Green Buildings and Rating Systems

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Five Day Residential Training Programme on “Traditional and New Construction Methodologies of Buildings and Bridges”, APHRDI, Bapatla, AP
Sustainability and Green concepts

- Why are they in fashion / promoted?

- Were not these part of our traditional design?
Dwellings around the world
Dwellings around the world

A badgir, or cooling tower, built around a central dome.
Complex Houses of Hakka Family, Fujian, China

- In dry Fujian area, the houses are built with the hard solid soil walls.
- The houses were built about 300 years ago.
- They build the many town houses surrounded by the hard walls to protect from the outsiders.
- The houses are 4-storied and hundreds of people are living together.

Source: [http://www.hgpho.to/wfest/house/house-e.html](http://www.hgpho.to/wfest/house/house-e.html)

[http://naturalhomes.org/timeline/hakka-tulou.htm](http://naturalhomes.org/timeline/hakka-tulou.htm)
Dwellings around the world
Adobe granaries of Tataouine, Tunisia

- a vaulted adobe (ghorfa) castle (ksar) designed as a fortified granary standing on a defensive hilltop.
- The ksar consists of two courtyards each with a perimeter of multi-storey vaulted adobe cellars.
- The cellars were used to store grains, olive oil and animal fat.
- The food stayed cool and dry behind the thick adobe walls and palm wood doors.

http://naturalhomes.org/timeline/ksar.htm
Dwellings around the world

Bamboo roundhouse by the Sidama people of Ethiopia

The dome, with its pointy top, is designed to shed heavy rainfall where a circular dome would have a flat region prone to leaks.

Bamboo once played an important role in the rural economies of East Africa but indiscriminate clearing of natural bamboo forests have resulted in losing natural resources and many of the traditional building skills.

16 July 2018
Dwellings around the world

Ondol (Heated Floor during Winter) Suwon, Korea

Dwellings around the world

Wooden Frame Houses, Rheinland-Pfalz, Germany


Source: http://www.hgpho.to/wfest/house/house-e.html
Dwellings around the world

Source: http://www.hgpho.to/wfest/house/house-e.html
Dwellings around the world

Taos Pueblo

Source: [http://www.hgpho.to/wfest/house/house-e.html](http://www.hgpho.to/wfest/house/house-e.html)
Dwellings around the world

Figure 1: Examples of houses around the world that all developed a building style with a circular plan, which performs well in earthquakes.

Top left: (WHE Report 35, Kyrgyzstan)
Top right: (WHE Report 72, India)
Bottom left: (WHE Report 43, Malawi)
Center: (WHE Report 72, India)
Dwellings around the world - India
Dwellings around the world
- India

Fig. 5 Traditional ‘Kath-khuni’ wall construction with timber & stone.

Fig. 7 Roofing pattern and skyline of the settlement.

against damage from rain-water.
Basic design of dwellings based on climate

Figure I.3.2. Hot/humid traditional building, raised huts.

Figure I.3.3. Hot/arid traditional building, desert pueblos.
Basic design of dwellings based on climate

Minimize surface exposure to cold by joining structures

Shallow roof slopes to retain some snow for insulation

Low ceilings to keep heat from rising above inhabitants

Protection from north winds in shape and entry location – minimal openings

Figure 1.3.5. Cool area traditional building type, igloos and plank huts.
Basic design of dwellings based on climate

**Climatic Design of the Malay House**

Fig. 1 “...the near perfect house form which is appropriate to local climate” (Yuan L. J.)

Climate-responsive architecture takes advantage of free energy in the form of heat and light.

Each region of the world employs its own techniques and designs in its buildings that are best suited to that particular region and that encompass the region’s cultural patterns.

This is known more commonly as vernacular architecture, or “forms which grow out of the practical needs of the inhabitants of a place and the constraints of the site and climate”.

Vernacular architecture varies for regions of hot climate and regions of cold climate. Many of the same techniques are employed, but it is the way they are used in each respective climate that makes them unique.
Vernacular Architecture

- Vernacular architecture is a very open, time tested, comprehensive concept.
- refers to structures built of local materials in a functional style devised to meet the needs of common people in their time and place.
- Vernacular structures were built by people not schooled in any kind of formal architectural design
- at least 90 percent of the world's architecture is vernacular.
- An estimate says that only five to ten percent of the world's building stock has been designed by architects
Sustainability and Green concepts

• Why are they *in fashion* / promoted?

• Were not these part of our traditional design / classical architecture practice?
Green building movement – Evolution or Revolution – Few thoughts

Trigger of boom in Construction industry after Industrial revolution

Availability of materials (more variety)- more than less- need for decisiveness – with environmental awareness

Cost effective (it is!! or Is it?)

Aesthetics

Social acceptability

Markets
Classical architecture design paradigm

- Element of Architectural design and Design philosophy

- Climate responsive architecture
  - Vernacular buildings in different climate zones

- Climate and buildings
  - Climate zones, Design Charts.

- Ventilation and day lighting
  - Design and placement of openings

- Construction materials and technologies
Design Sequence

Landform: topography and slope orientation
Vegetation type and pattern
Water bodies
Street widths and orientation
Open spaces and built spaces
Ground character

Plan form
Plan elements
Building orientation
Surface area to volume ratio
Roof form
Fenestration pattern and configuration
Fenestration orientation
Fenestration controls

External colors and textures
Roof materials
Walls
Internal layouts and partitions
Internal materials
Internal finishes
Significance of green building movement

Is this something new?

Refer to vernacular architecture

Possibility of traditional climate responsive design/architecture in various scales in current scenario

- Small independent residential buildings (easier)
- Large multi storied residential/office buildings
- Other major buildings (not easy due to various compulsions)
Energy consumption in Buildings

• Buildings worldwide account for up to 40% of total end-use energy.

• The US, OECD/ Europe and Russia consume most of their energy (about 40%) in building sector (IEA, 2008).

• There is over 50% saving potential in the building sector - a potential sector to meet the challenges of global energy and climate change.
Potential for savings in Energy, Social and Financial Sectors

Buildings Have Long Economic Lifespans Compared to Other Energy-Consuming Infrastructure

Investments in the building sector are less risky and create better returns when directed toward energy-efficient buildings.

