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UNIT-6

DEFINITION

LEED (Leadership in Energy and Environmental Design) is an ecology-oriented building certification program run under the auspices of the U.S. Green Building Council (USGBC). LEED concentrates its efforts on improving performance across five key areas of environmental and human health: energy efficiency, indoor environmental quality, materials selection, sustainable site development, and water savings.

LEED rests on a collection of special rating systems that apply to all kinds of structures, including schools, retail, and healthcare facilities. Rating systems are available for new construction and major renovations as well as existing buildings. The program is designed to inform and guide all kinds of professionals who work with structures to create or convert spaces to environmental sustainability, including architects, real estate professionals, facility managers, engineers, interior designers, landscape architects, construction managers, private sector executives, and government officials.

On its Web site, the USGBC says that LEED defines "a nationally accepted benchmark for the design, construction, and operation of high-performance green buildings" and "provides building owners and operators with the tools they need to have an immediate and measurable impact on their buildings' performance." According to the American Institute of Architects, the 69 LEED points that make up the program's specific design points and considerations can be reviewed in a two-hour meeting, during which time the design team and the owner can decide what level of LEED compliance is desirable for their building project.

State and local governments around the United States are adopting LEED for public buildings of all kinds, and LEED initiatives at the US Departments of Agriculture, Defense, Energy, and State drive activity at the federal level. In addition, various types of LEED projects are currently underway in over 40 other countries, including Canada, Brazil, India, and Mexico.

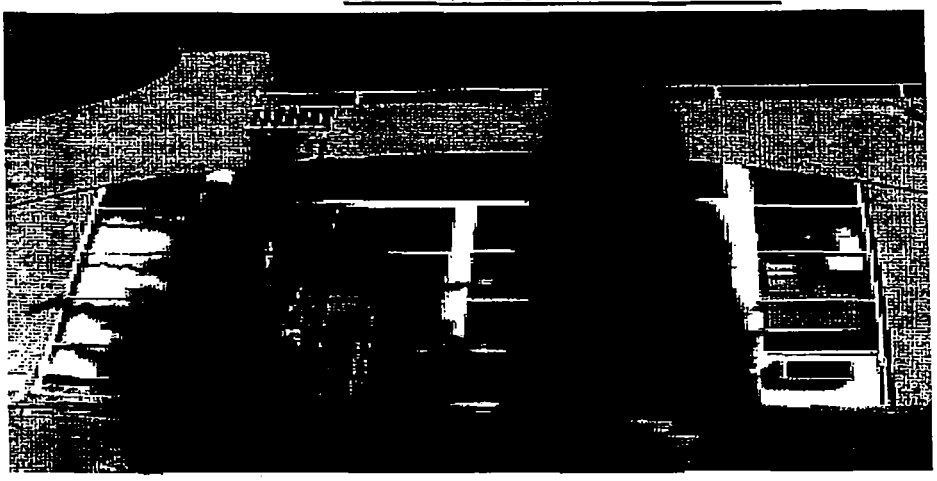
Why LEED?

School districts need an objective standard of green building against which to measure the results of their actions. Several green building standards in use today could be suitable for this purpose.

LEED provides a collaborative platform and assurance that building renovations have been designed, are built, and will perform as expected. It provides credibility because of its third-party certification process. LEED also undergoes a process of continuous improvement that allows new technologies to be incorporated.

The US Green Building Council has recently established the LEED for Schools Rating System, which recognizes the unique nature of K-12 schools design and construction.

PASSIVE SOLAR HEATING



When using passive solar heating, it is important to provide unobstructed access to south-facing walls in the winter months, to allow as much sunlight exposure as possible. In four-season climates, planting deciduous trees on the south side of a property is often ideal, because the lack of leaves in the winter allows for good sun exposure, while in the summer, tree leaves provide shade and help to keep the house cool.

While home construction can incorporate many technologies to help homeowners save energy, there are additional measures you can design into your home to take advantage of solar energy without installing solar collectors on your roof. Some existing homes can also take advantage of passive solar heating. Buildings that use passive solar design need fewer or smaller-scale active technologies to meet the remainder of their heating and lighting needs (i.e., smaller mechanical heating systems). Because the sun's energy is free, maximizing use of passive solar techniques before adding active technologies can significantly reduce your energy bills. Work with your architect to incorporate the following into your blueprints.

