combating climate change. Energy efficiency is also one of the fastest, cleanest, and cheapest ways, to not only address India's energy demand, but to also save costs, improve thermal comfort, and spur economic growth in the Indian context. Energy efficiency is also a key part of India's efforts to combat climate change.

Drop in demand following Covid-19 upsurge

Electricity demand dropped quickly with confinement measures but steadily recovered as the measures were gradually softened. In October, following relaxing of restrictions and a stronger economic environment, India seemed to be back on track of pre-Covid19 trends. The electricity demand (weather corrected) was more than 10% above October 2019 levels.[4]

Buildings energy consumption in India is expected to increase faster than in other regions. Among all regions of the world, the fastest growth in buildings energy consumption through 2040 will occur in India, EIA's *International Energy Outlook 2017* (IEO2017) projects.



Source: U.S. Energy Information Administration, *International Energy Outlook 2017* Reference case

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[1]Niti Aayog, Government of India, "India Energy Security Scenarios 2047," http://iess2047.gov.in/ pathways//electricity (accessed on 09 August 2019)

[2]https://www.unido.org/sites/default/files/2009-02/Module18_0.pdf

[3]https://niti.gov.in/sites/default/files/2020-01/IEA-India%202020-In-depth-EnergyPolicy_0.pdf

[4]https://www.iea.org/reports/covid-19-impact-on-electricity


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HALL

2

Understanding Buildings

Humans generally feel comfortable between temperatures of 22°C to 27°C and a relative humidity of 40% to 60%.

Our environment cannot be expected to maintain a consistent, 23.3°C (74°F), 50% humidity, climate. Hence, we adapt ourselves to environmental changes in our surroundings to seek comfort. We use umbrellas when it is raining, and also in summer to shield us from vagaries of the weather. However, we expect our homes to provide a consistent temperature and humidity every day, and protection from natural elements. This is possible only if the envelope of our building is designed carefully. The envelope consists of its roof, exterior doors, windows and the exterior walls.

OBJECTIVES:

This unit will introduce you to the essential features and structures of a building. It will explain the differences between a good and bad building envelope, its working and also its effect on the health of its inhabitants.

- What does a building comprise? Essential features of a building
- Building Envelope. How it works?
- What effects do a bad building envelope have on the health of its occupants and energy consumption?
- How can buildings with a good envelope and efficient systems be made?

Learning Outcomes: At the end of this unit, readers will understand the principles for minimising the environmental impact of buildings. They will also comprehend the background and understand the reasons for a more sustainable development of the built environment.

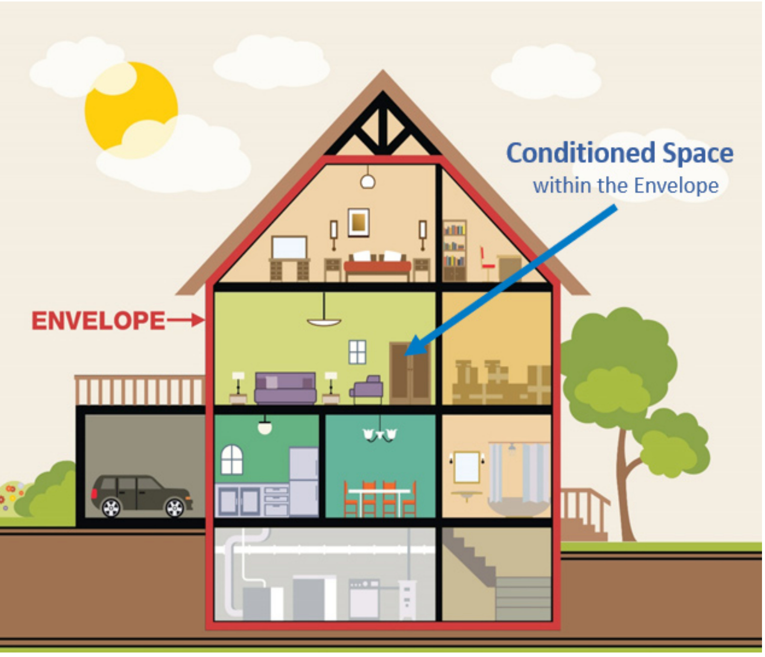
Highlights: Buildings owners can now achieve efficiencies in energy and water use, that were out of reach even in the recent past. Several options are available following advances in building technology, construction techniques, and operating strategies.

It is the exterior or shell of a building that protects the occupants from the natural elements. It is a silhouette of sorts. The concept relates to design and construction of the exterior. It is the physical or structural barrier between interior and exterior of a building. It is responsible for maintaining climate control, cooling and heating, inside the building.

In any building structure, the roof, walls and window face the same challenges i.e. heat, rain and wind, albeit in different measures. The roof bears the brunt of heat all day long. However, the intensity of the heat and wind that the walls and windows have to bear depend on which façade they are i.e. (North, South, East, West).

The envelope provides protection by enclosure and by balancing internal and external environmental forces. Hence, each element has to be designed very carefully. The envelope has also to respond to human values. Human concerns include safety, security, and task success.

Building envelope components work together to perform many functions. These can be divided into: support, control and finish. Support ensures strength and rigidity; providing structural support against internal and external loads and forces. Control is for the exchange of water, air, condensation and heat between the interior and exterior of the building. These facets ensure that a house is energy efficient, comfortable, and sustainable. Finishing makes the building look attractive while still performing the support and control functions. It is for aesthetic purposes. A good envelope should have climate-appropriate designs, and be structurally sound and aesthetically pleasing.



Building envelope system

A building envelope system needs to be designed and constructed properly. When it is correctly built, very few occupants pay attention. But when the envelope fails, everyone notices. The failures can include aesthetic loss, corrosion, poor indoor air quality, energy inefficiencies, and, in some cases, life-threatening structural failure and eventual litigation. Hence, a well-designed, well-maintained and regularly observed building envelope does not just save on energy bills; it will be better built to stand the test of time and mother nature.

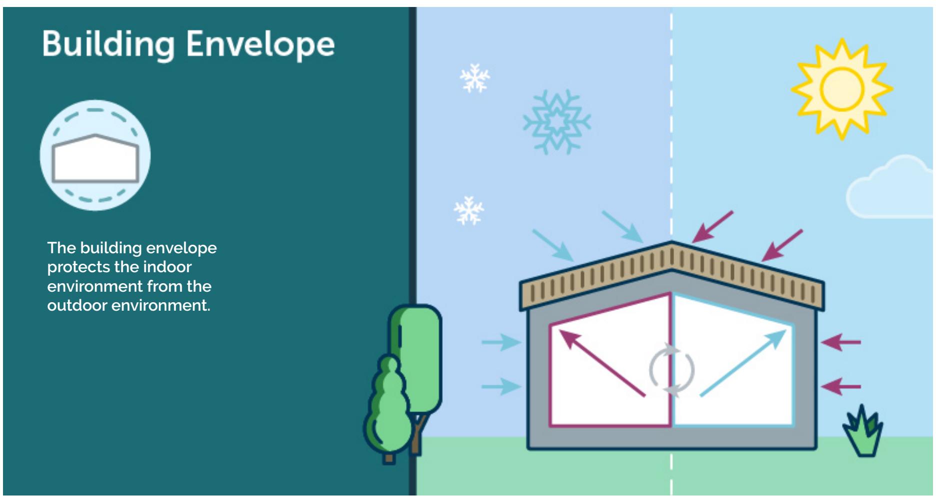
One among the best ways to get better energy efficiency is to focus on the design and construction of the building envelope. Energy efficiency refers to attempting to get a desired energy service using less primary energy.

Effects of a bad building envelope on occupants' health

More importantly, the building envelope is directly related to the health of inhabitants. A better building envelope leads to a healthier, more sustainable building. When built badly, it not only affects the health of the natural environment, it affects occupants' health as well.

Studies have shown that excess moisture or dampness and mould growth in buildings are associated with some upper respiratory symptoms (nasal congestion, sneezing, runny or itchy nose) and respiratory diseases, especially asthma, in children and adults. Excess water or moisture can lead to structural failures and health problems when materials stay wet long enough for microbial growth, physical deterioration, or chemical reactions to occur. However, excess moisture can be managed effectively if a building is properly designed, sited, constructed, operated and maintained.

The creation of a sturdy structure, or a base, depends on the way the foundation and walls are built for rest of the building. This is one of the main functions of construction because a well-built envelope is essential to merely keep the structure standing. The building's design should be precisely planned and followed to ensure that there are no open edges, cracks between the windows and walls and imperfections between the roof and the walls, or between the walls and the foundation. All these should be included in the building envelope concept.



High performance building strategies

Advances in building technology, construction techniques, and operating strategies now enable building owners to achieve efficiencies in energy and water use, that were out of reach even in the recent past. These advances touch almost every element in building operations, including the building envelope.

High-performance building envelopes, like their conventional design counterparts, protect the building and its occupants from the elements. But they can do more. They can respond to changes in interior and exterior conditions. They can provide levels of fresh air to building occupants based on occupancy levels. They can harvest solar energy. They can harvest and put to use rainwater. And, they can perform all of these activities through a combination of active and passive strategies.

For long, building envelopes have been known to protect the buildings and its contents. And, for how they affect total building energy use. To be successful, these envelopes must attain a balance of controlling the difference between the indoor and outdoor environments; meeting the needs of the occupants; protecting the building contents, and keeping operating costs as low as possible.

The envelope should also provide occupant comfort, while minimising energy and water use. Following are some high-performance building strategies.

Vegetative Roofs

Vegetative roofs have gained widespread acceptance in commercial and institutional facilities. Among the benefits:

By absorbing rainwater, a vegetative roof controls the rate of run-off, reducing the surge on the stormwater system.

Vegetative green roofs on top of a building

Vegetative roofs, also known as green roofs or living roofs, are thin layers of living vegetation installed on top of conventional roofs. A vegetative roof may be partially or fully covered with vegetation. Plants are used to create a green space on top of a building. Typical green roofs consist of multiple layers, including a durable waterproofing layer, a root management system, drainage layers, and some type of growing medium. Vegetation can be grown in large containers. However, true green roofs are those that are physically part of the roofing system. Depending on the climate, the system may include an irrigation system for periods of drought, and a drainage system to remove excess water from the roof.

The vegetation is planted in a growing medium installed over a waterproof membrane.

These roofs offer several advantages over conventional roofs. They provide a buffer between the temperature gradient across the roofing materials, decreasing heat loss or gain through the roof and reducing thermal stresses on the roof membrane. Since the membrane is covered by the vegetation and growing medium, it is protected from the harmful effects of the sun's UV light.

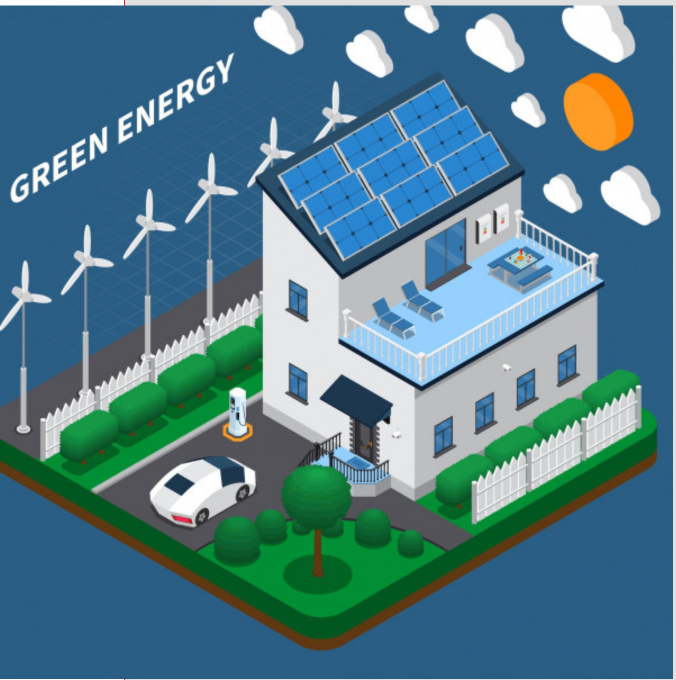
Vegetative roofs cost more to instal than conventional roofs, up to twice as much.

3

Designing Energy Efficient Buildings

Buildings, as they are designed and used today, consume excessive energy and other natural resources. Hence, they contribute to serious environmental problems. Energy intensive solutions sought to construct a building and meet its demands for cooling, ventilation, lighting and heating cause severe depletion of invaluable environmental resources. Thus, there is a close connection between energy use in buildings and environmental damage.

OBJECTIVES:



Overall, journalists will gain an understanding about the importance of design in energy conservation. In addition they will understand the goal of reducing a building's carbon footprint and total energy costs. They will also understand Passive/ climate responsive architecture, Design and Green Principles, Use of renewable energy sources and Green vs Conventional buildings.

Learning Outcomes: This chapter will create an awareness about developing an energy efficient and sustainable approach to design. It will also acquaint readers with designing energy efficient building envelopes that respond to the climate of a place, efficient practices in India.

Highlights: Design is one of the most important aspects of a building. Cooling, heating and ventilation should be given utmost consideration in a building's architectural design. Otherwise, it will lead to severe depletion of invaluable environmental and financial resources.

Therefore, buildings ought to be designed to meet an occupant's requirement for thermal and visual comfort, with reduced levels of energy and resources consumption. An integrated approach to design is necessary in new constructions for energy resource efficiency.

Green Principles

A solar passive design can be incorporated to minimise load on conventional systems (cooling, ventilation, lighting and heating). Passive systems provide thermal and visual comfort by using natural energy sources and sinks e.g. solar radiation, outside air, sky, wet surfaces, vegetation, internal gains.

In these systems, energy flow systems are by means such as radiation, conduction, convection. Thus, solar passive systems vary according to climate. In a hot climate, an architect would primarily aim to reduce solar gains and maximise natural ventilation and so on. While in a cold climate, he would design in such a way that solar gains are maximised.

Lighting, Ventilation and HVAC Systems

Another important aspect is the design of energy-efficient lighting and HVAC systems (heating, ventilation and air-conditioning). Once the passive solar architectural concepts are applied to a design, the load on conventional systems (HVAC and lighting) is reduced. Further, energy conservation is possible by judicious design of the artificial lighting and HVAC system using energy efficient equipment, controls and operation strategies.

Renewable energy systems (solar photovoltaic systems/solar water heating systems) can be used to meet a part of building load. The pressure on non-renewable resources can be alleviated by judiciously using renewable resources i.e. solar energy. Consumption of conventional forms of energy can further be reduced by using solar energy for electrical needs for a building.

Energy efficiency in architecture

An architect should aim at efficient structural design, reduction of use of high embodied energy building material (glass, steel etc.). Thus, an energy efficient building balances all aspects of energy use in a building: lighting, space-conditioning and ventilation, by providing an optimised mix of passive solar design strategies, energy-efficient equipment and renewable sources of energy. Use of materials with low embodied energy also forms a major component in energy-efficient building design.