• Globally, buildings and construction are responsible for 60 percent of electricity use, 12 percent of water use, 40 percent of waste and 40 percent of material resource use. In cities, buildings occupy 50 percent or more of the land area.


wri.org/buildingefficiency
In fact, an area equal to roughly 60 percent of the world’s current total building stock will be built or rebuilt in urban areas by 2030, mostly in developing or emerging countries such as China, India and Indonesia.
Building Efficiency Is One of the Most Affordable Ways to Cut Emissions

Note: ‘Low cost’ emission reductions = carbon price <20 US$/tCO₂-eq. ‘Medium cost’ emission reductions = carbon price <50 US$/tCO₂-eq.
‘High cost’ emission reductions = carbon price <100 US$/tCO₂-eq.

wri.org/buildingefficiency
Indoor air pollution related deaths

Sources of Air Pollution-Related Deaths in 2010

Note: In the white areas, annual mean PM2.5 is below the concentration–response threshold. Source: www.nature.com/nature/journal/v525/n7569/full/nature15371.html
Sustainable Development

Source: Wikipedia/Sustainability
Terms ‘green’ and ‘sustainable’ are often used interchangeably but there are fundamental differences between them.

‘Green’ is a label for the process of design and construction which aims to produce buildings that are less damaging to the environment—and the people that use them—than most buildings currently built today.

These buildings must be measurably less damaging in significant ways of course, and unfortunately there are many examples of ‘green’ buildings that purport to be less damaging without supporting measurements, or that otherwise claim to be have integrated environmental concerns without addressing the most significant issues.
GREEN BUILDING AND SUSTAINABILITY

‘Sustainable building,’ however, refers more precisely to the goal of designing and constructing buildings that have

“no net impact on the environment, such that a total built environment composed of similar buildings could co-exist with the world’s ecological balance indefinitely”.
GREEN BUILDING AND SUSTAINABILITY

• **Green building** focuses on incremental steps to solve known and measurable problems with our current practice, whereas

• **Sustainable building** seeks models for an unidentified future state of society.

• Each term describes a distinct approach.

• Most of the **environmentally responsible construction practiced today falls into the first category** –

• we have few if any examples of sustainable buildings according to the above definition.
“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” - IGBC
Green buildings

Efficiently using energy, water, and other resources

Protecting occupant health and improving employee productivity

Reducing waste, pollution and environmental degradation

Source: Wikipedia/green building
Elements of design

Figure 1 Schematic diagram highlighting select green building features

Source: GRIHA Manual 1
LEGEND:
1. ECBC* COMPLIANT WALL WITH INSULATION
2. ECBC* COMPLIANT ROOF WITH INSULATION
3. LOW VOC PAINT
4. BEE* STAR LABELLED EFFICIENT ARTIFICIAL LIGHTING (T5 AND CFL)
5. BEE* STAR LABELLED SPLIT AIR-CONDITIONER
6. DOOR FRAMES MADE USING RECYCLED MATERIALS
7. FLOORING TILES MADE USING RECYCLED MATERIALS
8. DUAL FLUSH WATER CLOSETS
9. LOW FLOW FAUCETS

Source: GRIHA Manual 1

Figure 2 Cross section through a typical building highlighting select green features
Designing Green Buildings

Climate responsive architecture

- Climate zones, Design Charts, Vernacular buildings in different climate zones

Site planning

- Landform, topography, vegetation, water bodies

Building envelope design

- Plan form, Orientation, S/V ratio, P/A ratio, Design and placement of openings

Building system design

- Active technologies - HVAC [heating ventilation and air conditioning], lighting, electrical, and water heating)
- Passive Technologies- Integration of renewable energy sources to generate energy on-site (Passive Solar architecture)
Designing Green Buildings

Water management in buildings
– Techniques to recycle, reuse and harvest water

Construction materials, techniques
– Selection of ecologically sustainable materials (with high recycled content, rapidly renewable resources with low emission potential),
– Life cycle analysis and cost (Environmental footprint and Cost of building, operation and maintenance)

Indoor environmental quality
– maintain indoor thermal and visual comfort and air quality
The design objective should be to strike a thermal balance which allows the building to be free-running (i.e., to maintain indoor comfort conditions without the need for conventional heating or cooling) for all of the occupied period.
Climate zones for buildings

Climate Zone Map Of India

Source: National Building Code 2005
Sun path diagrams

Need to understand

• the apparent movement of the sun (the solar geometry)
• energy flows from the sun and how to handle it (exclude it or make use of it).

Why?

• Shading
• Natural Lighting
• Thermal Control
Sun path

The hourly path of the Sun through the sky in Summer and Winter.
Sun path

*Hourly sun path.*

Animation showing changing sun-path on the 21st day of each month for latitude -32°.

*Annual sun path.*

Animation showing changing sun-path on the 21st day of a month for latitude -32°.

Sun paths for different latitudes

Source: Skozolay And Skozolay, *Introduction to Architectural Science The Basis of Sustainable Design*
Thermal Comfort - Two Design Approaches

• Using Mechanical / Active controls
  • HVAC approach (Heat balance or The Fixed Temperature Approach)
  • a 'comfortable thermal environment' as a 'product' of the building services:
  • thermal comfort is the corollary of a thermal balance between building and occupants.
  • Analytical modelling approach

• Adaptive model of thermal comfort
  • function of the building is then to provide the occupant with the means to make themselves comfortable
  • Variable Temperature Standard
  • Field study based
Architectural / Thermal Sailing

Conventional Mechanical System

Indoor “comfort zone” temperatures

“Mixed-Mode” Mechanical System

Closed Heating Mode Strategies

MECHANICAL
• Active Solar
• Furnace/Boiler

ARCHITECTURAL
• Thermal Mass: Heat
• Direct Gain: Sun

Closed Cooling Mode Strategies

ARCHITECTURAL
• Thermal Mass: “Coolth”
• Evaporation: Water

MECHANICAL
• Ceiling Fans
• Chillers
Controlling Thermal Environment in Buildings