Design elements of passive solar heating (and cooling) include:

- House orientation (south-facing windows)
- Vegetation/trees for shading and wind breaks
- Another simple strategy is to plant deciduous trees near south, east, and west-facing windows, which will provide needed shade in the summer, but let in the sun's heat during the winter (when the leaves have fallen). Also, evergreen trees on the north side of your home can help buffer winter winds.
- Use the sun's heat - During the heating season, open curtains on your south or west-facing windows during the day to allow sunlight to naturally heat your home, and close them at night to reduce any chill. (During the cooling season, keep your window coverings closed during the day to prevent solar gain.)

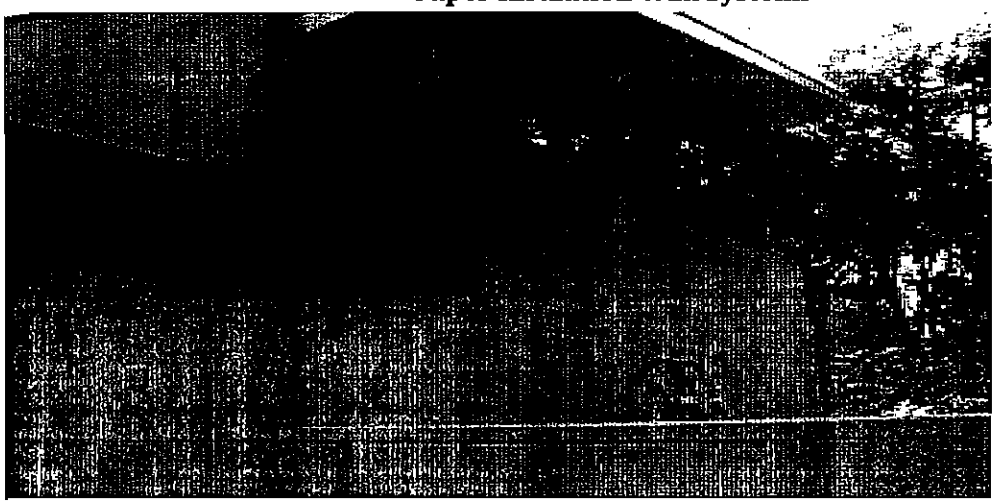
- Thermal mass materials - These materials retain or store heat produced by sunlight or other sources. They are typically dense materials such as stone, concrete, or metal, and are often an important component of solar heating systems and other high efficiency systems

- When building a new home or planning a major addition, consider orienting windows to the south. You can also use roof overhangs to help reduce energy use by providing shade from the sun in the summer and solar heat gain in the winter

Advanced New Home Construction

Because building codes continue to increase in stringency and housing technology continues to improve, the specifications for ENERGY STAR continue to move to more stringent specifications. While the following technologies are not required for an ENERGY STAR qualified home, the role of these technologies may increase to make ENERGY STAR homes even more energy efficient in the future. EPA has developed a program called Climate Choice that incorporates advance new home construction into homes that can save approximately 50 percent more energy than a home constructed to the model energy code (2006). These are the next generation of technologies that will help those home owners reaching for a carbon neutral home. These technologies are described in more detail at

Super Insulation Wall Systems



Insulated concrete forms (ICFs) are concrete blocks constructed with insulation on the inside.

Insulation is typically described in terms of R-value. However there is much more that goes into effective insulation including zero tolerance installation, a complete air barrier and the elimination of thermal bridging through the walls. The following technologies are important components of a super insulated wall system.

Conventional Framing with Rigid Insulation Sheathing

This wall system uses conventional framing and insulation between the studs, but with a complete air barrier formed on the outside with rigid insulation.

DoubleFramedWalls

Two sets of conventionally framed walls are constructed with offset vertical framing. This framing eliminates thermal bridging except at the top and bottom plates. This type of framing allows room for additional insulation for increased R-Value.

StructuralInsulatedPanels

Structural insulated panels (SIPs) are prefabricated insulated structural panels for use in building walls, ceilings, floors, and roofs. They provide superior and uniform insulation compared to more traditional construction methods (stud or "stick frame"), offering energy savings of 12-14 percent.

InsulatingConcretForms

Homes built using an insulating concrete form (ICF) system literally have the insulation built into the walls as part of the structure. This system creates walls that have a high thermal resistance, with R-values typically above R-17. Even though ICF homes are constructed using concrete, they can look just like traditional stick-built homes.