Some common design elements that directly or indirectly affect thermal comfort conditions, and thereby a building's energy consumption, are -- landscaping, ratio of built form to open spaces, location of water bodies, orientation, planform, building envelope and fenestration.

Roofs

The roof forms an important part in any building. It receives abundant solar radiation and thus plays a vital role in heat gain/losses, daylighting, and ventilation. Hence, proper treatment of roof is very important and depends on the climatic needs. In a hot region, the roof should have enough insulating properties. Various options are available.

Vermiculite concrete is one such option. It can provide effective roof insulation. It has been used in the RETREAT building at Gual Pahari (near New Delhi) and has reduced roof conduction by 60%.

The roof can also be used advantageously for effective ventilation and daylighting by incorporating vents and skylights. This has been demonstrated effectively in the office building of the WBREDA (West Bengal Renewable Energy Development Agency) in Calcutta. The four-storied building has been built with the solar passive architecture concept. The skylight provides natural light for its inner office spaces and is connected to the office spaces for inducing ventilation by stack effect.

TERI-Retreat building at Gual Pahari

Besides roof, walls are a major part of the building envelope and receive large amounts of solar radiation. Their heat storage capacity and heat conduction property are key to meeting desired thermal comfort conditions. Based on the cooling and heating needs of the building, thickness, material, and finishes can be chosen. Appropriate thermal insulation and air cavities in walls reduce heat transmission into the building—much needed in a hot region.

Green buildings vs Conventional buildings

Conventional buildings consume large amounts of water, energy and materials. A building that uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building, is called a green building. It has high thermal insulation, rain water harvesting, terrace gardening, ventilation and energy efficient appliances. Green buildings promote use of renewable energy, recyclable and recycled products. They should save 36-40% water, 30-40% energy and 25-40% material compared to a conventional building.[1]

Green buildings consume 40% to 60% lesser electricity as compared to conventional buildings. They rely on passive architectural interventions in design, and high efficiency materials and technologies in the engineering design.

A green building design should aim to minimise the demand on non-renewable resources, maximise utilisation efficiency of these resources, when in use, and maximise the reuse, recycling, and utilisation of renewable resources. It maximises the use of efficient building materials and construction practices; optimises the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximises the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions.

The building should have an integrated design. It should look into site planning, building envelope design, building system design, ((HVAC) heating ventilation and air conditioning, lighting, electrical, and water heating, integration of renewable energy sources to generate energy onsite, water and waste management, selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential, etc.) and indoor environmental quality (maintain indoor thermal and visual comfort, and air quality).

Design of Energy Efficient and Thermally Comfortable (EETC)

Residential Buildings

The design of a comfortable and energy efficient residential building largely depends on the design and properties of its building envelope (i.e. walls, windows and roof).[2] This is complemented by efficient lighting and appliances. Clean energy generated from renewable sources in the building premises completes this picture of energy efficiency.

Building Envelope

The building design and envelope should boost thermal comfort to the extent possible in the given climate. For this, the building's design should:

- Reduce heat gains into the house (in hot climates), and reduce heat loss from the house (in cold climates)
- Allow for adequate natural ventilation, when needed.

These two requirements can be achieved through a few simple design guidelines:

- Orienting the building to minimise solar exposure on vertical surfaces and for optimal utilisation of wind flow for ventilation.
- Selecting the building shape and massing to minimise or maximise solar exposure on vertical surfaces, depending on the climate zone, and to influence the building's wind access.
- Conducting a solar exposure analysis before deciding on building massing and spatial configuration. If there are other buildings in close proximity, this would also help understand mutual shading patterns.

- Reducing heat gain through the roof in hot climates by using insulation, shading the roof, or installing a high reflective finish.
- Windows on different orientations require different shading strategies.
- Optimising window sizes to allow enough daylight and ventilation. Window-to-Wall Ratio (WWR) should be between Window-to-Wall 10%–30%, depending on the amount of mutual shading by surrounding objects, allowing good balance between adequate daylight and reduced heat gains.
- Shading windows to cut off solar radiation in hot climates.
- An insulative wall and installing doubled glazed units on windows will help reduce heat gains through walls and windows in hot-dry, composite, and cold climate zones. In warm humid regions, it is more important to shade the windows than increase the wall insulation and use double glazed units.
- Designing and positioning windows to improve natural ventilation, be it cross-ventilation or single-sided ventilation.
- Sealing windows properly. In hot climates this reduces hot air infiltrating from outside when you're using the air-conditioner. In cold climates, properly sealed windows reduce cold drafts entering the home. Both strategies reduce electricity consumption.
- Using casement windows (or windows with hinges) instead of sliding windows. For the same window size, casement windows have more openable window area than sliding windows, allowing better ventilation potential. This is especially needed in warm humid climates.

Equipment

Certain equipment can make a residential building more thermally comfortable.

- In case of hot-dry and composite climates, evaporative cooling, when possible, could be used.
- Highest star-rated equipment and household appliances, including LED lights, star-rated ceiling fans, air-conditioners, LED Lights and other appliances.
- When using an air-conditioner, the cooling set-point up to 28°C should be raised and used along with a ceiling fan. The saving potential in cooling energy demand when increasing cooling temperature set-point from 24 °C to 28 °C is at least 55%.
- Energy-efficiency features could be incorporated in the design of shared services like common area lighting, community water pumping system, and lifts.

Renewable Energy: The building itself can be a source of energy generation. To do so utilise rooftops and other feasible open areas for renewable energy generation. For e.g. solar water heaters for hot water generation or solar PV for electricity generation.

Design of Energy Efficient and Thermally Comfortable (EETC)

Commercial Buildings

High occupancy and the constant use of equipment, artificial lighting, and air conditioning often make commercial buildings more energy intensive. While there is scope for large amounts of saving (up to 50%), it is important to incorporate good building design elements to attain these savings. It is also recommended to use various building performance simulation tools for taking the design decisions.[3]

The following steps can make a commercial building more energy efficient and thermally comfortable:

Passive measures to reduce heat ingress

With correct orientation, building massing and optimised design of building envelope (i.e. walls, windows, and roof), one can minimise heat ingress (or maximise for cold climate), utilise daylight and improve natural ventilation. All these aspects reduce the energy requirement for maintaining thermal and visual comfort.

Orientation: Longer façade oriented towards North-South is recommended to minimise solar exposure, for hot climates.

Building massing: While the compact form (low surface to volume ratio) helps in reducing solar exposure (and heat gains from exposed surfaces), it may also lead to lower potential for daylight and natural ventilation; hence, would need optimisation.

WIndow-to-Wall Ratio (WWR): Window sizes should be optimised to limit heat gains and yet allow enough daylight and natural ventilation potential; a WWR of 20-30% is recommended.

Window Design: Placement and size of windows (e.g. taller windows, placing in opposite façade, etc.), can help tap daylight and natural ventilation potential; evaluate and optimise the window design.

Glazing: For hot climates, low SHGC (0.5). For cold climate, it is important to reduce U-value of glazing by choosing at least two-pane glazing.

Shading: For hot climates, shading should be designed to reduce solar gains. For buildings with north and south orientation, static shading (overhang and side-fins) may be sufficient. For east and west orientation, a movable front screen is recommended.

Insulation and Reflectivity: For hot-dry and composite climates, the roof and walls should be insulated to reduce heat gain. For warm-humid and temperate climate, wall insulation should be checked for its effectiveness. Higher level of insulation is recommended for cold climate.

Higher reflectivity (using high SRI paint or construction material) is recommended for hot climates.

Building Tightness: All openings (windows, doors etc.) should be properly sealed to minimise infiltration/exfiltration.

This helps in reducing cooling and heating energy in hot and cold climates, respectively.

Active Measures to Meet Requirements Efficiently: These Including appropriate HVAC selection, lighting and other equipment should be put into place once the requirement for thermal and visual comfort is minimised. This will ensure reduced energy consumption by active systems for meeting the thermal and visual comfort.

HVAC System Sizing: The size should be determined using modern simulation tools, which accounts for loads (including passive measures) accurately, thereby providing appropriate system sizes.

HVAV Technology Selection: Depending on the loads and comfort requirement, select the most efficient HVAC system. e.g. radiant cooling, evaporative cooling system, etc.

Efficient HVAC Components: Better efficiency of each components, coupled with appropriate size and design, helps in achieving better efficiencies. e.g. high COP chillers, hybrid AHUs, 5-star rated unitary ACs, etc.

To improve system efficiency, energy efficiency features, such as enthalpy recovery wheels, VFDs for fans/pumps, demand-controlled ventilations, etc., may be added.

Lighting: Lighting design should be optimised and efficient lighting (like LEDs) used to minimise energy use. To further reduce it, daylight and occupancy sensors should be added.

Star Rated Equipment and Appliances: Use high star-rated equipment and appliance as far as possible.

Renewable Energy to Meet Part/Surplus Energy Requirement: By using renewable energy, it is possible to have near-zero or net-positivity energy in buildings, when the first two steps are followed carefully.

Solar Systems

Solar PV System: Typically, 1 kW of solar PV system takes 7-10 m^2 of space and can generate 4-5 kWh on clear days (depends on location). Maximise the solar PV system size by utilising maximum possible area.

Solar Water Heating (SWH) System:

The building design must have provisions to easily integrate SWH system, for instance, by adding additional piping for SWH in each room of a hotel building. The demand for hot water may vary significantly; hence, sizing calculations must be done meticulously.

Location of Solar Systems: Shade-free areas on rooftops, ground, parking, etc. could be used to instal solar energy systems. Prioritise use of area for solar system depending on the requirement.

[1]International Journal of Innovative Science and Research Technology

[2]https://www.beepindia.org/wp-content/uploads/2013/12/Energy-Efficient-Homes_7.pdf

[3]https://beepindia-ebizon.netdna-ssl.com/wp-content/uploads/2020/07/Summary-Note_Residential-Buildings.pdf

4

Schemes and Codes for Energy Efficiency in Buildings

Energy acts as a stimulant in the economic growth and social development of every nation. Buildings are responsible for more than 40% of global energy use and one-third of greenhouse gas (GHG) emissions--the main source of energy consumption.[1] But buildings are also major emitters of other non-CO2 greenhouse emissions such as halocarbons. Thus, buildings have a deep and possible adverse impact on the environment.

OBJECTIVES:

Source: WBREDA

This unit will give a general understanding about the importance of energy efficiency, energy flow, consumption and performance of commercial and residential buildings.

It will also offer an understanding of the methodology used to determine the energy efficiency of buildings. It will detail the energy efficiency measures, conservation, cost savings, and also opportunities for improving the energy efficiency of buildings and the potential savings.

- Labelling Programme for Residential buildings
- Determining a building's energy performance
- Energy efficiency
- Energy Efficiency Measures (EEMs) and Conservation
- Energy Performance Index (EPI)
- Certifying Energy Efficiency
- Bureau of Energy Efficiency (BEE)
- Star Rating for Commercial Buildings
- Star Labelling Programme for Residential buildings
- Star Labelling Program for Appliances and Equipment
- Adoption of Energy Conservation Building Code 2017 (ECBC 2017)
- Eco-Niwas Samhita 2018
- Rating Systems of Green Buildings
- Green Rating for Integrated Habitat Assessment (GRIHA)
- Indian Green Building Council (IGBC)

Learning Outcomes: To appreciate the significance and benefits of energy efficiency in buildings. Readers will get a general uunderstanding of the practice used to determine the energy efficiency of buildings, the different opportunities for improving energy efficiency and the potential savings.

Highlights: Buildings are major energy guzzlers. Hence, occupants should give a serious thought to energy conservation. To avoid long-term futile energy consumption liability, the BEE I has developed energy conservation codes for both commercial (ECBC 2017) and residential buildings (ENS 2018). It promotes the better design of buildings to be energy efficient. Energy saved is synergy paved.

Depending on the climate, dwelling type, and level of development, residential energy requirements vary from region to region and country to country. Given the massive growth in new construction in economies in transition, and the inefficiencies of existing building stock worldwide, GHG emissions from buildings will more than double in the next 20 years, if nothing is done.

In India, rapid economic growth, rising income, increasing population and urbanisation are leading to a surge in energy demand, and building energy consumption. Patterns of energy use vary between rural and urban populations. Buildings are responsible for around 35% of the total energy consumption. Their energy use is increasing at 8% annually. If left unchecked, the energy demand could increase by almost 700% by 2050 compared with 2005 levels (GBPN, 2014)[2]. The associated CO_2 emissions are likely to increase tenfold (1.1 Gt).

Buildings are designed for a specific climate. Yet, they often have a lifetime of 100 years.[3] Due to global warming, buildings can be vulnerable to climate change that may require a building to operate over a range of climatic conditions. Climate change is expected to have an impact on many aspects of building performance. Building codes and practices around the world attempt to protect people and property from the normal range of climate variation. Once this is exceeded, problems may arise. These may range from uncomfortable internal environments to extensive destruction of large numbers of buildings. In times to come, these may include declining health and significant loss of value as a result of more storms, snow or subsidence damage, water encroachment, deteriorating indoor climate and reduced building lifetime.

Energy Efficiency

Energy efficiency or efficient energy use means using less energy to achieve same or higher level of output and/or services. It is the amount of energy produced in proportion to the amount of energy used to produce it. For example, insulating a home allows a building to use less heating, and cooling energy to achieve and maintain a comfortable temperature.

Energy efficient buildings are those that are designed to provide a significant reduction of the energy need for heating and cooling, independently of the energy and of the equipment that will be chosen to heat or cool the building.

The energy efficiency of a building is determined by the rate at which energy is lost through the physical structure of the building (the building envelope), and the rate at which energy is used to meet the energy needs and physical comfort of the occupants. These two factors are often closely interrelated. This is because the physical structure and design of a building, interacting with the local climate, strongly influence the choice of energy system and the associated efficiency of that system.

Energy efficiency is an important conversion-related factor. It is calculated by dividing the energy obtained (useful energy or energy output) by the initial energy (energy input). For example, a refrigerator has an energy efficiency of 20 to 50%, an incandescent bulb about 5%, and an LED lamp over 30%.

The conversion efficiency for heating, lighting and household appliances is essential for calculating the energy efficiency of houses and buildings. The higher it is, the more energy efficient the building is likely to be—though, this also depends on other factors such as insulation quality.

Energy Efficiency Measures and Conservation

We spend maximum amount of time in buildings. Buildings consume energy at different levels in every stage of their life cycle, with building materials occupying a great share of this. Therefore, the energy consumed by materials during their life cycle is an important parameter in determining a building's energy efficiency.

Conventional building Vs Green building

There are six life cycle stages of a building: raw material extraction; manufacturing; designing and construction; operation and maintenance; as well as its disassembly, demolition and waste disposal, reuse or recycling. These stages are all intensively involved, in that the use of natural resources, energy and water are consumed in each of them. Nearly half of all non-renewable resources (water, energy, and raw materials) is used in construction. The energy consumed is collectively interpreted as embodied energy.