- **Shape (Mass)**
- **Fenestration**
  - Size, Positioning and Orientation
- **Solar Control**
  - Shading and surface finish
- **Building Fabric**
  - Insulation and Thermal Storage
- **Ventilation**
Passive Strategies

Solar Passive Techniques

Passive cooling
- Ventilation & Operable Windows
- Wing wall
- Thermal Chimney
- PDEC System
- Earth berming
- Earth air tunnel
- Cooling tower
- Evaporative cooling
- Roof pond system
- Courtyard

Passive heating
- Direct gain
  - Window
  - Glazed wall
  - Glazed atrium

- Indirect gain
  - Roof space collector
  - Thermal storage wall system
  - Water wall
  - Sun spaces
  - Transwall
Passive Cooling

• heat flows from high temperature areas to low temperature areas
• reverse flow can only be induced by feeding additional energy into the thermal system
• passive cooling seeks to use natural heat flows whenever possible

Strategies:
• reduce heat gains (internal and external)
• open a high-to-low temperature heat flow path to divert the excess heat (heat removal into a suitable heat sink)
Passive cooling strategies

- Use available natural heat sinks:
  - ambient air (ventilation)
  - evaporative cooling (adiabatic)
  - radiative cooling (deep night sky)

- Passive cooling strategies
  - Wall and roof opening for convective cooling
  - Natural architectural means of Evaporative cooling
  - Radiative Cooling through roof
  - Ground Cooling and building Underground
  - Transitional spaces – Courtyard, patio, verandah
Ventilation for cooling purposes

- main ventilation mechanisms available:
  - wind-driven ventilation
  - stack-effect ventilation
  - forced ventilation (electric fans)
  - solar chimneys
  - ceiling and space fans
Thermal chimneys

- solar chimneys are *stack-effect ventilators*
- driving force: passive solar heat
- also called: *solar-enhanced ventilators*
- inlet draws air from indoors
- outlet discharges to the outdoors
- as indoor air evacuates, (cooler) outdoor air flows into the building
Passive Downdraft Evaporative Cooling (PDEC) System

- A system of inlet and outlet shafts.
- Locations, sizes and heights: generate required air movement.
- A fine spray of water cools the air at entry.
- 6-9 air change rates per hour observed.
- Strategy:
  - Hot season: evaporative cooling.
  - Monsoon: cooling off, induce ventilation by fans.
  - Winter: ventilation minimised (inlets closed by shutters)

Design of PDEC System

Ambient hot-dry air is trapped, cooled by evaporation of water and then introduced in the building. Simple system based on shower spray system developed by B. Givoni. PDEC system works very well in the summer months. For example, in May, the temperature of cooled air leaving the tower is about 25°C while the corresponding ambient temperature is about 38°C. Thus, the drop in day-time temperature is significantly high in May, i.e. about 13°C.
Water Management in buildings

• Reduction in Losses

• Reduction in Overall water use

• Reuse and Conservation Measures
Water Management in buildings

- **Reduction in Losses**
  - Conducting water audits and Monitoring water use
  - Identifying and checking Leakages in Distribution lines
  - Installing Water meters

- **Reduction in Overall water use**
  - Avoiding water intensive appliances
    - Washing machines
    - Dish washers
  - Water efficient Toilets
    - Conventional toilets – 13 litres/flush
    - Low flush – 6 litres/flush
    - Ultra low flush – 3 litres /flush
    - Dual flush adapters
Reduction in Overall water use

- Waterless Toilets
  - Incineration or composting
- Electronic Flush Systems
- Water efficient Urinals
  - From 7.5 L/flush to about 0.4 L per flush
- Waterless Urinals
  - Allows liquid/urine to pass through a sealant liquid but stops odour.
  - Sealant liquid is biodegradable and cartridge is recyclable
  - 65000L per urinal can be saved/ quantity passing through treatment systems can be saved
  - Sensor taps for urinals
Reduction in Overall water use

- Water taps
  - Low flow faucets
    - Conventional 11.35 to 19 Lpm
    - Low flow 7.5 Lpm
- Auto control Valves
- Pressure reducing Device
- Showerheads

- Efficient irrigation systems
  - Drip and sprinkler systems
  - Auto irrigation systems
  - Rain shutoff devices
  - Soil moisture sensor
  - Grouping plants with similar water requirements
- Use of native species and drought resistant plants
Reuse and Conservation Measures

• Conserving wetlands

• Purification and infiltration ponds

• Rainwater harvesting systems

• Man-made Systems for wastewater treatment

• Conventional treatment Systems

• Artificial Wetlands or reed bed system
Next session

- Choosing Building materials
- LCA
- Alternate Construction technologies
- Green Building rating Systems
- Case studies
Choosing Building materials

The material Life Cycle

Source: Michael Letch, Ph.D.
Life Cycle Analysis

Life cycle assessment (LCA) is a scientific method for measuring the environmental footprint of materials, products and services over their entire lifetime.

• Tool to measure the environmental performance of a building material

• Decision system to compare and select materials

• All materials have potential environmental impacts along their life cycle – select having minimal effects

• Based on the environmental life cycle concept
Life Cycle Assessment

- Transportation
- Water use
- Energy use
- Resource extraction effects
- Resource use (depletion)
- Emissions to air
- Emissions to water
- Solid waste
Types of Process-Based LCA Methods: In a process-based LCA, the inputs (materials and energy resources) and the outputs (emissions and wastes to the environment) for each step required to produce a product. LCA methods implemented in the building construction industry are based primarily on process-based LCA.
The Life-Cycle Stages of a building are:

→ **Materials Manufacturing**: Removal of raw materials from earth, transportation of materials to the manufacturing locations, manufacture of finished or intermediate materials, building product fabrication, and packaging and distribution of building products

→ **Construction**: All activities relating to the actual building project construction

→ **Use and Maintenance**: Building operation including energy consumption, water usage, environmental waste generation, repair and replacement of building assemblies and systems, and transport and equipment use for repair and replacement