Super Efficient Windows

ENERGY STAR qualified homes can include a variety of "tried-and-true" energy-efficient features that contribute to improved home quality and homeowner comfort, and to lower energy demand and reduce air pollution.

High Performance windows today feature soft-coat low-E coatings, inert gas in a vacuum sealed air gap, warm edge spacers and more efficient frame technology. The results are windows that block over 70 percent of the solar heat gain and provide overall R-3 thermal resistance. The most

efficient windows today enhance performance further with one or two additional low-E glazing layers, gas filled insulating gaps and more efficient framing

Air-Tight Air Handlers with High Efficiency with High-Efficiency Variable-Speed Fans

Research indicates that approximately half of duct losses occur in the air handler because these products are very leaky. Manufacturers of air-handlers are beginning to offer air-tight cabinets by sealing joints and using gaskets at access door panels. High efficiency speed fans would further increase the overall efficiency of the system.

Solar Domestic Water Heating System, De-super heater, or Heat Pump water Heater

These advances in water heating will become increasingly important as heating and cooling loads decrease with advance new construction components.

Super High Efficient HVAC Equipment

Commercially available super efficient heating and cooling equipment include SEER 18 cooling, 9.0+ HSPF heat pumps and 95% AFUE furnaces. When heating and cooling are substantially minimized with advanced wall systems, more expensive but highly efficient geothermal heat pump systems can become cost-effective.

Active Solar Heating

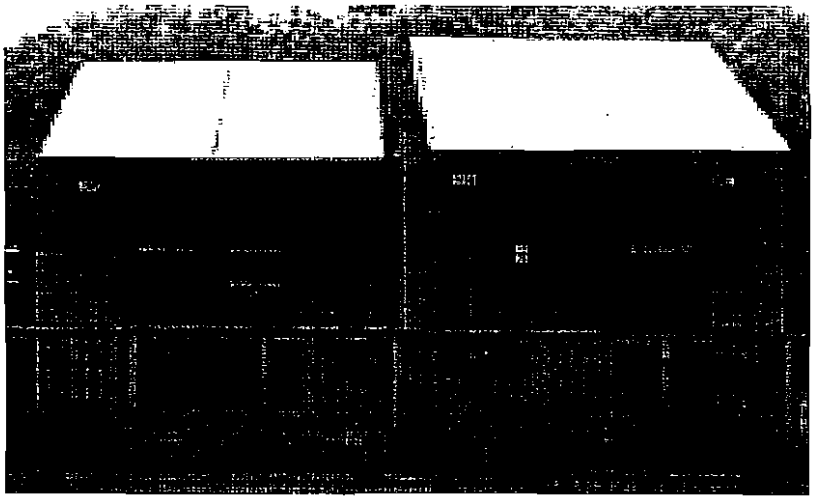
When passive solar heating is not enough, supplemental heating can be provided by active solar technologies. Small scale solar space heating systems often use a solar collector that concentrates heat in either a liquid or in the air which is then distributed throughout the home.

Active solar heating systems are cost-effective when they are used for a large part of the year, that is, in cold climates with good solar resources. They are most economical when displacing more expensive heating fuels, such as electricity, propane, and oil heat. Certain tax credits are also available for solar home heating technologies.

Green Power for the Home

Your home's purchased electricity use can be a significant source of air pollution and greenhouse gas emissions. Using green power, a subset of renewable energy, can help reduce your home's environmental impact while also providing a number of other valuable benefits. Green power is electricity produced from a subset of renewable resources, such as solar, wind, geothermal, biomass, and low-impact hydropower.

Homeowners can purchase green power through three options:



Photovoltaic solar panels that generate electricity can supplement a home with a renewable source of electricity.

- **Green Power Utility Product**

  Homeowners can check with their local electricity service provider to see if they offer a green power product. Currently, more than 850 utilities, or about 25 percent of utilities nationally, offer green power products to customers. These products allow customers to purchase some portion of their electricity from renewable resources-almost always at a higher price, but sometimes offered with price-hedging benefits.

- **Renewable Energy Certificates**

  Regardless of whether a homeowner's utility offers a green power product, any consumer in the U.S. can buy green power through renewable energy certificates, also known as RECs. RECs are the environmental benefits associated with renewable energy generation and are sold by renewable energy certificate marketers and are separate from your existing electricity service.