Energy Performance Index (EPI)

BEE has developed the Energy Performance Index (EPI). The total energy consumed upon total built up area is known as Energy Performance Index (EPI)--the total energy consumed in a building over a year divided by total built up area in kWh/sq m/year. It is considered as the simplest and most relevant indicator for qualifying a building as energy efficient or not. EPI is one of the many indicators in the holistic definition of green buildings. The unit of KW hours per square metre per year is considered for rating the building and especially targets air-conditioned and non-air-conditioned office buildings.

Globally, EPIs are used to evaluate and monitor residential and commercial building energy performance during design, construction, renovation and operation. The two most common indices are Asset Ratings and Operational Ratings. Asset Ratings are based on modelled energy use with uniform conditions of climate, schedules, plug loads (energy used by equipment that are plugged into a power outlet), occupancy, and energy management. Operational Ratings are based on measured energy use, often normalised for relevant variables like climate and level of energy service.

Certifying energy efficiency

BEE issues rating certificate indicating the level of compliance done by an organisation about the standards and guidelines issued by the bureau. The certificate is framed to regulate, audit the time intervals, monitor and improve energy efficiency.

Overall, energy savings estimates for commercial and residential buildings vary between 30 and 70%.

Buildings are given two ratings based on the intrinsic and actual energy performance:

- Design-based Rating: A rating of the proposed design of the building fabric and building services equipment and is based on theoretical values or software simulations.
- Operational/ Performance Rating. This will be influenced by the quality of the building (as measured by the Asset Rating), but also by the way the building is maintained and operated. It is based on the normalised actual metered energy consumption.

An energy efficiency certificate is a summary of the building energy audit. It is meant to give information on the building's energy consumption and its energy efficiency rating. It measures the power density of lighting system installations of buildings.

The purpose of energy efficiency certificates is to:

- Inform tenants and prospective buyers of the expected running costs. With buyers and prospective tenants better informed, builders and landlords will have greater incentive to incorporate energy-efficient technologies and designs into their buildings, in return for lower running costs.
- Create public awareness – In large buildings, regularly visited by the public, display of energy performance certificates will raise awareness among citizens of the issue of energy efficiency in their local community.
- Act as a prerequisite of measures to improve its energy efficiency;
- Effect incentives, penalties or legal proceedings.

The energy efficiency certificate is therefore essentially accompanied by modernisation recommendations for low-cost improvement of the building's energy efficiency.

Bureau of Energy Efficiency (BEE)

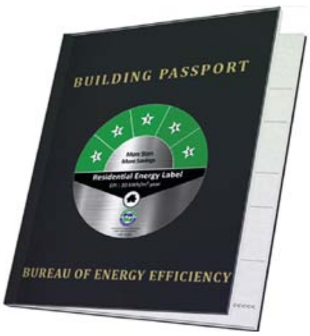
The Bureau of Energy Efficiency (BEE) develops policies and builds strategies with a push towards self-regulation to achieve energy efficiency. Established on March 1, 2002, it is monitored by the Ministry of Power, to enhance delivery mechanisms, provide leadership and create conservation policies leading to efficient energy preservation.

Star Rating for Commercial Buildings

Energy audit studies in buildings have shown large potential for energy savings both in government and commercial office buildings. Hence, to accelerate energy efficiency activities in commercial buildings across the country, BEE developed a scheme for energy efficiency labelling of buildings in February 2009. Star labels are given for day use to office buildings, BPOs, hospitals and shopping malls.

BEE's Star Rating Programme provides public recognition to energy efficient buildings, thus creating a market demand for such buildings. It is based on the energy usage in the building over its area expressed in kWh/sqm/year. Buildings are rated on a 1-5 Star scale with 5-Star labelled buildings being the most efficient. The rating scheme is based on actual performance of the building in terms of specific energy usage termed as EPI.

The Reserve Bank of India's buildings in Delhi and Bhubaneswar, the CII Sohrabji Godrej Green Business Centre and many other buildings have received BEE 5-star ratings.



Star Labelling Programme for Residential buildings

BEE label for residential buildings

The BEE label for residential buildings provides information to consumers about the energy efficiency programme standard of all types of homes across India.

The labelling programme aims to make the energy performance of a home an instrument of comparison while deciding on home prices in the future. It also aims to provide a benchmark to compare one house with the other on the energy efficiency standards to create a consumer-driven market transformation solution for energy efficiency in the housing sector. At the same time, it positions domestic industry to compete in such markets where norms for energy efficiency are mandatory. The labelling scheme covers all types of residential buildings in India. Till 2019, BEE gave the rating only to commercial establishments.

The labelling programme is expected to save a substantial amount of electricity through various energy efficiency efforts in residences nationwide in the medium and long run. By 2030, energy savings are estimated to be up to 40% over traditional houses with an annual savings of 90 billion units.

Star Labelling programme for appliances and equipment

Over the past three decades, with technological advances, efficiency of appliances and equipment used in homes and businesses has increased significantly.

BEE promotes the use of energy efficient products in India. Its Standards and Labelling Programme provides the consumer an informed choice about energy saving and thereby the cost saving potential of the marketed household and other equipment. Energy labels are informative labels affixed to manufactured products. These provide consumers with the data necessary for making informed purchases.

The scheme endorses display of energy performance labels on high energy end-use equipment and appliances and lays down minimum energy performance standards.

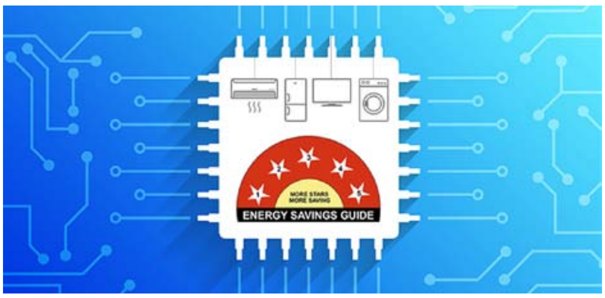
BEE issues two types of labels for products manufactured in India.

- Endorsement label: Products are labelled as per their minimum performance criteria to become a BEE certified company.
- Comparative label: Products are labelled as per the star rating (scale of 1 to 5) which includes BEE logo and license number on the product. This rating helps consumers choose the right product.

Labelling creates standards and regulates star rating for different appliances like refrigerators, water heaters, AC, fans, pump, etc. The star ratings define the standard of energy efficiency. For certification, manufactured products are subjected to tests designed by BEE.

Benefits of Star Labelling

Star labelling of appliances is a cost-effective policy tool for improving energy efficiency and lowering energy cost of appliances/equipment for consumers. The programme aims to foster a sustainable "market transformation" by shifting the markets toward increased sales of energy-efficient star labelled products.



Star rating for appliances

The Star rating schemes allows consumers to compare the operating cost and environmental performance of similar products. Thus, consumers can make better choices and see the potential ongoing future costs and greenhouse gas impacts our decisions may have.

Energy Conservation Building Code (ECBC)

To address the growing requirements of energy and promote energy efficiency in the building sector, BEE developed the Energy Conservation Building Code (ECBC) for commercial buildings in 2007. It is designed to provide minimum requirements for energy-efficient design and construction of buildings and their systems. The code was amended in 2017.

ECBC 2017 prescribes energy performance standards for new commercial buildings being constructed across India. Several states and cities have made strong progress in adopting the ECBC, working with leading real estate developers and other stakeholders.

ECBC 2017 code provides present and futuristic advancements in building technology to cut down building energy consumption and promote low-carbon growth. It sets criteria for builders, designers and architects to integrate renewable energy sources in building design through the inclusion of passive design strategies.

The code aims to optimise energy savings with the comfort levels for occupants and also achieve energy neutrality in commercial buildings. It takes into account market changes, and the country's energy demand scenario. The code has been set in such a way that it will set a benchmark for Indian buildings to be amongst some of the most efficient globally.

The building sector represents about 33% of electricity consumption in India, with the commercial sector and residential sector accounting for 8% and 25% respectively. Computations indicate that ECBC-compliant buildings can use 40 to 60% less energy than conventional buildings. It is estimated that the nationwide mandatory enforcement of the ECBC will yield annual savings of approximately 1.7 billion kWh.

To be ECBC-compliant, new buildings should be able to demonstrate minimum energy savings of

25%. Energy savings of 35% and 50% will enable the buildings to achieve higher grades like ECBC Plus or Super ECBC status respectively. The adoption of ECBC 2017 is expected to achieve a 50% reduction in energy use by 2030 which will translate into energy savings of about 300 billion units by 2030. It will result in expenditure savings of Rs 35,000 crore and reduction of 250 million tonnes of CO_2.

ECBC is a voluntary code and applicable only to commercial buildings with a connected load greater than 100 kW, or connected demand of 120 kVA and above. The scope extends to the building envelope, lighting systems and controls, HVAC systems and controls, and service hot water and electrical systems.

ECO Niwas Samhita 2018[4] or the Energy Conservation Building Code for residential buildings (ENS) is aimed to benefit occupants and the environment. The code aims to promote design and construction of homes including apartments and townships to give benefits of energy efficiency to the occupants. It is aimed to benefit occupants and the environment and provide a further stimulus to India's energy conservation efforts. The application of ENS is anticipated to preserve about 125 billion units of electricity by 2030, according to experts.

The code prescribes minimum standards for building envelope designs with the purpose of designing energy efficient residential buildings.

Building Systems	Requirements
Envelope	Roof and wall Insulation, window to wall ratio, glazing SHGC and VLT
HVAC	Equipment efficiency, duct and pipe insulation, HVAC controls, economisers variable flow systems, system balancing
Lighting	Lighting power density, lighting controls
Electrical	Transformers, EE motors, power factor, system losses, metering
Service Hot Water	Equipment efficiency, heat traps, pipe insulation

While the Centre has powers under the EC Act 2001, the state governments have the flexibility to modify the code to suit local or regional needs and notify them.

Eco-Niwas Samhita 2018

Another code was launched on December 14, 2018, to push for energy efficiency in the residential sector (homes, apartments and townships) and provide further stimulus to India's energy conservation efforts.

Rating Systems of Green Buildings

Incentive mechanisms and opportunities are available to help developers overcome barriers to building green to achieve higher levels of energy efficiency, locking in cost and energy savings. Building rating systems recognise newly constructed or retrofitted buildings that achieve high levels of energy efficiency. Besides lower operating costs and other benefits, building efficiency champions benefit from the brand recognition, leadership, and market competitiveness that come with such ratings.

India has three primary rating systems for green buildings.

The Ministry of New and Renewable Energy (MNRE) awards the Green Rating for Integrated Habitat Assessment (GRIHA) certification, a five-star rating system based on a building's various sustainability features.

The Indian Green Building Council (IGBC) awards the Leadership in Energy & Environmental Design (LEED) India certification, which range from "Certified" to "Platinum" based on efficient features. Both GRIHA and LEED require third-party verification before certification—a critical component to ensure efficiency savings and thereby maximize the potential benefits of these ratings programs. The Bureau of Energy Efficiency (BEE) also issues a five-star rating system based on the actual performance of a building, normalised for its operational use and climatic zone.

Green Rating for Integrated Habitat Assessment (GRIHA)

Keeping in view the Indian agro-climatic conditions, and in particular the multitude of non-AC buildings, a National Rating System called Green Rating for Integrated Habitat Assessment (GRIHA)[5] was developed. It is suitable for all kinds of buildings in different climatic zones.

The system was jointly developed by the Ministry of New and Renewable Energy, and TERI (The Energy and Resource Institute) as TERI-GRIHA. Later, it was altered to GRIHA. It takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 announced by BEE and other IS codes, local bye-laws, other local standards and laws. The system 'rates' a building based on the degree of its 'greenness'. The rating can be applied to new and existing building stock of varied functions – commercial, institutional, and residential.

Among the buildings that have received GRIHA rating are: Commonwealth Games Village, New Delhi, Fortis Hospital, New Delhi, CESE (Centre for Environmental Sciences & Engineering), IIT Kanpur, Suzlon One Earth, Pune.

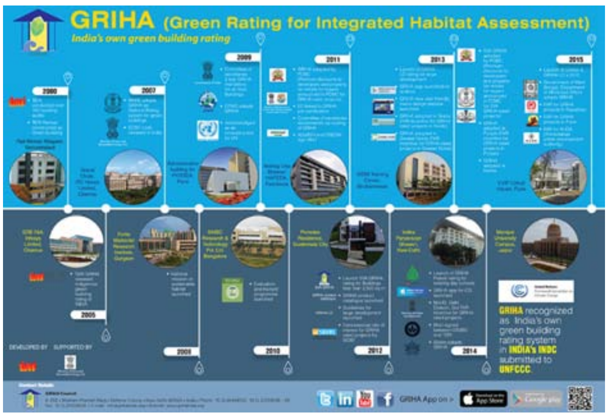


Figure 1: Evolving landscape of sustainable habitats in India: genesis of GRIHA

Indian Green Building Council (IGBC)

The Leadership in Energy & Environmental Design (LEED) is the rating system developed for certifying Green Buildings. LEED is developed by the U.S. Green Building Council (USGBC), the organisation promoting sustainability through green buildings. LEED is a framework for assessing building performance against set criteria and standard points of references. The benchmarks for the LEED Green Building Rating System were developed in 2000 and are available for new and existing constructions.[6]

The Confederation of Indian Industry (CII) formed the Indian Green Building Council (IGBC) in 2001. A non-profit research institution, IGBC has licensed the LEED Green Building Standard from the USGBC. IGBC facilitates Indian green structures to become one of the green buildings.

National Building Code (NBC) 2016

To regulate building construction activities across the country, India brought out a building code, a national instrument providing guidelines, in 1970. The National Building Code[7] serves as a model code for adoption by all agencies involved in building construction work--be they Public Works Departments, other government construction departments, local bodies or private construction agencies.

NBC[7] contains administrative regulations, development control rules and general building requirements like stipulations regarding materials, structural design and construction (including safety, fire safety requirements and building and plumbing services; approach to sustainability; and asset and facility management).

It is published by the Bureau of Indian Standards (BIS), which is under the Department of Consumer Affairs, Ministry of Consumer Affairs, Food and Public Distribution.

The NBC was first published in 1970. The code was then revised in 1983. Thereafter, three major amendments were made to the 1983 version, two in 1987 and the third in 1997. This was followed by a revision in 2005, to which two amendments were issued in 2015. In view of large-scale changes in the building construction activities, a project for comprehensive revision of the Code was taken up again.

And, finally the third revised version came out in 2016. The NBC 2016--the state-of-the-art and most contemporary building code to regulate building construction in the country--focuses on development of new innovative construction materials and technologies, equipment, and machines for future sustainable developments.

The changes also include changes in the nature of occupancies with prevalence of high rises and mixed occupancies; greater dependence on and complicated nature of building services; greater need for preservation of environment; and recognition of the need for planned management of existing buildings and built environment.