→ **End of Life**: Includes energy consumed and waste produced due to building demolition and disposal of materials to landfills, and transport of waste materials. Recycling and reuse activities related to demolition waste also can be included and have a “negative impact.”
The embodied and operational energies of two building projects. The baseline building (in red) has the smallest embodied energy but uses more energy over time. The green building alternative includes additional embodied energy from systems like high-performance insulation and glazing, and photovoltaics. Over time, the energy embodied in the green build systems is “paid back”, and the overall impact of the green building, embodied+operational, becomes less than that of the baseline building. If energy sources for building construction and operation are known, then energy use can be converted to carbon emissions, often denoted global warming potential or GWP.
Embodied energy of building materials

- Select materials based on their LCCs and maintenance requirement
- Check emission levels to ensure health and indoor air quality
- Select material for recycling, long life and adaptability
Embodied energy of Building materials

• Energy consumed in acquiring and transforming raw materials into finished Products and transporting them to the place of installation or building site
• http://www.vernaculararchitecture.com/
• http://www.vernarch.com/
• *Built By Hand: Vernacular Buildings Around the World*, Gibbs Smith Publishers
• http://www.historyforkids.org/learn/india/architecture/
• Skozolay And Skozolay, *Introduction to Architectural Science The Basis of Sustainable Design*
• Archive site for autodesk ecotect analysis educational resources, notes and tutorials. (Available at http://wiki.naturalfrequency.com/wiki/Solar_Position)
• Lectures of Martin A. Wilkinson, last accessed on 05/10/2012 http://people.bath.ac.uk/absmaw/
• Szokolay, S. V., 2008 *Introduction to architectural science : the basis of sustainable design* – 2nd ed. Elsevier
• Concorde green http://concordgreen.blogspot.in/2009_07_01_archive.html
Rating System

• Evaluation tool that measures environmental performance of a building through its life cycle.

• Comprises of a set of criteria covering various parameters related to design, construction and operation of a green building.

• Pre-assigned points and sets performance benchmarks and goals that are largely quantifiable. Rating based on cumulative points obtained for all criteria.

• Mandate independent third party evaluation and evaluation processes designed for fair evaluation.

• Largely voluntary in nature

• Instrumental in raising awareness and popularizing green building designs.
Rating systems in India

- Leadership in Energy and Environmental Design – India (LEED®- India) - 2001
- GRIHA (Green Rating for Integrated Habitat Assessment) - 2006
- IGBC Ratings
- BEE Star Rating for buildings
GRIHA

- Adopted as a national rating system under the MNRE, GOI, as of 1 November 2007

- Developed by TERI promoted by MNRE

- Operates under GRIHA Secretariat called ADaRSH (Association for Development and Research of Sustainable Habitats)

- Takes into account the provisions of the National Building Code (NBC) 2005, the Energy Conservation Building Code (ECBC) 2007 announced by BEE (Bureau of Energy Efficiency, ministry of Power, GOI) and other IS codes, local bye-laws, other local standards and laws.
GRIHA -Features

• Currently the system has been developed to help ‘design and evaluate’ new buildings (buildings that are still at the inception stages).

• A building is assessed based on its predicted performance over its entire life cycle – inception through operation.

• The stages of the life cycle that have been identified for evaluation are the preconstruction, building design and construction, and building operation and maintenance stages.
The issues that get addressed in these stages are as follows:

**Pre-construction stage** (intra- and inter-site issues)

**Building planning and construction stages** (issues of resource conservation and reduction in resource demand, resource utilization efficiency, resource recovery and reuse, and provisions for occupant health and well being). The prime resources that are considered in this section are land, water, energy, air, and green cover.

**Building operation and maintenance stage** (issues of operation and maintenance of building systems and processes, monitoring and recording of consumption, and occupant health and well being, and also issues that affect the global and local environment).
GRIHA – Ratings for building types

- **GRIHA**
  - For Buildings/group $\geq$ 2500 sq.m (34 Criteria, 100 Points)

- **SVA GRIHA** (Small Versatile Affordable GRIHA) —
  - less than 2500 sq. m (14 Criteria, Total 50 points)

- **GRIHA LD** —
  - greater than or equal to 50 hectares (Impact percent on Resources and Environmental Quality – lower impact higher rating)

- **GRIHA EB for existing buildings rating**

- **GRIHA AH for affordable housing**

- **GRIHA – Prakrithi**
  - For Existing Day Schools
Summary of GRIHA Criteria

Five Day Residential Training Programme on "Traditional and New Construction Methodologies of Buildings"

Source: GRIHA Manual 1
# SVA GRIHA Criteria and their weightage

<table>
<thead>
<tr>
<th>Criterion number</th>
<th>Criterion name</th>
<th>Points</th>
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<tbody>
<tr>
<td>1</td>
<td>Reduce exposed, hard paved surface on site and maintain native vegetation cover on site</td>
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<tr>
<td>2</td>
<td>Passive architectural design and systems</td>
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<td>3</td>
<td>Good fenestration design for reducing direct heat gain and glare while maximising daylight penetration</td>
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<td>4</td>
<td>Efficient artificial lighting system</td>
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<td>5</td>
<td>Thermal efficiency of building envelope</td>
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<tr>
<td>6</td>
<td>Use of energy efficient appliances</td>
<td>3</td>
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<tr>
<td>7</td>
<td>Use of renewable energy on site</td>
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<td>8</td>
<td>Reduction in building and landscape water demand</td>
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<td>9</td>
<td>Rainwater harvesting</td>
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<td>10</td>
<td>Generate resource from waste</td>
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<tr>
<td>11</td>
<td>Reduce embodied energy of building</td>
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<tr>
<td>12</td>
<td>Use of low-energy materials in interiors</td>
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<td>Adoption of green lifestyle</td>
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<tr>
<td>14</td>
<td>Innovation</td>
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<td><strong>Total</strong></td>
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<td><strong>50</strong></td>
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</table>
Urban Development & Housing Department, Government of Jharkhand incentivizes GRIHA Rated projects by awarding additional FAR of up to 7%

Public Works Department, Government of Maharashtra mandates GRIHA for all government projects