  Homeowners can use EPA's Green Power Locator to find a list of local utilities and renewable energy certificate marketers that sell green power products in their state.

- **On-site Generation**

  A homeowner can also investigate the option of installing an onsite energy generation system on their residence. On-site energy generation systems include such systems as photovoltaic (solar panels), wind generators, and other types of renewable energy technologies. Combining on-site renewable energy generation with energy efficiency improvements that reduce a home's energy load helps ensure that an installed system is properly sized. Further, the energy cost savings produced by energy efficiency improvements can be used to offset the purchase and installation costs of renewable energy generation systems and thus shorten payback periods.

On-site renewable provide advantages of reliability and price stability. In addition, when on-site renewable generate more power than is needed on site, many states allow the excess power to be returned to the electric grid for credit from the local electric utility. This process is known as net-metering. A variety of tax credits are available for on-site generation systems at the federal level; additional incentives are available from some states and localities.

Solar Electricity

Photovoltaic (PV) solar panels use available sunlight to generate electricity. PV systems can be used to reduce a home's use of electricity purchased from a utility. A growing market for solar PV, combined with federal and state support, has reduced the high up-front capital costs of PV systems.

HOW RATING SYSTEM DETAILS:-

Heading	Full name of heading	Pre - requisites,	Possible points	Total, %
SS	Sustainable site	1	13	18.84
WE	Water efficiency	0	6	8.7
EA	Energy and environment	3	17	24.64
MR	Materials and resources	1	13	18.84
EQ	Environmental quality	2	15	21.74
ID	Innovation and design process	0	5	7.24
Total		7	69	**100.00**

WHAT ARE KEY REQUISITES FORCONSTRUCTING GREEN BUILDING ?

PLANNING

Home design created by team of designers, builders, architects, energy consultants, and engineers; goal of creating systemic change; family involvement in design process.

SITE/LAND USE

Trees and natural features protected during construction; save and reuse topsoil; no use of toxic pesticides; south facing home with long dimension oriented on east-west axis; home placement saves east and south lot areas for outdoor use; front porch encourages interaction with neighbors; outdoor structures use recycled materials; backyard compost bin.

WASTE MANAGEMENT

Minimize waste; containment of job site trash; recycling bins in kitchen; prohibit burying of construction waste; recycle job site wastes (>50%); reusable materials donated or used on next job; non-toxic cleaners; kitchen compost container.

FOUNDATION

Rigid R-10 foam insulation; perimeter drain; shallow foundation; no crawl space; stemwalls used for thermal mass; earth-bermed foundation; minimum 5% drainage away from building; flyash content concrete >15%; non-asphalt based damp proofing; recycled aggregate in concrete.

STRUCTURAL FRAME

Beams made with engineered materials; "I" joists for floors; recycled content rim joists; avoid use of 2" x 10" lumber or greater; no pressure treated lumber; trusses made with small dimension lumber; timber reduced framing with 24" O.C. studs where possible and 2 stud corners; lesser quality boards for cripples and braces; finger-jointed or engineered material for plates and studs; elimination of unnecessary plates; "I" joists for headers.

ENVELOPE

Advanced sealing package; blower door test of approximately 0.15 ACH; all exterior penetrations sealed; house meets EPA 5-Star Program criteria.

SOLAR DESIGN

South-facing glass 8-10% of floor area; minimize use of windows on north, east, and west walls; home designed for passive-solar heating >20%; 22" overhang on soffits; top of windows are 14" below soffits; window height maximizes solar gain; provide sufficient thermal mass; provide south roof area for future solar collector within 20 degrees of south; night venting in summer; radiused window openings in straw bale walls to maximize solar gain.

INSULATION

R-38 ceiling insulation; cellulose insulation with recycled content material; 6" minimum insulation above exterior walls; attic baffles; R-45 straw bale walls; formaldehyde-free insulation; HCFC-free rigid foam; non-toxic spray foam insulation; insulated headers.

INDOOR AIR QUALITY

Radon mitigation installed; range hood and bath fans vented to outside; mechanical room enclosed R-13; no forced air furnace; cross ventilation; low-VOC indoor materials; operable windows in baths; meets American Lung Association Health House Standards; radon detector; carbon monoxide detector; heat recovery ventilator; sealed-combustion furnace and water heater (or boiler).