The Code comprises 12 parts. Some of these are further divided into 33 chapters. The major changes pertaining to energy efficiency, incorporated in the 2016 Code, are as follows:

- Inclusion of new and energy efficient options of air conditioning, heating and mechanical ventilation, such as variable refrigerant flow system, inverter technology, district cooling system, hybrid central plant using chilled beams, radiant floor components, and geo-thermal cooling and heating.
- Thrust on envelope optimisation using energy modelling, day lighting simulation, solar shade analysis and wind modelling software to optimize the air conditioning load.
- Air conditioning, heating, and ventilation (HVAC) provisions considering adaptive thermal comfort conditions for energy efficiency.

Energy efficiency needs to be advanced in buildings across cities to save energy, increase energy access, combat pollution, and strengthen prosperity. Constructing more efficient buildings is also a central strategy to achieve India's climate target. It is also important to meet targets on reducing cooling loads, a main focus of the India Cooling Action Plan (ICAP) released in March 2019. Building energy codes are effective tools for achieving energy efficiency in construction and operation of buildings.

[1] https://www.weforum.org/agenda/2021/02/why-the-buildings-of-the-future-are-key-to-an-efficient-energy-ecosystem/

[2] https://www.beeindia.gov.in/

[2.1] https://beeindia.gov.in/sites/default/files/BEE_ECBC%202017pdf

[3] https://journals.sagepub.com/doi/10.1177/0143624498019001l0?icid=int.sj-abstract.similar-articles.3&

[4] http://www.econiwas.com/

[4.1] Energy Conservation Building Code for Residential Building – Part-1 (Eco-Niwas Samhita 2018)

[5] https://www.grihaindia.org/

[6] https://igbc.in/igbc/

[7] https://bis.gov.in/?page_id=117159

5

Energy and Climate Change

By burning fossil fuels, cutting down rainforests and farming livestock, and destruction of marine ecosystems, humans are increasingly influencing the climate and earth's temperature. These activities are leading to massive concentrations of greenhouse gases, in particular carbon dioxide (CO_2), methane, nitrous oxide, water vapour and fluorinated gases (man-made).[1]

Daily human activities maximise the greenhouse effect by producing CO_2, the most common greenhouse gas, and cause the planet's temperature to increase even more.

OBJECTIVES:

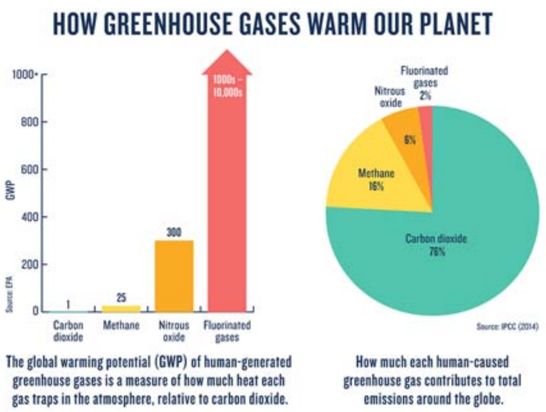
- What is Climate Change & What are its consequences?
- How will climate change impact temperature and rainfall patterns in India?
- What are the consequences of the temperature and rainfall changes on human thermal comfort and the increasing demand for cooling (space conditioning)?

Learning Outcomes: At the end of this chapter, readers will get an understanding about climate change and its effect on humans, buildings and how global warming has led to an increase in energy consumption. The ever-rising energy need poses a major dilemma and clear challenge, especially for India.

Highlights: Buildings impact the environment in a big way. Poor design and construction make buildings consume more energy. In turn, this increases the demand on energy production and contribution to global warming.

Hence, it is necessary to reduce human's overall environmental impact by decreasing energy use in buildings. Adapting more efficient heating, air conditioning and lighting could enable buildings use less energy, and successively help reduce GHG emissions.

Carbon dioxide (CO_2) and other greenhouse gases act like a blanket, like the walls of a greenhouse, trapping sun's heat and preventing it from escaping into outer space. The net effect is the gradual heating of Earth's atmosphere and surface, a process known as global warming. It is most commonly measured as the average increase in Earth's global surface temperature.



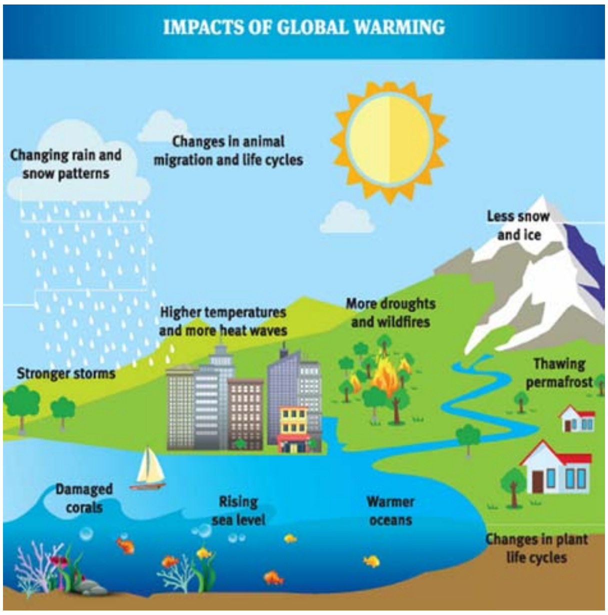
Global warming is caused by the greenhouse effect and warms our planet

Source- NRDC

Global warming is caused by the greenhouse effect that warms the Earth's surface. It is a natural process by which the atmosphere retains some of the Sun's heat, allowing the Earth to maintain the necessary conditions to host life. Without the greenhouse effect, the average temperature of the planet would be -18^{0}C. The process is called the greenhouse effect because the exchange of incoming and outgoing radiation that warms the planet works in a similar way to a greenhouse.

Carbon dioxide is responsible for 64% of man-made global warming. Its concentration in the atmosphere is 40% higher than it was when industrialisation began. Other greenhouse gases are emitted in smaller quantities. Methane is responsible for 17%, and nitrous oxide 6%. But they trap heat far more effectively than CO_2, and in some cases are thousands of times stronger.[2]

Global warming is the long-term heating of Earth's climate system observed since the pre-industrial period (between 1850 and 1900). Since then, human activities are estimated to have increased Earth's global average temperature by about 0.1°C, which is currently increasing by 0.2°C per decade. Most of the present warming trend is extremely likely (greater than 95% probability) the result of human activity since the 1950s. It is proceeding at an unprecedented rate over decades to millennia.



Impact of global warming and its effects

Global warming is most commonly measured as the average increase in Earth's global surface temperature. Often, "Climate change" and "global warming" are used interchangeably. Global warming is just one aspect of climate change. Climate refers to the long-term regional or even global average of temperature, humidity, wind and rainfall patterns over seasons, years or decades. Climate change refers to both human- and naturally produced warming and the effects it has on our planet. The main cause of climate change is global warming, which has many negative consequences on physical, biological and human systems, as well as other effects.

Some key indicators of climate change are global land and ocean temperature increases; rising sea levels; ice loss at Earth's poles and in mountain glaciers; frequency and severity changes in extreme weather such as hurricanes, heat waves, wildfires, droughts, floods and precipitation; and cloud and vegetation cover changes.

In recent years, India has been experiencing extreme rain, frequent heat wave, large scale floods, and increased drought due to climate change. Temperature rise has largely affected northern and central Indian states.[3]

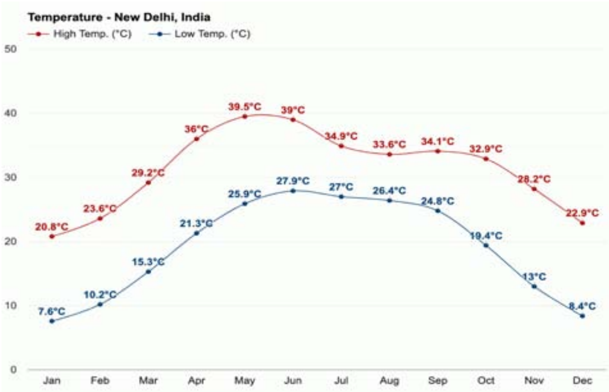
Climate change is making rainfall erratic. The implications of projected increases in rainfall and temperatures could have potential risks at a larger biophysical level. India is undergoing a major transition with changes in rainfall patterns leading to increased frequency of droughts, floods, heat waves amidst fear of a major water crisis in the years to come. Food security is also at a risk. Changes in climate, particularly during the southwest monsoon, would have a significant impact on agricultural production, water resources management and overall economy.

If the world's average temperatures rise by 2°C, India's summer monsoon will become highly unpredictable. At 4°C warming, an extremely wet monsoon that currently has a chance of occurring only once in 100 years is projected to occur every 10 years by the century end. If it occurs, the abrupt change in the monsoon could precipitate a major crisis; and trigger more frequent and greater flooding in large parts of India. India's northwest coast to the south eastern coastal region could see higher than average rainfall. Dry years are expected to be drier and wet years wetter (World Bank, June 2013).

Being close to the equator, India would see much higher rises in sea levels than higher latitudes. Sea-level rise and storm surges would lead to saltwater intrusion in the coastal areas, impacting agriculture, degrading groundwater quality, contaminating drinking water. Building codes will need to be strictly enforced and urban planning will need to prepare for climate-related disasters.

Extreme heat often affects the most vulnerable populations, leaving them at risk. Globally, extreme heat waves could kill more than 255,000 people annually, according to WHO. Hence, access to cooling is needed to prevent fatalities. However, populations in tropical and sub-tropical regions have lower access.

India faces a formidable challenge--how to provide access to cooling to its citizens without warming the planet. Summers in the north and central India are already extremely hot. Average temperatures range from 32°C to over 45°C. But the heat is getting worse every year.



Source- Weather Atlas

Led by a combination of warmer temperatures and increased activity, cooling energy use in buildings has doubled since 2000, making it the fastest growing end-use in buildings.

As the world warms up, millions more will need cooling. Consequently, the growing use of air conditioning and other cooling equipment will accelerate. And in a dangerous feedback loop, the extra energy needed to power the equipment will itself increase global warming as long as it comes from fossil fuel.

India will lead the world in terms of the power consumed for residential space cooling, according to the International Energy Agency (IEA). Its cooling-related energy demand will surge 15 times by 2050.

Within the next decade, India's cooling energy demand will grow 2.2 to 3 times over the current level, under moderate-growth or potential high-growth scenarios respectively, a study by Alliance for an Energy Efficient Economy (AEEE) projects. This will have far reaching environmental and societal impacts.

Of this, space cooling, i.e. comfort cooling in the building sector, comprises 50% of the total; this sector also shows the maximum improvement potential in terms of energy saving and carbon emission reduction. Space cooling thus represents a key opportunity area for proactively managing India's cooling energy demand. Most of India's air-conditioner stock is yet to come.

With increasing incomes and urbanisation, the world will see a four-fold increase (from 1.2 bn to 4.5 bn) in room air conditioner (RAC) units by 2050. India's share is projected to jump from 2.2% to almost 25%. The demand will soar to 1 bn RAC units (from 26.3 mn installed stock in 2016)—a phenomenal jump.

This projected jump in space cooling requirement will need three times more electricity in the next three decades in a world that has witnessed nearly 1°C (one degree Celsius) rise in average temperatures from the pre-industrial level. The residential sectors will drive the more than three-fold increase. Continued use of the same AC technology in cooling units alone will push the planet's temperature by 0.5 degrees.

Given the criticality of what is at stake, a collective difference is necessary: building energy efficiency, equipment efficiency, alternate cooling technologies, as well as user behavioural adaptations. Adaptive thermal comfort (ATC) is recognised as a definitive means to achieving energy savings by building scientists the world over. It offers a low-capital intervention opportunity to achieve savings through user adaptation.

The catapulting energy need poses a major dilemma and clear challenge, especially for India, with a 1.39 bn population (UN)[4]. How to break this vicious circle, and keep people cool without heating the planet? How can we meet everyone's cooling needs affordably, reliably and also sustainably?

Lack of cooling will present another problem. It threatens health, vaccines, food, and economic productivity.

At present use of energy, mostly non-renewable, are a major threat to climate change and holds lots of avenue for media reporting.

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[1]https://www.acciona.com/climate-change

[2]https://climate.nasa.gov/resources/global-warming-vs-climate-change/

[3]https://www.weforum.org/agenda/2019/05/india-heat-cooling-challenge-temperature-air-conditioning/

[4]http://glassed.vitroglazings.com/topics/how-low-e-glass-works

6

Modern Energy Management Systems

We all are continuously consuming energy in various facets of life, whether it is lighting, cooling or heating of homes and offices, or operating data centres with numerous servers. Primarily, due to the emergence of a 24/7 society, buildings consume enormous amounts of energy. Different buildings have dissimilar power consumption levels. Residential and commercial buildings are the largest consumers. Power is consumed continuously as most buildings and machines run day and night. Energy usage is significantly influenced by the time we spend indoors.

OBJECTIVES:

To introduce modern energy management systems and provide a basic understanding about the following systems and their usefulness in energy conservation.

- Automation systems
- Collection and analysis of energy measurement data
- Online monitoring tools
- Sensors and voice activation control of energy

Learning Outcomes: Acquaintance with conservation of energy and its management, and energy planning.

Highlights: Energy conservation methods and management systems can cut a building's energy consumption. Home automation systems can decrease overall energy usage and thereby increase monthly energy savings; and hence decreased home expenses.

Hence, it becomes imperative to monitor and control a building's energy needs. This calls for putting in place energy management systems. These will not only help reduce the negative effect a commercial building has on the environment, but also reduce overhead costs. Besides, these systems will cut the building's energy consumption (the amount of electricity used in a billing period).

Energy Management Systems

Managing energy usage and other needs in buildings efficiently and intelligently can have considerable benefits. This can be done with the help of a building energy management system (BEMS). Other terms frequently used for this technology are Building Management System (BMS) and Energy Management System (EMS).[1]

A BEMS is an integrated computer-based control system and has data storage and communication. It detects and eliminates waste, and enables the efficient use of electricity resources. Its basic function is to reduce energy consumption from conventional energy sources and operational costs, and maximise savings. It monitors, controls and measures the building's mechanical and electrical equipment and optimises its energy consumption needs.

This sophisticated centralised platform can be installed in residential and commercial buildings--in individual or groups of buildings. The use of widely dispersed sensors enables the monitoring of ambient temperature, lighting, room occupancy, fire, smoke detection and alarms, motion detector, CCTV, security, access control, lifts, heating, ventilation and air conditioning (HVAC), maintenance and energy management.

One of the most important systems is a building management platform that ensures all disciplines interact optimally. Room automation, for example, assures a uniform control strategy and creates a perfect interaction between HVAC systems, lighting and shading. Building tenants benefit from individual comfort control and optimal air quality. Besides, they want to feel safe too. This is where high-tech fire safety and security systems enter the picture.

The following figure illustrates a possible BEMS configuration in which multiple buildings are connected to each other. They are connected via the internet to a central operating unit to allow smooth cooperation among the buildings and increase efficiency. Increased cooperation among different buildings through the BEMS allows for additional increased energy efficiency, as functions of different buildings can be coupled.