Uttar Pradesh Housing and Urban Planning Department: GRIHA incentives

Haryana government: GRIHA Incentives

Government of West Bengal, Department of Municipal Affairs: GRIHA incentives

Pune Municipal Corporation (PMC) - GRIHA incentives

Pune Municipal Corporation (PMC) - SVA GRIHA incentives

Sikkim adopts GRIHA

Additional 5% free of cost FAR for GRIHA projects in Rajasthan

Fast track environmental clearance for GRIHA pre certified projects

NOIDA and Greater NOIDA embrace GRIHA

Pimpri Chinchwad Municipal Corporation: GRIHA incentives

Pimpri Chinchwad Municipal Corporation: SVA GRIHA Incentives

SIDBI announces concessional rate of interest for GRIHA projects

Additional 5% free of cost FAR for GRIHA projects in Punjab

Ministry of Urban Development, Government of India announces free of cost 1% to 5% extra ground coverage and FAR for GRIHA.
LEED India Ratings

• First Rating System to be promoted in India (LEED –India)

• Was promoted by The Indian Green Building Council (IGBC)

• Initially under license from USGBC and promoted by CII-Sohrabji Godrej Green Business Centre (for LEED®- India)

• Since 2014 have developed its own ratings (IGBC ratings) under CII-Sohrabji Godrej G B C

• From 1 July 2014, projects in India have been managed by Green Business certification Inc. India (GBCI India)
LEED Ratings

LEED V4 rating systems (Since 2016)
• LEED for Building Design and Construction.
• LEED for Interior Design and Construction.
• LEED for Building Operations and Maintenance.
• LEED for Neighbourhood Development.

LEED 4.1 is latest

Older versions
• LEED India v2011 systems also exist for India
• LEED v3 (2009)

Further reading
V4 rating systems https://www.usgbc.org/articles/rating-system-selection-guidance
LEED in India https://www.usgbc.org/help/which-leed-rating-systems-are-available-projects-india
IGBC Rating types

- IGBC Green New Buildings
- IGBC Green Existing Buildings
- IGBC Green Homes
- IGBC Green Schools
- IGBC Green Factory Building
- IGBC Green Townships
- IGBC Green SEZs
- IGBC Green Landscapes
- IGBC Green Mass Rapid Transit System

Many more [https://igbc.in/igbc/redirectHtml.htm?redVal=showratingSysnosign](https://igbc.in/igbc/redirectHtml.htm?redVal=showratingSysnosign)
IGBC Rating Criteria

- Varies from types of building considered
- Certified as PLATINUM, GOLD, SILVER, and CERTIFIED
- Precertification possible
IGBC rating criteria groups

- Sustainable Architecture and Design
- Site Selection and Planning
- Water Conservation
- Energy Efficiency
- Building materials and resources
- Indoor Environmental Quality
- Innovation and Development
### IGBC New buildings rating criteria

<table>
<thead>
<tr>
<th>Modules</th>
<th>Points Available</th>
<th>Owner-occupied buildings</th>
<th>Tenant-occupied buildings</th>
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<td>SA Credit 3: Passive Architecture</td>
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<td><strong>Site Selection and Planning</strong></td>
<td>14</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>SSP Mandatory Requirement 1: Local Building Regulations</td>
<td>Required</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>SSP Mandatory Requirement 2: Soil Erosion Control</td>
<td>Required</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 1: Basic Amenities</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 2: Proximity to Public Transport</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 3: Low-emitting Vehicles</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 4: Natural Topography or Vegetation</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 5: Preservation or Transplantation of Trees</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 6: Heat Island Reduction, Non-roof</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 7: Heat Island Reduction, Roof</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 8: Outdoor Light Pollution Reduction</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 9: Universal Design</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 10: Basic Facilities for Construction Workforce</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SSP Credit 11: Green Building Guidelines</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Water Conservation</strong></td>
<td>18</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>WC Mandatory Requirement 1: Rainwater Harvesting, Roof &amp; Non-roof</td>
<td>Required</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>WC Mandatory Requirement 2: Water Efficient Plumbing Fixtures</td>
<td>Required</td>
<td>Required</td>
<td></td>
</tr>
<tr>
<td>WC Credit 1: Landscape Design</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>WC Credit 2: Management of Irrigation Systems</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>WC Credit 3: Rainwater Harvesting, Roof &amp; Non-roof</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>WC Credit 4: Water Efficient Plumbing Fixtures</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>WC Credit 5: Wastewater Treatment and Reuse</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>WC Credit 6: Water Metering</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## IGBC New buildings rating criteria

<table>
<thead>
<tr>
<th>Modules</th>
<th>Owner-occupied Buildings</th>
<th>Tenant-occupied Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE Mandatory Requirement 1</td>
<td>Ozone Depleting Substances</td>
<td>Required</td>
</tr>
<tr>
<td>EE Mandatory Requirement 2</td>
<td>Minimum Energy Efficiency</td>
<td>Required</td>
</tr>
<tr>
<td>EE Mandatory Requirement 3</td>
<td>Commissioning Plan for Building Equipment &amp; Systems</td>
<td>Required</td>
</tr>
<tr>
<td>EE Credit 1</td>
<td>Eco-friendly Refrigerants</td>
<td></td>
</tr>
<tr>
<td>EE Credit 2</td>
<td>Enhanced Energy Efficiency</td>
<td></td>
</tr>
<tr>
<td>EE Credit 3</td>
<td>On-site Renewable Energy</td>
<td></td>
</tr>
<tr>
<td>EE Credit 4</td>
<td>Off-site Renewable Energy</td>
<td></td>
</tr>
<tr>
<td>EE Credit 5</td>
<td>Commissioning, Post-installation of Equipment &amp; Systems</td>
<td></td>
</tr>
<tr>
<td>EE Credit 6</td>
<td>Energy Metering and Management</td>
<td></td>
</tr>
<tr>
<td>Building Materials and Resources</td>
<td>Segregation of Waste, Post-occupancy</td>
<td>Recommended</td>
</tr>
<tr>
<td>BMR Mandatory Requirement 1</td>
<td>Sustainable Building Materials</td>
<td></td>
</tr>
<tr>
<td>BMR Credit 1</td>
<td>Organic Waste Management, Post-occupancy</td>
<td></td>
</tr>
<tr>
<td>BMR Credit 2</td>
<td>Handling of Waste Materials, During Construction</td>
<td></td>
</tr>
<tr>
<td>BMR Credit 3</td>
<td>Use of Certified Green Building Materials, Products &amp; Equipment</td>
<td></td>
</tr>
</tbody>
</table>