CONCRETE SLAB FLOOR

Finish floor is durable; finish floor is structural floor; moisture barrier under slab; insulation under slab; provides thermal mass; dark-color to maximize solar gain; contains recycled content material.

SUB-FLOOR

OSB sub-floor with fast growth material; urea-formaldehyde free material; avoid use of underlayment; no Luan underlayment.

WALLS

OSB sheathing with fast growth material; recycled content siding or stucco; recycled content fascia; redwood, cedar, tropical woods avoided; deep-set window ledges for plants; recycled content sheetrock; drywall clips; recycled brick.

WINDOWS

Double glazed with ½" airspace; no metal-frame windows; sealed with non-expandable foam; insulated window coverings; low-E windows NFRC rated at u=0.37 or lower.

DOORS

Exterior doors insulated to R-5 or greater; weatherseal on exterior doors; recycled content doors; no Luan doors.

ROOF

Minimum 30-50 year roofing material; recycled content steel roofing; OSB with fast growth material; continuously vented soffits and ridge vent.

INISH FLOOR

Recycled or recycled-content tile; tile installed with low toxic mastic or mortar and grout; no vinyl flooring; water based floor finishes; minimal use of carpet; recycled content carpet pad; recycled content carpet.

FINISHES AND ADHESIVES

Paints with no or low VOC content <250 grams/liter; water based paints; no vinyl wallpaper; water based drywall joint compound and texture; low toxicity or non-solvent

adhesives; non-toxic stain on slab floor.

CABINETRY AND TRIM

Finger-jointed trim; domestic woods; no tropical or endangered woods; recycled or recycled content materials for shelving, etc.; particleboard painted or sealed; formaldehyde-free cabinets; formaldehyde-free particleboard.

MECHANICAL SYSTEMS

90% or higher efficiency furnace; fresh-air intake; set-back thermostat; insulated sidearm boiler; hot water baseboard heat on interior walls to reduce runs; insulated copper water lines; ceiling fan; solar water heating system.

APPLIANCES

Gas range with electronic ignition; energy-efficient appliances; provide a list of energy-efficient appliances if they are not included; avoid use of dishwasher or use dishwasher with energy-saving cycle.

LIGHTING

Light-colored interior walls, ceilings, soffits and carpet; four or more compact fluorescents for high-use areas; no can lights in insulated ceiling or airtight can lights are used; natural daylighting; open layout to reduce artificial lighting; extended-life bulbs greater than 2000 hrs.

WATER

1.5 gpm bath faucets; 2.0 gpm kitchen faucet; low-flow shower heads; low-flow toilets; water filter at sink.

LANDSCAPING

Pervious materials for 40% of paving and walkways; recycled slag material for paving; recycled content wood mulch; waste straw used as mulch; natural fertilizer; plant more trees than were originally on the site; trees do not block solar gain; landscape uses edible plants and fruit trees; gutters and downspouts installed with direction to landscaping; controlled runoff ; xeriscape with drought resistant plants; list of native drought resistant plants for owners; efficient irrigation system; plants selected to attract butterflies and birds; low water variety turf grass.

TERMINOLOGY:

SUSTAINABILITY
A form of progress that meets the needs of the present without compromising the ability of future generations to meet their own needs. (World Commission on Environment and Development)

SUSTAINABLE DESIGN
The integration of built and natural environments. A broad, holistic, and inclusive approach to building design. It creates communities, buildings, and products that meet ongoing needs in ways that support enduring public and environmental welfare.

GREEN BUILDING
The term commonly used to describe buildings that achieve definable sustainable design goals

Green Building Defined
"A green building is one which uses less water, Optimizes energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building."