In commercial buildings or in industrial facilities, the BEMS technology can contribute to social development in two ways. By making the workplace safer, and healthier. First, due to improved fire, security and other emergency procedures that the technology offers, the workplace will be much safer. It can locate potential hazards within the workplace, notify emergency response teams, and inform personnel about the potential danger.

Second, BEMS can monitor and control the environmental conditions in the buildings. This capacity of the technology has the potential to make the workplace healthier. Similar to potential fire or security hazards, the technology can monitor factors such as air and water quality and react when value thresholds are crossed. For instance, the system can increase ventilation when the carbon monoxide levels in a facility increase above a level considered safe.

In residential buildings, a BEMS informs residents about their energy consumption. They can draw upon this information to apply conservation measures. In addition, it can apply certain comfort settings for the residents. The information the technology provides to residents and the actions it can perform can therefore contribute to social development by increasing comfort and reducing energy consumption. The system ensures appropriate access and simplify security processes. Further, all systems are flexible and can be adapted quickly and inexpensively to new room requirements and layouts.

Metering and sub-metering functions

BEMS offers monitoring, metering and sub-metering functions, that help collect energy data. It uses the information collected to make informed decisions regarding energy activities. It helps reduce carbon emissions and enables early detection of power issues. Also, BEMS recognises system maintenance problems early. Property managers and owners can analyse the data so obtained to get a comprehensive insight into the building's energy usage.

Home automation system

Several options for energy conservation are available. One such is home automation systems. These decrease overall energy usage and thereby increase monthly energy savings and hence decreased home expenses. Also, they diminish the carbon footprint. They offer an easy way to users to control devices in a building--for properly programming lighting, temperature, shades, and ceiling fans. These can be coupled with one-stop "all off" electronics command.

Home automation system

Most often, many of us do not always remember to switch off home appliances whenever not required. Examples of frequently-used ones are fans and lights. Some even leave them on and step out of their homes. They may be unaware that this is one of the reasons for undue wastage of power. These habits can be overcome if they enter the world of home automation. It will surely help them reduce energy consumption and save on their monthly bill.

Automation can also secure our home when we go out. The door locking system can be controlled (open or close the lock) by voice with the help of Bluetooth module and smartphone. Similarly, home appliances like fan, light, television, air conditioner, running in unnecessary situations, can be controlled by using a microcontroller.

Smart Homes

A mobile device can also be used to access and operate smart home automation systems. From any part of the world, one can monitor climate conditions, and control security, lights, media, video surveillance. It provides accessibility and confidence, so you can fully engage in your priorities.

Design of smart home

Even when they are turned off, a variety of appliances, surprisingly, drain a reasonable amount of electricity. These include everything from your dryer and toaster to microwave. The energy used from appliances that are plugged in, yet turned off, may be up to 10% of the monthly electric bill. Earlier, the only way to avoid this energy drain was to unplug appliances when not being used. Today, home automation system can undo the appliance "standby" modes. This means an effective savings on the monthly electricity bill.

In recent times, developments in home automation systems have led to construction of smarter infrastructure. Such systems offer an easy way to users to control devices in a building. Commercially, several technologies are being implemented for home automation purposes. Research in this field has extended the capabilities of the technology into areas such as remote monitoring and control, power management, tracking and security systems and disaster warning systems. Power management allows for a greener future and is an added advantage to users as a cost-cutting measure.[2]

If energy efficiency and CO_2 emissions goals are to be achieved, sound energy management practices will need to be implemented on a massive scale. This starts with energy consumption measurement. The essential tools for measurement are metering and monitoring that form the basic constituents of efficient energy management. Metering and monitoring provide building owners and operators with the crucial information they need to improve building energy performance.

Energy Monitoring

What is energy monitoring? It is an energy efficiency technique that enables feedback and measurement of energy consumption, patterns and trends. It aims to note opportunity areas in order to reduce energy usage and costs. A critical feature of monitoring is to understand what drives energy consumption. Is it production, hours of operation or weather?

In recent years, household demand for electricity has multiplied with the use of new computerised gadgets and modern appliances. Traditional electric meters, in use since the late 19th century, exchange data between electronic devices in a computerised environment--for both electricity production and distribution. These meters are digitally operated. The measurement process is supported by a specific mechanical structure, and hence they are called electromechanical meters. However, they have some limitations. They do not provide adequate information to consumers. Consumers get insufficient feedback, and hence they have no knowledge about power consumed by individual appliances. Users need to wait for the monthly bill. A large number of technical personnel have to be employed for meter reading.

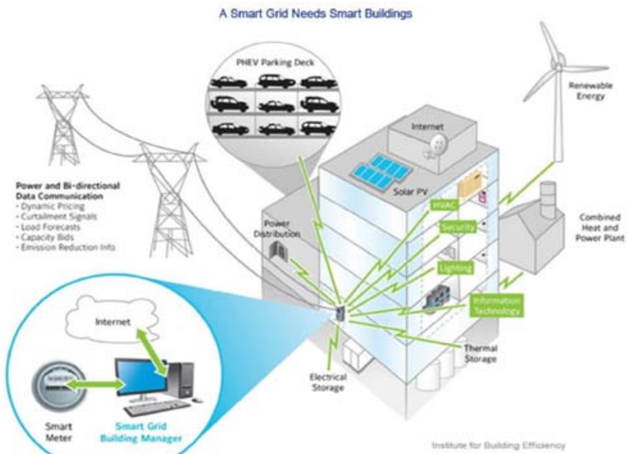
Analog vs Smart Meters

Traditional or analog electric meters are useful for monitoring electricity use on a periodic basis and for checking the accuracy of electric bills from month to month. Analog meters have multiple spinning dials, which are best read by qualified meter reading representatives. Whereas digital or "smart meters" record daily electricity use and share information about consumption between users and electricity suppliers over wireless digital radio frequency (RF) networks.

Smart meters may one day enable consumers to programme electricity use for nonpeak hours when power is available at a lower cost. This interactive capability could also allow utility companies to manage energy use and adjust loads during periods when there is a danger of a potential system overload, such as during periods of extremely hot or cold weather.

A smart meter can facilitate consumers to keep track of power consumed by various appliances. Data can be collected regularly and enable in distributing electricity smartly and efficiently by consumers. The data illustrates consumers' behaviour in using devices. It analyses consumption patterns i.e. measurement and analysis of consumption over time. And, consumption can be made 'visible', dispensing with meter reading staff.[3] Data also enable benchmarking of energy usage, and assist in identifying and evaluating energy efficiency opportunities. Data from meter readings, mined over a long period, can provide valuable information. These can be analysed to understand energy usage, according to areas of a building, and identify efficiency opportunities.

Many people, especially in developing nations, are unaware of the technology of employing smart electricity meters. Installation of smart meters could lead to considerable energy saving.



Smart grid building and web based energy monitoring system to keep a check and save electrical energy

Web-based Energy Management System

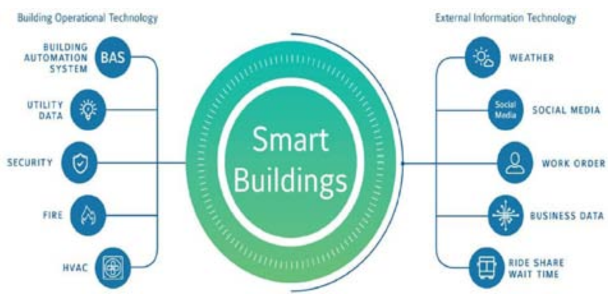
Web-based energy monitoring systems are available to keep a check and save electrical energy. Software solutions help in analysing and monitoring of usage. The system enables analysis of power usage from various perspectives. Its features include energy use, maximum demand, load balancing, tariffs and operation. A multitude of reports can then be produced to fully understand and assess how power is used within your property. Real time monitoring can be done on mobile phone/PC/laptop remotely and at any time.

What is a Smart Building?

A smart building is any structure that uses automated processes to automatically control the building's operations including heating, ventilation, air conditioning, lighting, security and other systems. A smart building uses sensors, actuators and microchips, in order to collect data and manage it according to a business' functions and services. This infrastructure helps owners, operators and facility managers improve asset reliability and performance, which reduces energy use, optimises how space is used and minimises the environmental impact of buildings.[4]

A smart building is a super system of interconnected building systems. Like the Internet, it connects individual computer networks into one larger super network. Smart buildings use information and communication technologies (ICT) to enable automated building operations and control. They can enhance occupants' comfort and productivity while using less energy than a conventional building.

They use ICT to connect building systems together to optimise operations and whole-building performance. Whereas, conventional buildings have systems operating independently.



Building operational technology

At the most fundamental level, smart buildings make occupants more productive with lighting, thermal comfort, air quality, physical security, sanitation and more at lower costs and environmental impact than buildings that are not connected.

Making a smart building, or making a building smart, begins by linking core systems such as lighting, power meters, water meters, pumps, heating, fire alarms and chiller plants with sensors and control systems. At a more advanced stage, even elevators and access systems can become part of the system.

Controlling energy usage with devices and gadgets

These developments and trends, combined with higher energy prices and network charges, and the increasing focus on greenhouse gas emissions, will increase the already rapid uptake of energy metering, monitoring and control systems. Several devices and gadgets to control energy usage are available at affordable prices. These can be installed by an electrician to control lights, fans, water heaters, coolers and heaters and other appliances. The most common types of lighting controls are: dimmers; motion occupancy, and photo sensors; and timers.

Dimmer controls provide variable indoor lighting. When you dim lightbulbs, it reduces their wattage and output, which helps save energy.

Motion sensors automatically turn outdoor lights on when they detect motion and turn them off a short while later. They are very useful for outdoor security and utility lighting. Besides, there are dusk-to-dawn sensors that trigger bulbs on in low-light situations and switch them off once daylight creeps in. As the term implies, the sensor lights up the bulb at dusk. And at dawn, it switches it off. The fixture is inexpensive and can be installed at the door entrance or backyard of homes for security and safety. It uses a small photocell to detect the presence of available and/or existing light.

It is necessary to keep track of your residential or business energy usage before getting stung with a high electricity bill. Usage of your air conditioning, electric hot water (water heaters), lighting, and more should be tracked regularly. You should find out your standby, after-hours, and/or overnight energy consumption.

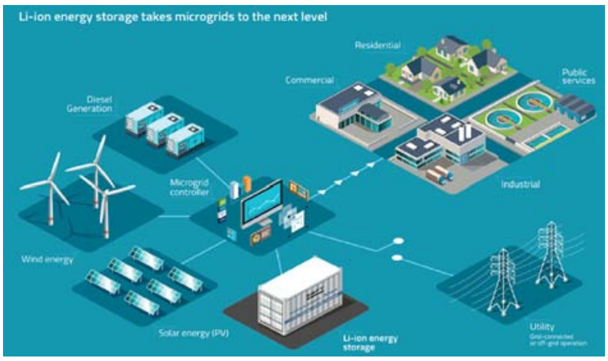
Wireless Energy Monitors

Energy monitors provide a real-time display of electricity consumption. They are a cost-effective way to track an entire home or businesses energy cost and power usage trends. They are referred to as Household Power Monitors, Home Energy Monitors or In-Home Displays (IHDs). They are Wireless Energy Monitors because they track readings wirelessly. This distinguishes them from power meters which are usually plug-in or hard-wired devices. This home energy management system is a technology platform that comprises both hardware and software. It allows the user to monitor energy usage and production and to manually control and/or automate the use of energy within a household. Software solutions help analyse monitoring usage.

As buildings get "smarter", our ability to perform daily activities is more than ever dependent on power availability. In an essential facility or hospital, loss of power can prove life threatening. Besides, we face increasing weather-related threats due to climate change. We want smart buildings even in a power outage. What can be done?

The standard solutions are provided by an uninterruptible power supply (UPS), or an emergency generator—or a combination of both. Both systems utilise proven technologies, are commercially available, and are well-documented in the building codes. The two standard sources of emergency power are battery via an inverter and diesel (or less common gas) powered generators.

Microgrids



In addition to the traditional power solutions, a number of technologies and solutions, such as a microgrid, are evolving. These can keep buildings smart, safe, and powered while addressing some of the challenges associated with the standards solutions.

A microgrid is a local energy grid with control capability. It generally operates while connected to the grid. But importantly, it can break off and operate on its own using local energy generation in times of crisis like storms or power outages, or for other reasons.

The grid connects homes, businesses and other buildings to central power sources, which allow us to use appliances, heating/cooling systems and electronics. But this interconnectedness means that when a part of the grid needs to be repaired, everyone is affected.

A microgrid can be powered by distributed generators, batteries, and/or renewable resources like solar panels. Depending on how it is fuelled and how its requirements are managed, a microgrid may run indefinitely.

It can be continuously utilised as an emergency power source. Unlike the traditional sources, it can be used, not just when there is a power outage, as with a standby generator or UPS. In the event of power loss, it can then provide (or supplement) instantaneous power, acting like a large uninterruptible power supply.

Components of smart buildings

[1]https://www.ctc-n.org/technology-library/built-environment/building-energy-management-systems-bems

[2]https://www.sciencedaily.com/releases/2019/06/190624111517.htm

[3]https://www.energy.gov.au/business/equipment-and-technology-guides/metering-and-monitoring

[4]https://www.rcrwireless.com/20160725/business/smart-building-tag31-tag99

7

Policy Scenario on Climate Change with Focus on Buildings

Buildings make several forms of negative contributions to climate change. High on the list are embodied and operational energy demands, which largely depend on fossil fuels and result in greenhouse gas emissions.

Given the urgency of the risks associated with climate change and to contain it in order to reduce the energy demand and decarbonise radically, a key challenge is what actions can be taken across a whole suite of areas relating to the building stock.

OBJECTIVES:

To introduce to various national and international initiatives and policies.

- International initiatives – Paris Agreement, Global Alliance for Buildings and Construction (GABC) -- By UNEP, International Energy Agency (IEA) - Energy Efficiency in Emerging Economies (E4)
- Government of India's initiatives/ policies/ schemes – India's Nationally Determined Contributions, National Building Code, Efficient Building Energy Code

Learning Outcomes: To gain an understanding about the various international and national policies.

Highlights: Various national and international organisations are actively engaged across the world in mitigating climate change, and advocating efficient use of energy. India intends to reduce emissions intensity by 33-35% by 2030, from the 2005 level.

What Is the Paris Agreement?

Recognising that climate change is a global danger, and can only be curbed with global action, world leaders representing 195 nations gathered in Paris in December 2015. They adopted a landmark environmental accord on December 12 to address climate change and its negative impacts, and agreed to a set of measures aimed at curbing climate change.

The pact was signed after two weeks of intense deliberations in Paris during the United Nations Framework Convention on Climate Change's (UNFCCC)[1] 21st Conference of Parties (COP21).

The Paris Agreement, as it is known now, marked a historic turning point for a global action to combat climate change, and to accelerate and intensify the actions and investments needed for a sustainable low carbon future.[2]

The accord sets a goal for constraining global warming and contains pledges by countries aimed at meeting it. It includes measures to help poorer nations prepare for unavoidable climate impacts, and to ensure rich nations provide financial and technical assistance (as they are obliged to do). It establishes a process to increase carbon-cutting ambition over time and a mechanism for ensuring countries are transparent.