### Modules

<table>
<thead>
<tr>
<th>Modules</th>
<th>Owner-occupied Buildings</th>
<th>Tenant-occupied Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEQ, Credit 4</td>
<td>Minimise Indoor and Outdoor Pollutants</td>
<td>1</td>
</tr>
<tr>
<td>IEQ, Credit 5</td>
<td>Low-emitting Materials</td>
<td>3</td>
</tr>
<tr>
<td>IEQ, Credit 6</td>
<td>Occupant Well-being Facilities</td>
<td>1</td>
</tr>
<tr>
<td>IEQ, Credit 7</td>
<td>Indoor Air Quality Testing, After Construction and Before Occupancy</td>
<td>2</td>
</tr>
<tr>
<td>IEQ, Credit 8</td>
<td>Indoor Air Quality Management, During Construction</td>
<td>1</td>
</tr>
<tr>
<td>Innovation and Development</td>
<td>Innovation in Design Process</td>
<td>4</td>
</tr>
<tr>
<td>ID Credit 1</td>
<td>Optimisation in Structural Design</td>
<td>1</td>
</tr>
<tr>
<td>ID Credit 2</td>
<td>Waste Water Reuse, During Construction</td>
<td>1</td>
</tr>
<tr>
<td>ID Credit 3</td>
<td>IGBC Accredited Professional</td>
<td>1</td>
</tr>
</tbody>
</table>

### The threshold criteria for certification levels are as under:

<table>
<thead>
<tr>
<th>Certification Level</th>
<th>Owner-occupied Buildings</th>
<th>Tenant-occupied Buildings</th>
<th>Recognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certified</td>
<td>40 - 49</td>
<td>40 - 49</td>
<td>Good Practices</td>
</tr>
<tr>
<td>Silver</td>
<td>50 - 59</td>
<td>50 - 59</td>
<td>Best Practices</td>
</tr>
<tr>
<td>Gold</td>
<td>60 - 74</td>
<td>60 - 74</td>
<td>Outstanding Performance</td>
</tr>
<tr>
<td>Platinum</td>
<td>75 - 89</td>
<td>75 - 89</td>
<td>National Excellence</td>
</tr>
<tr>
<td>Super Platinum</td>
<td>90 - 100</td>
<td>90 - 100</td>
<td>Global Leadership</td>
</tr>
</tbody>
</table>
Assessment of Ratings

“LEED-India and GRIHA rating systems are based on design intent rather than actual performance during building occupancy. They are not designed primarily to rate energy performance of existing buildings and to reward their performance through a systematic evaluation and award scheme.”

Satish Kumar et al., 2010
BEE Star rating

- Energy conservation Act 2001

- ECO (Energy Conservation and commercialization - Program Involving Ministry of Power, GOI – USAID and other agencies (in three Stages) - ECOIII

- Establishment of BEE (Bureau of Energy Efficiency)

ECBC


- Central Government have power to notify building as designated consumers in consultation with BEE under section 14(e) of the Energy Conservation Act 2001.

- The State Governments can amend the ECBC to suit regional and local climatic conditions (Section 14(q) and Section 15(a) of the Act) as well as direct every owner or occupier of the building or building complex, being designated consumer to comply with the provisions of the ECBC for efficient use of energy and its conservation (Section 14 (r) and Section 15 (b) of the Act).
Implementation Status of ECBC

• **Notification Issued**
  - Rajasthan, Odisha, Uttarakhand, Punjab, Karnataka, Andhra Pradesh, Telangana and UT of Puducherry

• **Amended ECBC to suit their local and regional climatic condition**
  - Uttar Pradesh, Kerala, Chhattisgarh, Gujarat, Bihar, Tamil Nadu, Haryana, Maharashtra and West Bengal

• **In process of amendment**
  - Himachal Pradesh, Assam, Tripura, Mizoram, Jharkhand, Goa and Madhya Pradesh

Source: BEE
ECBC Compliance

- Component-based (**prescriptive**): requires little energy expertise; provides minimum performance requirements; no flexibility

- System-based (**trade-off**): allows some flexibility through the balance of some high efficiency components with other lower efficiency components – (Only on building envelope)

- **Whole building design analysis** (performance): allows flexibility in meeting or exceeding energy efficiency requirements (as compared to a baseline building)

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Mandatory Provisions for ECBC</th>
<th>Flexibility</th>
<th>Expert Knowledge</th>
<th>Linear Approach</th>
<th>Use of Energy Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Prescriptive</td>
<td>Required</td>
<td>Low</td>
<td>Low</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>2. Trade-off</td>
<td>Required</td>
<td>Medium</td>
<td>Medium</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3. Performance-based</td>
<td>Required</td>
<td>High</td>
<td>High</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
BEE Star - Features

• Based on actual performance of the building in terms of specific energy usage (kWh/sq m/year).

• Rate buildings on a 1-5 Star scale with 5 Star labeled buildings being the most efficient.

• Categories of buildings considered - Office buildings, hotels, hospitals, retail malls, and IT Parks in five climate zones. (Multistorey Residential Buildings included)

• Ratings Office buildings in the 3 climatic zones (Warm and Humid, Composite, Hot and Dry) for air-conditioned and non-air-conditioned currently considered:

• Buildings having a connected load of 100 kW and above would be considered for BEE star rating scheme

Source: Sanjay Seth, 2011
BEE ratings

• Energy Performance Index (EPI) in kWh / sqm/ year will be considered for rating the building.