EXAMPLE'S OF LEED RATED BUILDINGS:

Some examples of LEED rated building in India

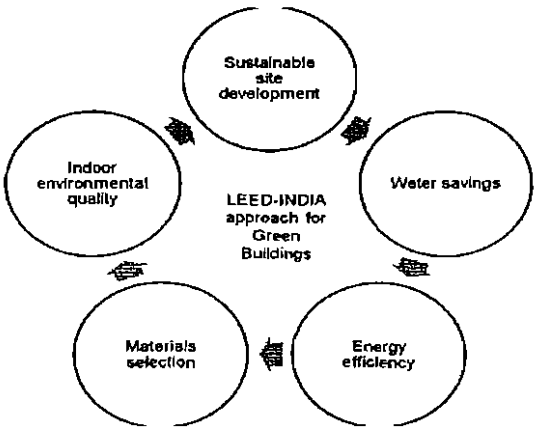
Sr. No	Green Buildings	Rating received
1	ABN Amro Bank N.V., Ahmedabad	LEED 'Platinum' rated
2	American Embassy School, Delhi	LEED 'Gold' rated
3	Anna Centenary Library Building, Chennai	LEED 'Gold' rated
4	Biodiversity Conservation India Ltd (BCIL) – Bangalore	LEED 'Platinum' rated
5	Birla International School, Jaipur	LEED 'Gold' rated
6	CII – Sohrabji Godrej Green Business Centre	LEED 'Platinum' rated
7	ITC Green Centre – Gurgaon	LEED 'Platinum' rated
8	Olympia Technology Park – Chennai	LEED 'Gold' rated
9	Rajiv Gandhi International Airport – Hyderabad	LEED 'Silver' rated
10	Suzlon Energy Limited – global headquarter in Pune	LEED 'Platinum' rated

What is Green building certification and why is it required?
Whether Green buildings are really green is to be decided against the predefined rating systems. There are three primary Rating systems in India.

1. GRIHA
2. IGBC
3. BEE

1. Green Rating for Integrated Habitat Assessment (GRIHA)
Green Rating for Integrated Habitat Assessment (GRIHA) is India's own rating system jointly developed by TERI and the Ministry of New and Renewable Energy, Government of India. It is a green building design evaluation system where buildings are rated in a three-tier process. The process initiates with the online submission of documents as per the prescribed criteria followed by on site visit and evaluation of the building by a team of professionals and experts from GRIHA Secretariat. GRIHA rating system consists of 34 criteria categorised in four different sections. Some of them are – (1) Site selection and site planning, (2) Conservation and efficient utilization of resources, (3) Building operation and maintenance, and (4) Innovation. (Know more about the criteria for the GRIHA rating system)
Commonwealth Games Village, New Delhi, Fortis Hospital, New Delhi, CESE (Centre for Environmental Sciences & Engineering) Bldg, IIT Kanpur, Suzlon One Earth, Pune and many other buildings has received GRIHA rating (Know about more such buildings here).

2. 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 organization 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 year 2000 and are currently available for new and existing constructions.



Confederation of Indian Industry (CII) formed the Indian Green Building Council (IGBC) in year 2001. IGBC is the non profit research institution having its offices in CII-Sohrabji Godrej Green Business Centre, which is itself a LEED certified Green building. Indian Green Building Council (IGBC) has licensed the LEED Green Building Standard from the USGBC. IGBC facilitates Indian green structures to become one of the green buildings.

IGBC has developed the following green building rating systems for different types of building in line and conformity with US Green Building Council. Till date, following Green Building rating systems are available under IGBC; (more information here)

1. LEED India for New Construction
2. LEED India for Core and Shell
3. IGBC Green Homes
4. IGBC Green Factory Building
5. IGBC Green SEZ
6. IGBC Green Townships

3. Bureau of Energy Efficiency (BEE):

BEE developed its own rating system for the buildings based on a 1 to 5 star scale. More stars mean more energy efficiency. BEE has developed the Energy Performance Index (EPI). The unit of Kilo watt hours per square meter per year is considered for rating the building and especially targets air conditioned and non-air conditioned office buildings. The Reserve Bank of India's buildings in Delhi and Bhubaneshwar, the CII Sohrabji Godrej Green Business Centre and many other buildings have received BEE 5 star ratings. (Know more on BEE green buildings rating system).

Indians were aware of Green Building concepts from the beginning. Conventional homes with baked red colour roof tiles and clay made walls is a really good example of energy efficient structures that are used to keep cool during summers and warm during the winters. Most of rural India is still attached to this building technology with naturally available materials like clay, wood, jute ropes, etc. Today we have advanced technologies that create smarter systems to control inside temperature, lighting systems, power and water supply and waste generation. Green buildings might be a bit heavy on the pursebut are good for the environment. In this rapidly changing world, we should adopt the technology that helps us to save precious natural resources. This would lead us to true sustainable development.