Global Framework to Avoid Dangerous Climate Change

The Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming to well below 2°C and pursuing efforts to limit it to 1.5°C. in accordance with the recommendations of the Intergovernmental Panel on Climate Change (IPCC).

It also aims to strengthen countries' ability to deal with the impacts of climate change and support them in their efforts. The pact is the first-ever universal, legally binding global climate change agreement.

The agreement formally came into force on November 4, 2016, several days before the COP22. To this date, 189 of the 197 Parties have ratified to the Convention (the last signatory being Syria). As of January 2020, the only countries with over 1% share of global emissions which have not ratified, and so are not parties, are Iran and Turkey.

The number of participants and the force of the commitments made the Paris Agreement a landmark event unprecedented in the field of climate change negotiations.

The agreement includes commitments from all major emitting countries to cut their climate-altering pollution and to strengthen those commitments over time. The deal provides a pathway for developed countries to assist developing countries in their climate mitigation and adaptation efforts. It creates a framework for transparent monitoring, reporting, and intensifying countries' individual and collective climate goals.

The Paris Agreement requires all Parties to put forward their best efforts through "nationally determined contributions" (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties report regularly on their emissions and on their implementation efforts. There will also be a global stocktake every 5 years to assess the collective progress towards achieving the purpose of the agreement and to inform further individual actions by Parties.

In the lead-up to COP-21, more than 90 countries identified buildings or buildings efficiency-related activities in their Intended Nationally Determined Contributions (INDCs)[2]. For the first time ever, the building sector's critical role in the fight against climate change was recognised. Buildings were recognised and identified as a key sector based on mitigation potential and realisation that 2°C path is not achievable without reducing emissions from buildings and construction. The Government of France, as Presidency of COP21, proposed 'Buildings Day', and supported the formation of a global alliance. The first 'buildings day' held on December 3, 2015, was devoted to decarbonisation of the building stock.

The leaders committed unequivocally to decarbonisation–in particular, through the building and construction sector. Business leaders, policy-makers, city officials and other organisations also acknowledged that the building and construction industry is one of the single biggest contributors of greenhouse gases.

The agreement was a vital step for the UNFCCC--established in 1992 to prevent climate change.

Global Alliance for Building and Construction (GABC)

Building and construction are a heavy weight when it comes to climate change, employment and wealth. Globally, building stock is increasing. The equivalent of Paris is added in floor space every 5 days and that of Japan every year until 2060! Half of the buildings standing in 2060 have not yet been built!

In the coming years, the number of new buildings is likely to grow rapidly, especially in Africa and Asia. This speedy growth will challenge the target of a 30% energy intensity improvement in buildings by 2030, needed to put the sector on track to meet the goals of the Paris Climate Change Agreement.

The rising energy use from inefficient buildings will impact us all, whether it be through access to affordable energy services, poor air quality or higher energy bills. What we build today will be our emissions legacy, the buildings and the construction sector need to lock in new norms of energy efficiency, green materials, and better practice in design and construction. Hence, to futureproof buildings and lock in growth, climate-friendly and resilient standards are needed.

The Global Alliance for Buildings and Construction (GABC or GlobalABC)[3] was launched at the 21st Conference of Parties Buildings Day in Paris on December 3, 2015. The objective of this alliance was to bring together the buildings and construction industry and other stakeholders to raise the awareness and facilitate the global transition towards low emission. It functions as an umbrella or meta-platform–a network of networks–that brings together initiatives and actors focusing on the buildings and construction sector. Currently, it includes over 130 members, among which are 29 countries.

The GABC members acknowledged that the buildings and construction sector can contribute significantly to achieving climate goals and the common objective of limiting global warming to well below 2°C.

The alliance aims at supporting and accelerating the implementation of the NDCs, and thus facilitate the implementation of the Paris Agreement for the buildings and construction sector in terms of energy efficiency gains, growth of renewable energy and GHG emissions reduction. Moreover, its objectives are to dramatically reduce GHG emissions of the global building stock by increasing the share of eco-friendly buildings, whether new or renovated.

GABC activities are organised around different working groups contributing to the transition towards low-GHG and resilient real estate: Education and Awareness; Public Policies; Market Transformation; Finance; and Measurements, Indicators and Accountability.

These working groups were established during the inaugural meeting and seminar of the GABC, held in Paris on April 18 and 19, 2016. The members agreed on the need for two ad hoc frameworks: a global roadmap for the transition towards low-emission and resilient real estate and a Global Status Report, along with a Building and Climate Yearbook, that will be produced annually.

The GABC Secretariat is hosted by the UN Environment, Economy Division in Paris, and served by the GABC Coordinator.

International Energy Agency

The International Energy Agency (IEA) is an autonomous intergovernmental organisation. It was established within the framework of the Organisation for Economic Co-operation and Development (OECD). IEA was created in 1974 in the wake of the 1973 oil crisis to help coordinate a collective response to major disruptions in the supply of oil. While oil security remains a key aspect of its work, the IEA has evolved and expanded significantly since its foundation.[4]

The IEA works with policy makers and stakeholders to scale up action on energy efficiency to mitigate climate change, improve energy security and grow economies while delivering environmental and social benefits.

Taking an all-fuels, all-technology approach, the IEA advocates policies that enhance the reliability, affordability and sustainability of energy. It examines the full spectrum issues including renewables, oil, gas and coal supply and demand, energy efficiency, clean energy technologies, electricity systems and markets, access to energy, demand-side management, and much more.

Based in Paris, the agency works to ensure reliable, affordable and clean energy for its member countries and beyond. Its main areas of focus are energy security, economic development, environmental awareness and engagement worldwide.

The IEA is made up of 30 member countries. It also comprises eight association countries. Only the OECD member states can become members. Except for Chile, Iceland, Israel, and Slovenia, all OECD member states are members. In 2014, Estonia joined the IEA and became its 29th member. Brazil, China, India, Indonesia, Morocco, Singapore and Thailand are the associate members. The governing board is the main decision-making body, composed of energy ministers or their senior representatives from each member country.

Energy Efficiency in Emerging Economies (E4) Programme

The IEA works closely with six of the world's largest emerging economies on energy efficiency through its Energy Efficiency in Emerging Economies (E4) Programme.

The collaboration is highly flexible based on changing needs but generally falls into three main categories: Understanding the potential of energy efficiency to enable a secure, sustainable energy system; Setting targets and tracking progress through energy efficiency indicators and policy evaluation for continuous improvement; and Developing strategies and policy design to deliver energy efficient prosperity.

There are five main modes of collaboration:

1. Support for policy development: focusing on the day-to-day needs of officials responsible for delivering energy efficiency policies
2. Thematic workshops: bringing together officials and experts from a range of countries to explore specific topics
3. Policy training: group training for officials and future leaders, primarily through the E4 Training Weeks
4. Webinars: online seminars offering access to a range of experts on key policies or technologies
5. Online training: self-paced learning on energy efficiency indicators.

As part of the E4 programme, the IEA is increasingly working with countries on quantifying and communicating the multiple benefits of energy efficiency with the objective of engaging leaders, ministries of finance and economy, as well as other influential stakeholders. The concept of Energy Efficient Prosperity aligns well with the social development and economic growth agenda of the emerging economy governments.

The E4 Programme is enriching the IEA's ongoing portfolio of work by feeding lessons learned and data collected from emerging economies back into IEA analysis and publications, such as the Energy Efficiency Market Report, the World Energy Outlook, and Energy Technology Perspectives.

India's Policies

Nationally Determined Contributions (INDCs):

Mitigation: Commitments to reduce greenhouse gas emissions

Even before the Paris summit started, almost every nation, including India, put forward pledges, known as Intended Nationally Determined Contributions (INDCs), to reduce their emissions intensity by 33-35% by 2030, from the 2005 level.[5] If implemented, these pledges would limit global warming to about 2.7° C, avoiding the very worst impacts of climate change.

More than 180 countries, including India, submitted their INDCs during 2015. India intends to reduce the emissions intensity by 33-35% by 2030, from the 2005 level.

India's NDC enlists enhancing energy efficiency as one of the mitigation strategies through the Bureau of Energy Efficiency (BEE's) Standards and Labelling Programme and energy-efficient buildings through building code compliance. Incorporating the adaptive thermal comfort model guidelines to heating, ventilation and air-conditioning (HVAC) operations in building code norms and its stringent compliance will help advance the country's international commitments.

India Cooling Action Plan

Cooling is a cross-sectoral requirement linked with economic growth and recognised as key to health, wellbeing, and productivity of people in hot climates. India is a growing economy characterised by low penetration of air-conditioning, rising per capita income, rapid urbanisation and population growth and a largely tropical climate. All these would lead to a rise in cooling requirement.[5]

A large part of the cooling demand is catered through refrigerant-based cooling globally across sectors such as buildings, cold-chain, refrigeration and transport. Refrigerants used in cooling equipment are regulated under the Montreal Protocol regime.

Another important aspect related to refrigerant-based cooling is energy use, resulting in a much larger portion of the emissions–nearly 70%. Refrigeration and air conditioning (RAC) cause 10% of the global CO_2 emissions, according to IEA.

All these make provision for cooling an important developmental necessity. To provide sustainable cooling, while keeping in mind the need to protect the ozone layer from substances that can deplete it, India developed a comprehensive Cooling Action Plan in March 2019. It was one of the first countries to develop the plan.

The Indian plan (ICAP) was launched by the Ministry of Environment, Forests and Climate Change. It provides a long-term (20-year) integrated vision to address the cooling requirement across sectors, and lists actions which can help reduce the cooling demand, refrigerant transition, enhancing energy efficiency and better technology options. The ICAP is to look for synergies in actions for securing both environmental and socio-economic benefits.[6]

The ICAP provides short, medium- and long-term recommendations across different sectors. It also provides linkages with various government programmes aimed at providing sustainable cooling and thermal comfort for all. An implementation framework is also set forth to coordinate the implementation of these recommendations.

The thematic areas identified are--Space cooling in buildings, cold-chain and refrigeration, transport air-conditioning, air-conditioning and refrigeration servicing sector, refrigerant demand and Indigenous production; and R&D and the production sector – alternative refrigerants.

The Rationale for the plan

The many high-temperature cities in India are only set to get hotter in the coming future. The cooling requirement is thus being recognised as a key to health and well-being. The ICAP comes as an effort to assess this requirement and plan ahead. The cooling requirement is projected to grow around 8 times by 2037-38. This is in terms of tonnes of refrigeration (TR) required.

- The building sector shows the most significant growth in required TR, nearly 11 times as compared to 2017-18.
- The cold-chain and refrigeration sectors grow around 4 times the 2017-18 levels.
- The transport air-conditioning grows around 5 times the 2017-18 levels.
- The growing transport sector and income levels will increase ownership of cars, a majority of these air-conditioned.
- It is thus expected to grow almost 9% annually up till 2040.
- For space cooling, room air-conditioners constitute the dominant share of cooling energy consumption. It was around 40% in 2017-18 and is projected to grow to around 50% in 2037-38.

Active (AC) and passive cooling strategies

The Ministry of Environment and Forests (MoEF) states that the plan takes a holistic and balanced approach. It proposes combining active (air-conditioning) and passive cooling strategies. For instance, it considers

1. passively-cooled building design that deploys natural and mechanical ventilation
2. promoting the use of energy-efficient refrigerant
3. adoption of adaptive thermal comfort standards to specify pre-setting of temperatures of air-conditioning equipment
4. development of energy-efficient and renewable-energy-based cold chains for perishable foods
5. HFCs are commonly used in air-conditioners and as refrigerants

Even by 2038, a significant percentage of households will not be able to afford refrigerant-based cooling equipment. Therefore, wider proliferation of thermally efficient residential built spaces is required. They should have reduced heat load and enhanced ventilation. This should be coupled with efficient non-refrigerant-based cooling equipment, such as fans and coolers.

Benefits

Above and beyond environmental benefits, the following gains would accrue to society:

- Thermal comfort for all-provision for cooling for EWS and LIG housing
- Sustainable cooling–low GHG emissions related to cooling
- Doubling of farmers income–better cold chain infrastructure–better value of produce to farmers, less wastage of produce
- Skilled workforce for better livelihoods and environmental protection
- Domestic manufacturing of air-conditioning and related cooling equipment
- Robust R&D on alternative cooling technologies–to provide push to innovation in cooling sector.

[1]https://unfccc.int/

[2]https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/nationally-determined-contributions-ndcs

[3]https://globalabc.org/

[4]https://www.iea.org/

[5]https://tinyurl.com/y4t8v6ac

[6]https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1568328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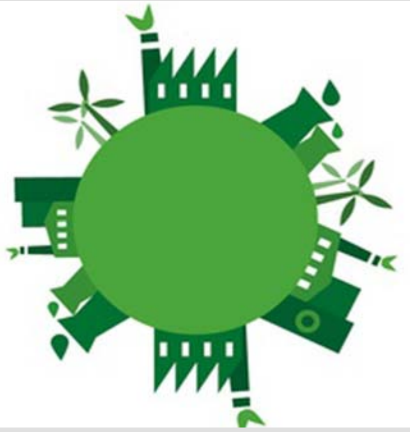
What is BEEP and how does it Contribute in Mitigating Climate Change?

India has committed to reducing carbon dioxide pollution produced for every dollar of GDP by 33 to 35% below 2005 levels, ahead of 2030.[1] The country is set to surpass its commitment to increase the share of renewables in its energy generation basket. To achieve this goal, it is necessary that new buildings are designed to be energy efficient and thermally comfortable.

OBJECTIVES:



To introduce to the media persons about the Indo-Swiss Building Energy Efficiency Project (BEEP) as well as BEEP design guidelines.

Learning Outcomes: Familiarity with BEEP

Highlights: BEEP is an Indo-Swiss bilateral co-operation project on building energy efficiency. Its goal is to reduce energy consumption in new commercial, public and residential buildings in India through energy-efficient and thermally comfortable (EETC) designs.

With the construction of megacities progressing rapidly to accommodate India's booming economy, the country faces challenges in the development of building regulations. The building stock is expected to double in the next 15 years and buildings are expected to emerge as the largest electricity consuming sector.

A large number of these are residential buildings. The residential building sector is expected to double in terms of area by 2030 from the 2017 level. Residential buildings today account for nearly 25% of the total electricity consumed in the country. With increasing construction and availability of air conditioning, residential buildings are fast becoming the major power consumer. In the next 10 years, they are projected to consume around 37% of the total electricity.

The impact of India's buildings in numbers

It is crucial that new buildings are designed to be energy efficient and thermally comfortable (EETC). Hence it is necessary to have simple codes and guidelines to ensure implementation of energy efficiency measures in new buildings.

Indo-Swiss Building Energy Efficiency Project (BEEP)

In India, until 2017, there was no building code for residential buildings. A collaborative Indo-Swiss Building Energy Efficiency Project (BEEP), started in 2011, helped change this.[2] The BEE is the implementing agency on behalf of the Ministry of Power while the Swiss Agency for Development and Cooperation (SDC) is the agency in charge on behalf of the Federal Department of Foreign Affairs (FDFA). It supports the state governments and city corporations in the implementation of energy efficiency measures in buildings.