• EPI with the corresponding Star Label under the various climatic zones are given for two cases
  • For buildings having air conditioned area greater than 50% of their built up area
  • For buildings having air conditioned area less than 50% of their built up area
# BEE Ratings - LESS THAN 50% AIR CONDITIONING

## Composite

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>80-70</td>
<td>1 Star</td>
</tr>
<tr>
<td>70-60</td>
<td>2 Star</td>
</tr>
<tr>
<td>60-50</td>
<td>3 Star</td>
</tr>
<tr>
<td>50-40</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 40</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

## Warm and Humid

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>85-75</td>
<td>1 Star</td>
</tr>
<tr>
<td>75-65</td>
<td>2 Star</td>
</tr>
<tr>
<td>65-55</td>
<td>3 Star</td>
</tr>
<tr>
<td>55-45</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 45</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

## Hot and Dry

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>75-65</td>
<td>1 Star</td>
</tr>
<tr>
<td>65-55</td>
<td>2 Star</td>
</tr>
<tr>
<td>55-45</td>
<td>3 Star</td>
</tr>
<tr>
<td>45-35</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 35</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

Source: Sanjay Seth, 2009
### BEE Ratings - More THAN 50% AIR CONDITIONING

#### Composite

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>190-165</td>
<td>1 Star</td>
</tr>
<tr>
<td>165-140</td>
<td>2 Star</td>
</tr>
<tr>
<td>140-115</td>
<td>3 Star</td>
</tr>
<tr>
<td>115-90</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 90</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

#### Warm and Humid

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>200-175</td>
<td>1 Star</td>
</tr>
<tr>
<td>175-150</td>
<td>2 Star</td>
</tr>
<tr>
<td>150-125</td>
<td>3 Star</td>
</tr>
<tr>
<td>125-100</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 100</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

#### Hot and Dry

<table>
<thead>
<tr>
<th>EPI (Kwh/sqm/year)</th>
<th>Star Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-155</td>
<td>1 Star</td>
</tr>
<tr>
<td>155-130</td>
<td>2 Star</td>
</tr>
<tr>
<td>130-105</td>
<td>3 Star</td>
</tr>
<tr>
<td>105-80</td>
<td>4 Star</td>
</tr>
<tr>
<td>Below 80</td>
<td>5 Star</td>
</tr>
</tbody>
</table>

Source: Sanjay Seth, 2009

---

16 July 2018
## Comparison of similar rating/programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Organization</th>
<th>Compliance Required</th>
<th>Building Type</th>
<th>Applicable to</th>
<th>Scope</th>
<th>Linkage to ECBC</th>
</tr>
</thead>
<tbody>
<tr>
<td>BEE Star Rating</td>
<td>BEE / Ministry of Power</td>
<td>Voluntary</td>
<td>Office, BPO, Shopping Mall, Hospital</td>
<td>Building with Connected Load ( \geq 100\text{kW} )</td>
<td>Energy Efficiency</td>
<td>Actual verification of operational building energy performance</td>
</tr>
<tr>
<td>ECBC</td>
<td>BEE / Ministry of Power</td>
<td>Voluntary so far, mandatory going forward</td>
<td>Commercial</td>
<td>Building with Connected Load ( \geq 100\text{kW} ) or Contract Demand ( \geq 120\text{kVA} )</td>
<td>Energy Efficiency</td>
<td>-</td>
</tr>
<tr>
<td>LEED-India</td>
<td>IGBC / CII-GBC</td>
<td>Voluntary</td>
<td>Commercial / Institutional</td>
<td>-</td>
<td>Sustainable design / green building</td>
<td>Refers to ECBC for energy efficiency credits</td>
</tr>
<tr>
<td>GRIHA</td>
<td>ADaRSH / MNRE</td>
<td>Voluntary</td>
<td>Residential / Commercial / Institutional</td>
<td>-</td>
<td>Sustainable design / green building</td>
<td>Refers to ECBC for energy efficiency credits</td>
</tr>
<tr>
<td>Environmental Impact Assessment (EIA)</td>
<td>Ministry of Environment and Forests</td>
<td>Mandatory</td>
<td>Commercial / Residential</td>
<td>Large Projects ( \geq 20,000 ) sq. m.</td>
<td>Environmental Impact</td>
<td>ECBC requirements incorporated as part of EIA</td>
</tr>
<tr>
<td>National Building Code</td>
<td>Bureau of Indian Standards / Urban Local Bodies</td>
<td>Model Code / Mandatory</td>
<td>All</td>
<td>All buildings</td>
<td>Planning, development, civil, structural, services, sustainability</td>
<td>Harmonization included in newly added Sustainability chapter</td>
</tr>
</tbody>
</table>

Source: Deshmukh, 2014
Comparison

Five Day Residential Training Programme on “Traditional and New Construction Methodologies of Buildings and Bridges”, APHRDI, Bapatla, AP

Deshmukh, 2014

Voluntary Design Based
- LEED, IGBC

Voluntary Design and Performance Based
- GRIHA

Regulatory
- EIA
- ECBC
- NBC

BEE Star Rating
(Based on ACTUAL performance of EXISTING buildings)
The myth of green building

Recent Controversies

Certified, not certain

Making sense of green building rating

High on power

The energy efficiency of several LEED-certified green buildings in the country is worse than the minimum benchmarks set by the Bureau of Energy Efficiency.