The project's overall objective is to reduce energy consumption in new commercial buildings and to disseminate best practices for construction of low-energy residential and public buildings.

BEEP members, from India and Switzerland, provided the Indian government with expertise to develop the first Indian code for energy-efficient residential buildings. Switzerland started with simple building envelope code in the 1980s and periodically made building energy codes more stringent. Building regulations played an important role in encouraging the Swiss building industry to incorporate energy efficiency.

ENS 2018–A Code for Residential Buildings

To improve thermal comfort and energy conservation in buildings, BEEP assisted the Bureau of Energy Efficiency (BEE) in developing a code for residential buildings. It is known as Eco-Niwas Samhita (ENS) the Energy Conservation Building Code for Residential Buildings (ENS Part I: Building Envelope) or Eco Niwas Samhita 2018. The Code provides minimum requirements for energy-efficient design and construction of buildings. It also gives two additional sets of incremental requirements for buildings to achieve enhanced levels of energy efficiency that go beyond the minimum requirements.

Designs for Energy-efficient and Thermally Comfortable (EETC) Buildings

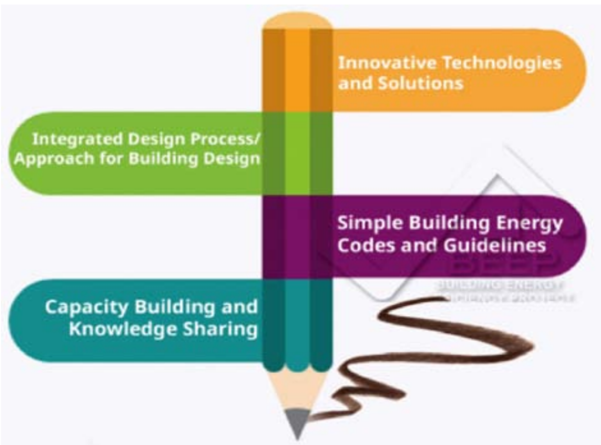
BEEP promotes the Integrated Design Process (IDP) for designing EETC (energy-efficient and thermally comfortable) buildings. The emphasis is on reducing heat gains from the building envelope, improving natural ventilation, use of energy efficient space cooling and application of renewable energy.

BEEP aims to reduce energy consumption in new commercial, public and residential buildings through EETC design and application of renewable energy technologies. It works directly with the building industry and various stakeholders such as policy makers, builders, developers, architects, engineers and academic institutes to catalyse adoption of EETC building design and technologies. It also works alongside national and international organisations and initiatives to localise global trends and innovations in EETC buildings.

A multi-pronged approach is being adopted to achieve this project. BEEP focuses on reducing heat gains from the building envelope, improve natural ventilation, use of energy-efficient space cooling and application of renewable energy.

It promotes the use of new/innovative technologies and building design tools to make EETC buildings a reality in India. As part of its outreach, BEEP is involved in events (including seminars and trainings), networking for the building industry and for students and educators (including an annual camp) and awards.

The multi-pronged approach used by BEEP:



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Design Guidelines for Energy Efficient Multi-Storey Residential Buildings

The project has also developed Design Guidelines for Energy Efficient Multi-Storey Residential Buildings. It is projected that the residential sector of India will grow many folds in the next two decades. Hence, the share of energy consumption of this sector in the total energy consumption of the country will increase dramatically. The guidelines take into account different climatic conditions prevailing in India. The first set of guidelines is for the country's composite and hot-dry climatic regions.

The guidelines, which provide comprehensive information, have 14 recommendations on energy-efficient features for consideration at the design stage of multi-storey residential buildings. These encompass building massing (refers to the shape, size, and orientation of the building blocks) and spatial configuration (characterises how the building blocks are arranged in a given plot of land) to reduce solar radiation exposure on the building surface through proper orientation and mutual shading; strategies for reducing cooling energy and improving thermal comfort through proper window design, insulation of walls and roof, external movable window shutters, wall finishes, and natural ventilation.

The recommendations also include methods to reduce electricity consumption in space cooling, appliances, and in common services such as lighting, lifts, and water pumping.

In the composite and hot-dry climate, space cooling and fans account for a large share of the total electricity consumption. Thus, during building design, a primary concern should be to include strategies that can reduce heat gains inside living spaces. One such important source is solar heat gain through the building envelope (walls, roof, windows). Solar exposure and hence solar heat gains can be reduced through appropriate selection of building forms (exposed surface area/built-up area), building orientation (façades orientation), and spatial configuration.

The suggestions on renewable energy integration include solar water heating and solar photovoltaic.

Significant energy savings can be achieved by designing climatically appropriate buildings so as to minimise the seasonal periods and daily durations when air-conditioning is resorted to. Savings can also be achieved by more efficient design and selection of lifts and pumps, as well as by improving the efficiency of space-cooling equipment.

[1]https://economictimes.indiatimes.com/news/politics-and-nation/india-to-meet-its-paris-agreement-commitments-ahead-of-2030-pm-narendra-modi/articleshow/81351882.cms

[2]https://www.beepindia.org/
Other BEEP publications can be accessed at www.beepindia.org




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Success Stories




OBJECTIVES:

To expose readers to projects that have resulted in energy conservation and efficiency in buildings

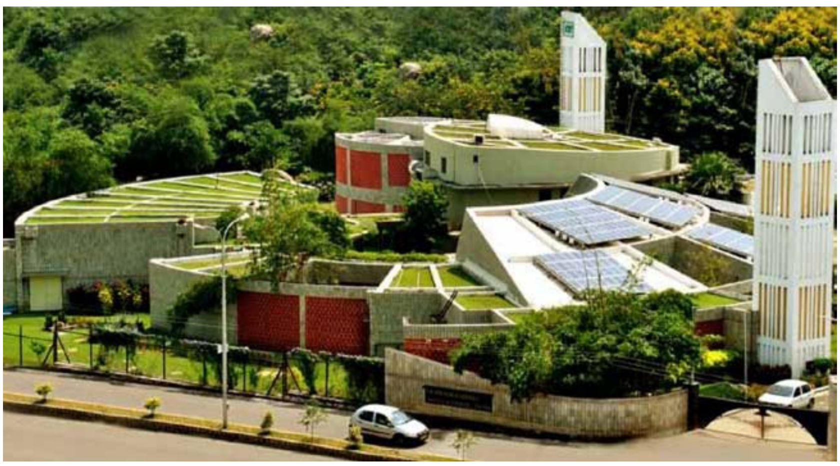
Case studies under BEEP: Aranya Bhavan, Jaipur; Jupiter Hospital, Pune; Infosys campus, Hyderabad, Indira Paryavaran Bhavan, New Delhi; IT firm Cisco Systems B-16 campus building in Bangalore; Confederation of Indian Industries (CII)-Godrej Green Business Centre Building, Hyderabad.

Learning Outcomes: To appreciate the gains accrued through thoughtful architecture.

Highlights: Some of India's landmark buildings have gained prominence for their efficient energy use and also conservation of natural resources.

A green building is one which uses less water, optimises energy efficiency and conserves natural resources. It generates less waste and provides healthier spaces for occupants, as compared to a conventional building. Eco-friendly buildings that are energy efficient and use water management techniques are the need of the hour. Some developers have succeeded in creating such buildings. Given below are a few success stories.

CII-Godrej Green Business Centre Building, Hyderabad



Confederation of Indian Industries (CII)-Godrej Green Business Centre Building, Hyderabad—India's first LEED Platinum rated green building.

The green building movement in India began with the construction of the CII-Sohrabji Godrej Green Business Centre in Hyderabad.[1] It was certified LEED Platinum for New Construction v 2.0 by the US Green Building council (USGBC) in 2003- the first in India and the first outside of the US. LEED Green Building Rating System is a nationally and internationally accepted benchmark for design, construction and operation of high-performance green buildings.

The building is an embodiment of modern construction prowess with 55% of the 20,000 sq. ft. structure being covered by a green roof. Besides, it has performance windows, biological water treatment ponds and wind towers. Around 90% of it does not require artificial lighting during daytime while 20% of the structure's total energy requirements are generated by solar panels. Additionally, it recycles 100% of wastewater making it a zero water-discharge building.

The building is a perfect blend of India's rich architectural splendour and technological innovations, incorporating traditional concepts into modern and contemporary architecture. Extensive energy simulation exercises were undertaken to orient the building in such a way that minimizes the heat ingress while allowing natural daylight to penetrate abundantly.

The building incorporates several world-class energy and environment-friendly features, including solar PV systems, indoor air quality monitoring, a high efficiency HVAC system, a passive cooling system using wind towers, high performance glass, aesthetic roof gardens, rain water harvesting, root zone treatment system, etc. The extensive landscape is also home to varieties of trees, most of which are native and adaptive to local climatic conditions.

The green building boasts a 50% saving in overall energy consumption, 35% reduction in potable water consumption and usage of 80% of recycled/ recyclable material. Most importantly, the building has enabled the widespread green building movement in India.

Green features and sustainable technologies

Energy Efficiency

State-of-the-art Building Management Systems (BMS) were installed for real-time monitoring of energy consumption. The use of aerated concrete blocks for facades reduces the load on air-conditioning by 15-20%.

Several large companies have taken the lead to improve efficient building design including the Park Hotel Group, TCS, Cisco, Infosys, ITC, and Wipro, which improved building design in their hotels, IT campuses, and business parks.

Indira Paryavaran Bhawan

Located in New Delhi, this eight-storey structure has been given a platinum rating by LEED ((Leadership in Energy and Environmental Design) and a 5-star rating by The Energy and Research Institute's GRIHA (Green Rating for Integrated Habitat Assessment). The building uses geothermal heat exchange system to reduce the power required to run air conditioners, and recycles all its water thereby reducing water demand by over 50%.[2]

The Indira Paryavaran Bhavan[3] is India's first net zero energy building that has been constructed with adoption of solar passive design and energy-efficient building materials. It is one of the first buildings in India to have deployed energy efficiency and renewable energy technologies at a large scale. It has set standards that can be emulated by upcoming buildings in the region."

The building boasts an earthquake-resistant structure with a total plinth area of 31,488 sq. m. It covers only 30% of the total area, while more than 50% area outside the building is a soft area with plantation and grass. The building has a robotic parking system in the basement that can accommodate 330 cars. Thin-client networking system has been provided instead of conventional desktop computers to minimise energy consumption.

The building received GRIHA 5-star (provisional) rating for the following features:

The design allows for 75% of natural daylight to be utilised to reduce energy consumption.

- The entire building has an access friendly design for differently-abled persons. With an installed capacity of 930 kW peak power, the building has the largest rooftop solar system among multi-storied buildings in India.
- The building is fully compliant with ECBC requirements. Total energy savings of about 40% have been achieved through the adoption of energy efficient chilled beam system of air-conditioning. As per this, air-conditioning is done by convection currents rather than airflow through air handling units, and chilled water is circulated right up to the diffuser points unlike the conventional systems.
- Green materials like fly ash bricks, regional building materials, materials with high recyclable content, high reflectance terrace tiles and rock wool insulation of outer walls have been used.
- Use of renewable bamboo jute composite material for doorframes and shutters.
- UPVC windows with hermetically sealed double glass. Calcium silicate ceiling tiles with high recyclable content and grass paver blocks on pavements and roads.
- Reduction in water consumption has been achieved by use of low-discharge water fixtures, recycling of waste water through sewage treatment plant, use of plants with low water demand in landscaping, use of geothermal cooling for HVAC system, rainwater harvesting and use of curing compounds during construction.

ITC Maurya Hotel, New Delhi

In the hotel category, ITC Maurya has come to be known as the "Greenest Luxury Hotel Chain in The World". The hotel has been awarded the LEED Platinum Rating on account of its environment best practices such as energy efficiency, water efficiency, sustainable site development, indoor environment quality, sustainable materials & purchasing.[4]

It is the world's first and largest LEED Platinum rated hotel to use parabolic solar concentrators. The magnificent building recycles almost 99% of its solid waste (by means of recycling programmes or composting). Another distinguishing feature of the building is that it uses low VOC (Volatile Organic Compounds) paints.

The hotel uses 23% less energy than USGBC's national average for large size luxury hotels. Its other features are: Usage of solar thermal system for hot water and low pressure steam application, Usage of non-ozone depleting gases for refrigeration; Heating, Ventilation and Air Conditioning (HVAC) system, thermal system, water management system and building management system underwent retro-commissioning to enhance performance efficiencies; Only treated recycled water is used for landscape, cooling tower and miscellaneous cleaning resulting in further reduction of water consumption. Excess treated recycled water is given to government bodies for irrigation of landscapes, gardens and forests. Through automation, it has reduced water demand in cooling tower.

The hotel's rain water harvesting capacity is 30% of the peak rainfall. This helps in reducing water demand and run-off. Steps have been taken to protect the ecological stability of the immediate surroundings and landscape. The building consciously promotes cultivation of native plants (covering more than 25% of building area). Over 75% of roof area is covered with a special paint that has a high Solar Reflective Index, thereby reducing the cooling demand. The Exterior hardscape is maintained without use of chemicals.

Aranya Bhavan

Aranya Bhavan is the head office of the Rajasthan Forest Department. Situated in Jaipur (composite climate), the five-storey building has offices, museum, library, auditorium and guest rooms. It has also a basement for parking and services.

With a total built-up area of 10,000 sq. m. (excluding basement parking and service area), Aranya Bhavan comprises high quality work places for over 340 users, an auditorium, an exhibition area, a library and guest rooms. The structure lays emphasis on reducing heat gains, improving day lighting, energy efficient lighting and cooling systems and integration of renewable energy.

BEEP provided technical assistance to the developers during the conceptualisation and design phase.

Aranya Bhavan was one of the first projects selected for the BEEP Integrated Design Charrette and the charrette was held in December 2012. The project was inaugurated on 23rd March, 2015. During the charrette, its energy performance was simulated, using energy simulation tool Design Builder/Energy

Plus. Aranya Bhavan qualifies for 5-star rating under the BEE star rating programme for office buildings.

The building is a good example of optimised design for energy-efficient and climate-friendly solutions.

The Bhavan has Extruded Polystyrene (XPS) insulation in the cavity walls to reduce heat transfer. Its windows have Double Glazed Unit (DGU)--two panes of glass with an air gap in between. This air gap acts as insulation. The low-e outer pane also reflects heat back to the outside. To reduce heat transfer from the top, 40 mm Polyurethane Foam (PUF) insulation is used over the roof slab. Light coloured terrazzo tile finish reflects some of the solar radiation falling on the roof.

Aranya Bhavan has a centralised high-efficiency water-cooled chiller for air- conditioning the building. It uses lesser energy compared to an air-cooled system. Given the water scarcity in Jaipur, treated waste water is used in this system.