<table>
<thead>
<tr>
<th>Minimum BEE energy efficiency benchmark for buildings</th>
<th>Energy efficiency reported by LEED-certified green buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>190 kWh/sqm/year or EPI for day use office buildings in composite climatic zone (Central and North India)</td>
<td>379 EPI ITC Ltd, Saharanpur</td>
</tr>
<tr>
<td>293 EPI DuPont Knowledge Centre, Hyderabad</td>
<td></td>
</tr>
<tr>
<td>230 EPI Wipro Technologies, Gurgaon</td>
<td></td>
</tr>
<tr>
<td>1,020 EPI Wipro Tech KDC Tower-4, Kolkata</td>
<td></td>
</tr>
<tr>
<td>205 EPI Enercon India Pvt Ltd, Mumbai</td>
<td></td>
</tr>
<tr>
<td>200 EPI F L Smidt House, Chennai</td>
<td></td>
</tr>
<tr>
<td>110 AAAEPI Wipro Technologies, Gurgaon</td>
<td></td>
</tr>
<tr>
<td>81 AAAEPI Fast Track Building 1&amp;2, Wipro Technologies, Greater Noida</td>
<td></td>
</tr>
<tr>
<td>490 AAAEPI Wipro Technologies KDC Tower-4, Kolkata</td>
<td></td>
</tr>
<tr>
<td>170 AAAEPI Chennai Development Center, S3 and S4 blocks, Wipro Technologies</td>
<td></td>
</tr>
<tr>
<td>127 AAAEPI Wipro S1, Kochi</td>
<td></td>
</tr>
<tr>
<td>67 AAAEPI Software Development Block 3, Wipro Ltd, Phase II, Pune</td>
<td></td>
</tr>
</tbody>
</table>

Green-rated buildings in India are not necessarily energy efficient.
**ENERGY PERFORMANCE OF LEED-RATED DAYTIME USE BUILDINGS**

![Graph showing energy performance of buildings with climate types and ratings.]

**Note:** See Annexure for the names of the buildings.
**Source:** Computed by CSE on the basis of LEED-India (IGBC) data.

**Annexure: Name of buildings**

- Corp Office 01: CII Green Business Centre, Hyderabad
- Corp Office 02: Surlon One Earth, Pune
- Corp Office 03: Bayer’s EcoCommercial, Noida
- Corp Office 04: Spectral Services Consultants Office, Noida
- Corp Office 05: ITC Green Centre, Gurgaon
- Corp Office 06: CII Suresh Neotia Centre of Excellence for Leadership, Kolkata
- Corp Office 07: Enercon India Pvt Ltd, Mumbai
- Corp Office 08: Thermax, Pune
- Corp Office 09: FL Smidth House, Chennai
- Corp Office 10: CRISIL House, Mumbai
- Fact 01: ITC Ltd., Saharanpur
- Fact 02: ITC Ltd., Bangalore
- Fact 03: Grundfos Pumps, Chennai
- Edu 01: Birla International School, Jaipur
- Edu 02: Great Lakes Institute of Management, Chennai
- Rrch 01: Du Pont Knowledge Centre, Hyderabad
- IT Office 16: Wipro Technologies KDC Tower - 4, Kolkata
- IT Office 05: Wipro Technologies, Gurgaon

**Source:** CSE
**Energy Performance of LEED-Rated BPO Buildings**

- **Note:** See Annexure for the names of the buildings. AAhEPI – Annual Average Hourly Energy Performance Index

**Source:** Computed by CSE on the basis of LEED-India (IGBC) data

**Annexure: Name of buildings**

<table>
<thead>
<tr>
<th>IT Office 01</th>
<th>TCS Technopark Phase I, Chennai</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT Office 02</td>
<td>TCS Technopark Phase II, Chennai</td>
</tr>
<tr>
<td>IT Office 03</td>
<td>GE India Technology Centre Phase V, Bangalore</td>
</tr>
<tr>
<td>IT Office 04</td>
<td>Olympia Tech Park, Chennai</td>
</tr>
<tr>
<td>IT Office 05</td>
<td>Wipro Technologies, Gurgaon</td>
</tr>
<tr>
<td>IT Office 06</td>
<td>Wipro S1, Kochi</td>
</tr>
<tr>
<td>IT Office 07</td>
<td>Fast Track Building 182, Wipro Technologies, Greater Noida</td>
</tr>
<tr>
<td>IT Office 08</td>
<td>Software Development Blocks 3, Wipro Ltd, Phase II, Hinjawadi, Pune</td>
</tr>
<tr>
<td>IT Office 09</td>
<td>Wipro Limited, Special Economic Zone PDC-2 S2, Pune</td>
</tr>
<tr>
<td>IT Office 10</td>
<td>Wipro Special Economic Zone, Blocks S1 &amp; S2, Gopanpally, Hyderabad</td>
</tr>
<tr>
<td>IT Office 11</td>
<td>Wipro Chennai Development Center - SEZ, Chennai</td>
</tr>
<tr>
<td>IT Office 12</td>
<td>Chennai Development Center SS &amp; St Blocks, Wipro Technologies, Chennai</td>
</tr>
<tr>
<td>IT Office 13</td>
<td>Wipro Special Economic Zone - S2, Bangalore</td>
</tr>
<tr>
<td>IT Office 14</td>
<td>Wipro Special Economic Zone (SR) - Tower S3, Bangalore</td>
</tr>
<tr>
<td>IT Office 15</td>
<td>Wipro Technologies, BHDC, Bhubaneswar</td>
</tr>
<tr>
<td>IT Office 16</td>
<td>Wipro Technologies KDC Tower - 4, Kolkata</td>
</tr>
<tr>
<td>IT Office 17</td>
<td>Wipro Ltd. (Infotech), Kottwara</td>
</tr>
<tr>
<td>IT Office 18</td>
<td>BPO-1, Infosys BPO Limited, Jaipur</td>
</tr>
<tr>
<td>IT Office 19</td>
<td>Software Development Block, Infosys Technologies Ltd, Thiruvananthapuram</td>
</tr>
<tr>
<td>IT Office 20</td>
<td>Infosys - SDB 2, Thiruvananthapuram</td>
</tr>
<tr>
<td>IT Office 21</td>
<td>Infosys - SDB 1, Pocharam Campus, Hyderabad</td>
</tr>
</tbody>
</table>

**Source:** CSE
What Developers Are Saying about ECBC
Implementation Barriers

- Strong first cost bias
- Availability of efficient products
- Equipment testing & certification
- Energy expertise
- Awareness, information and tools
- Electricity rate structures / rural subsidies
- Territoriality by agencies
- Potential code official abuses
- Lack of government & utility “Champions”
Conclusion

• Rating systems would provide public recognition to energy efficient buildings, thus create a demand for such buildings.

• ECBC once completely implemented would largely effect only energy savings

• ECBC Implementation Barriers

• ECBC along with adoption of other rating systems can achieve holistic design.
Sources


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Thank You

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