The structure has a grid-connected roof-top solar PV system with net metering. The system size is 45kWp with an estimated annual electricity generation of around 60,000 kWh.

Energy Efficient Hospitals

Hospitals are the backbone of the health care delivery system in India. These institutions function round the clock.

They usually 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 systems, depending on external weather conditions and ventilation systems combined with good insulation of the hospital building, usually reduces hospital's sensitivity to the outside weather.

Hospitals also require standby 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. The actual lifetime is normally over 50 years. 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 health care 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.

Jupiter Hospital, Pune

One such example is the Jupiter Hospital, a 350-bed multi-specialty hospital building in warm-humid climate (Pune). Hence, it incorporates energy efficiency measures such as building envelope to reduce cooling load--the AAC block external wall, insulated roof and double-glazed window. The HVAC system has optimum sizing of chiller, selection of energy efficient chillers with a good part load performance, enthalpy recovery wheels for fresh air, use of condenser for reheating in air AHUs and heat pumps for water heating.

The building's annual electricity consumption shows that around half of the electricity is consumed by the HVAC system. Its EPI is 136 kWh/m2.y, which is very close to the predicted performance (130 kWh/m2 .y). The hospital gets a 4-star rating under the BEE star rating for hospitals.

The break-up of energy consumption (pie chart) shows that the HVAC system consumes 50% of the total energy consumption, and chillers contribute maximum (19%). Chiller plant hydronics mainly includes primary chilled water pump, secondary chilled water pump, cooling tower pump and cooling tower fans. Other HVAC mainly includes hot water system, cold storage and basement ventilation.

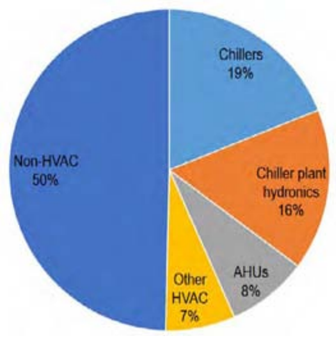


Figure break-up of energy consumption

Cisco Building, Bangalore

IT firm Cisco Systems B-16 campus building in Bangalore

The large office building structure of the multinational IT firm Cisco in Bengaluru offers another interesting case study. The campus houses eight glass-and-concrete buildings showcasing a digitally connected and sustainable environment where techies don't have an assigned workplace. With LEED Platinum Certified buildings, the campus ecosystem resembles a smart city.[5]

It uses the Internet of Everything (IoE) to showcase how connected education, connected healthcare, smart buildings, connected transport and smart parking can transform the way cities and communities are designed, built and renewed to ensure economic, social and environmental sustainability.

Spread over 2.18 million sq ft and designed as a campus-as-a-city for its employees to work, play and learn, the buildings showcase how a pervasive physical network infrastructure can easily connect to devices (such as sensors, information access points and mobile devices) with a high degree of security. The B-16 campus building also demonstrates how intelligent networks could enable digitally empowered citizens avail government services in real time, online and via mobile platforms. The fully networked campus is a demonstration of how 'connecting the unconnected' creates a more flexible and stimulating work environment, reduces the carbon footprint, lowers costs and provides more sustainable operations.

Workers can pick any conference room, and adjust the lights, shutters or even control the AC. The building has over 1500 interoperable VAV units. It sources more than 70,00,000 kWh of green power per annum and recycles 100% of waste water. It has a high-performance glazing and energy-efficient HVAC design and uses recycled materials and rapidly renewable materials for construction. Ventilation and temperature controls enable occupants.

The rooftop solar system also generates 1 MW of power through solar energy panels placed strategically on the building terraces. With increased use of the network, Cisco has gone in for power trading. The entire superstructure gets linked to an integrated dashboard with pointers on energy usage, transportation, space utilisation et al. making life a lot easier.

The building has been awarded the LEED Platinum ID+C (Interior Design and Construction) certification by the USGBC.

Infosys, Hyderabad

Infosys'Pocharam SEZ Campus, Hyderabad.

The global consulting and technology firm Infosys has also given a new high to energy efficiency. Its

460-acre Pocharam campus in Hyderabad is a laboratory to test construction technologies. It was built using a holistic approach to sustainability in five key areas: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality.[6]

The edifice is split into two symmetric halves–its most strikingly visible feature. One half of it is cooled by conventional air conditioning, the Variable Air Valve (VAV) cooling system. And the other half by radiant slab cooling system (pumping cold water through pipes embedded in concrete), the first in a commercial building in India. It consistently uses one-third less energy than the VAV system. All parameters in the two halves–the area, number of occupants, orientation, envelope and lighting – are similar. Hence, the building is ideally suited for comparing two different technologies. This allowed Infosys to demonstrate the efficiency of the radiant design from the beginning. Its other green architectural features range from efficient lighting to smart building systems.

Infosys' campus buildings are based on passive design principles such as minimising heat and glare, strategically situated windows, white-painted roofs and radiant cooling technology. The building uses efficient building envelope (that includes high-performance glazing, ample shading, radiant cooling, etc), energy efficient lighting and HVAC system to achieve energy efficiency. It won the UK's prestigious Ashden Awards, also known as the 'Green Oscars'.

Three of its Software Development Blocks (SDB) 1, 2 and 3 are LEED India Platinum rated.

[1]http://www.greenbusinesscentre.com/site/ciigbc/index.jsp

[2]https://www.grihaindia.org/indira-paryavaran-0

[3]https://www.architecturaldigest.in/article/eco-conscious-ethos-itc-hotels-leed-platinum-certified-hotels-sets-progressive-benchmark-greater-greener-good/#s-cust0

[4]https://acutherm.com/project/cisco-systems-b16-building/

[5]https://www.infosys.com/newsroom/press-releases/2012/leed-india-platinum-rating-hyderabad.html

[6]https://cpwd.gov.in/CPWDNationBuilding/InaugurationPM25.02.2014/architectural_design.pdf

10

Reporting on Energy-Efficient and Comfortable Buildings

Conventionally, journalists are exposed to the general beats so as to get familiar with almost everything and report on events in society. They get a broader view of the world as they are drilled on the nitty-gritty of media profession. Thereafter, generalists (journalists exposed to general beats) can specialise and carve out a niche for themselves in a particular area or beat. And eventually, they become specialists in the chosen field and concentrate on particular areas of news. One such round or beat is energy.

OBJECTIVES:

To equip journalists with techniques and resources

- Ideation on energy efficiency stories
- Observation during routine reporting
- Challenges and pitfalls of reporting the technical subject like energy efficient buildings.

Learning Outcomes: Making media persons write/report on the future trends in creating a sustainable built environment; and also, application of renewable energy systems and promotion of efficient lighting and HVAC system to reduce energy demand in commercial and residential buildings.

Highlights: Journalists aspiring to become specialists in a specialised field such as energy should have a deep understanding of the subject. Constant updation of knowledge and interaction with experts, scientists, engineers and architects is necessary.

Eager specialists can acquire knowledge by attending workshops, especially on energy, climate change and environment.

Energy is a vast specialised subject and encompasses related fields, such as the environment and climate change, and revolves around humans and buildings specifically.

Environmental science is the study of the effects of natural and unnatural processes, and of interactions of the physical components of the planet on the environment (particularly human action). It covers a number of disciplines: climatology, oceanography, atmospheric sciences, meteorology, and ecology.

Climate change is especially of concern to the energy sector, since energy use accounts for some 60% of greenhouse gas emissions. Similarly, energy and the environment have always been and will continue to be closely linked.

Hence, an energy reporter writing on the environment and climate change has to be well versed in all these subjects. This calls for a working definition of the concept of environment for a reporter to know the latitude or functional boundaries, issues and coverage areas that make up an environment beat.

The old adage, "If it isn't documented, it didn't happen," does not represent the truth. We do not write down everything that happens in our lives, day-to-day, hour-by-hour. A great deal happens that a reporter does not document. An energy reporter has to be observant during routine reporting. Comprehensive recording and report writing are based on vigilant observation of events. In energy writing, which forms part of science writing, evidence-based reporting is crucial. Writing has to be supported by facts.

Specialised Reporting

Considering the expansion in the media sector, industries and housing, there is a need for a specialised aspect of reporting that will acquaint both practicing and aspiring journalists to a specific area of coverage. Many reporters may be working for one organisation, bringing in news regularly from different areas on different issues or subjects. Those who do not have any journalistic knowledge may think that reporters just go into the field, get stories from any place and file them for publication without any organised news hunting arrangement in the field (Nwabueze, 2009). The reality is that each reporter has a responsibility in terms of area or subject of coverage.

Most reporters seen in the field ensure good use of human resources, effective coverage of society and organised practice of the profession. Each reporter has a specific geographic area, subject or issues one regularly covers or works in. Reporters who have regular beats get used to the terrain, the sources in that beat and add invaluable assets to their organisation. In some cases, stories pursue them, they do not pursue stories.

Writing on energy is far beyond the routine speech reporting or surface reporting. It necessitates in-depth, thorough, elaborate, comprehensive, discriminate and very lucid report of a specific area or field of journalistic coverage. In other words, specialised reporting is knowledge demanding and brain tasking intellectual piece focusing on specific issues in specific areas of media coverage.

The subject is quite vast and hence provides several angles. A reporter needs to ideate and look for new topics. Let us consider buildings, which is just one facet of the energy beat. If you dig deep, you can find a number of specialised stories that will impact your readers.

Since we have focused on buildings, the topics for coverage will dwell on energy efficiency, effect of environment on buildings and vice-versa and their impact on climate change. Hence the field necessitates constant awareness and keeping posted with information. An energy journalist should regularly interact with experts, read articles written by specialists, look through peer-reviewed journals on energy, and watch stories on television and on the web. Visits to academic and engineering institutions will help in tracking progress in this domain.

With every activity shifting to social media, Twitter is a great way to get a pulse on the beat and stay on top of breaking news. There are the mandatory follows: companies you cover, government agencies and energy-specific publications. But these accounts can be a bit lacklustre. That's why accounts of other journalists should find their way into your timeline. Not only is it a way to find out what others in your field are working on or reading, real people are just more entertaining.

A wide range of subjects and issues pertaining to energy conservation in homes could be explored for reporting and feature writing.

Learn Everything You Can

Energy is a specialised beat–a specific area such as science and technology. Journalists should function less like generalists and more like doctors, lawyers, or other highly trained professionals. To cover the beat effectively, learn everything you can. Being an energy reporter means you need to know everything you can about the subject. That means talking to people in the field and reading a lot. This can be especially challenging. It does not mean that you should know everything an engineer, climatologist or an architect does.

But you should have a strong layperson's command over the subject so that when interviewing someone like an engineer or architect you can ask intelligent questions. Also, when you write your story, understanding the subject well will make it easier for you to translate it into terms everyone can understand. Technical jargons must be avoided or explained in a nutshell.

Get to Know the Players

You should know the experts in the field. Beyond just getting to know these people, you need to develop a level of trust with at least some of them to the point where they become reliable contacts or sources. Cultivating specialists is quite important as you will require their views whenever new developments unfold in this domain and related areas.

Environmental and science journalism are particularly complex due to the nature of scientific efforts and the transversal nature of environmental affairs. Energy beat interweaves these two. All these require in-depth reporting on a particular issue, sector, organisation or institution, over time. This distinguishes reporters from other journalists who might cover similar stories now and then.

Specifically, journalists should embrace an educated understanding of energy, environment, climate change and architecture—before reporting on energy efficiency in buildings.

Specialised reporting follows the principles of knowledge-based journalism. And, knowledge-based journalism requires balancing competencies spanning skills, expertise, and values to create better prepared and rounded journalists, who will go on to produce higher quality journalistic products.

Training for acquiring skills

Aspiring specialists can acquire knowledge by attending workshops, especially on energy, climate change and environment. Acquisition of subject knowledge and skills would increase the quality of reporting, sourcing, and news judgment. Besides, rigorous intellectual training would help preserve journalistic standards amid an overabundance of non-professionalised information available online. Undergoing such training would increase the quality of reporting, sourcing, and news judgment. Besides, rigorous intellectual training would help preserve journalistic standards amid an overabundance of non-professionalised information available online.

In the long run, a specialist in these fields should gradually attain some solid science knowledge, develop abilities to navigate a journal and a good backing in statistics. More importantly, one should develop capabilities to communicate with sources.

Ideation–How to Cover the Energy Beat Effectively

A month or two ahead of the onset of summer and winter, reporters can start pitching and writing stories on ways to conserve energy in households and more specifically buildings. A series of articles can be planned starting with combustion of coal in thermal plants to generate power and its impact on the environment. Readers are always interested in a piece weighing energy needs and jobs with the health of the environment.

Outlets are also looking for stories revealing the other side of the coin. What jobs are renewable energies creating and can they pay as much as fossil fuel jobs? Construction of renewables is booming, largely due to tax benefits and improved technology.

Your newspaper/magazine/news portal could bring out a special report on smart systems and look at emerging systems of urbanism.

The National Smart Cities Mission is a government's urban renewal and retrofitting programme to develop smart cities across the country, making them citizen friendly and sustainable. A series of features focused on buildings may be planned.

Energy affects every person in this country. If you can humanise the story, you will have readers. People may not care how their switches work, but they do care if their lights turn on. Or worse, if they don't.

While covering this beat, it's easy to exaggerate the decline of coal, which despite all the reports still provides a third of the nation's energy, and over-hype renewables, which combined only produce 13% of the nation's energy. Before grabbing your reporter's notebook, take time to understand the energy matrix and the role each energy source plays in powering the nation.

Challenges and Pitfalls:

Most often, small newspapers merely reproduce press release material in a verbatim manner. Increasing pressures on science or energy journalists are leading to an erosion of journalistic independence through their increasing use of press release and PR material. While metropolitan newspaper journalists use press release material to varying degrees, they still retain a measure of control on how they use this material. Another factor working against journalists becoming too reliant on press releases and PR material is the frustration journalists feel towards certain PR practices, especially the need to email enquiries or the seeming constant unavailability of people listed on press releases.

Science reporting has changed at the turn of the century with the internet, and press releases issued by universities, scientific institutions and scientific journals. These stories often carry an embargo. Energy reporting is almost similar.

Eminent octogenarian science journalist Dr K S Jayaraman says, "This has made the job of science reporters a lot easier as one can write stories from home unlike in the 1970s and the 1980s when reporters were mostly on the road or near telephones."

In an interview in the book *Raising Hackles: Celebrating the life of science journalist Dr. K S Jayaraman*[1], he says, "Internet journalism, however, limits one to follow-up work done by others. It robs one the thrill of spotting a potential story and turning out an article after a lot of running around." This is true for reporters writing on energy, climate change and environment.

By reproducing press releases, reporters tend to peddle what is written. They become victims of 'surface journalism'—believing what is written and not questioning further. Specialised journalists should be sceptical—question and probe what is written. Instead of scratching the surface, you should get to the heart of the matter and face its real challenges.

[1] Raising Hackles: Celebrating the life of science journalist Dr K S Jayaraman, August 2020, Publisher: Notion Press, ISBN: 9781648927119

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