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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – INTRODUCTION TO GREEN RATING SYSTEMS – SARA5333

I. Introduction

GREEN BUILDINGS AND RATING SYSTEMS

Buildings have extensive direct and indirect impacts on the environment. During their construction, occupancy, renovation, repurposing, and demolition, buildings use energy, water, and raw materials, generate waste, and emit potentially harmful atmospheric emissions. These facts have prompted the creation of green building standards, certifications, and rating systems aimed at mitigating the impact of buildings on the natural environment through sustainable design.

History

The push toward sustainable design increased with the launch in 1990 of Building Research Establishment's Environmental Assessment Method (BREEAM), the first green building rating system in the world. In 2000, the U.S. Green Building Council (USGBC) followed suit and developed and released criteria also aimed at improving the environmental performance of buildings through its Leadership in Energy and Environmental Design (LEED) rating system for new construction. Since that first release, LEED has continued to grow in prominence and to include rating systems for existing buildings and entire neighbourhoods.
Others also responded to the growing interest and demand for sustainable design including the Green Building Initiative (GBI), which was created to assist the National Association of Homebuilders (NAHB) in promoting its Green Building Guidelines for Residential Structures. Although originally developed for Canada, GBI helped to make Green Globes available for use in the U.S. in 2005. Additional rating systems have been developed that were influenced by these early programs but are tailored to their own national priorities and requirements or seek to go beyond the limits of current policy and building practices to address broader issues of sustainability or evolving concepts such as net zero energy, and living and restorative building concepts that improve the natural environment, or those that model nature's processes.

What is Green Building?

"It is the practice of increasing efficiency with which buildings use resources-energy, water and materials-while reducing building impacts on human health and the environment."
As we know the air which surrounds us within a building are a closed environment is directly related are directly connected to the health and well being. So we have to maintain such standards to have good indoor air quality, to have good respiration and which is all impacted by this green building design, which reduces the resources such as energy, water and materials.

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 Building Technology Should Reach All"

Concept

- Is the aim of this green building design .The concept is gaining importance in various Countries, including India. These the some of the rating systems are develop to create awareness and to make people to get its reach from technicians to normal lay man community to know about the importance and significant of green building design.

- These buildings that ensure that waste is minimized at every single stage during the construction and operation of the building, resulting in low costs, according to experts in the technology. So as we saw in the previous presentation, this not only improve the health and increase energy efficiency but also ensures that wastes and materials recycle are reuse in every states of its operation that is the concept which is been adopted to make it as a green building or green building material.

- The technique associated with the 'Green Building' include measures to prevent erosion of soil, rainwater harvesting, use of solar energy, preparation of landscapes to reduce heat, reduction in usage of water, recycling of waste water and use of world class energy efficient practices. It can also be adopted for the entire side. Such as using good landscaping or predicting and usage of solar energy and preventing from soil erosion and using reduced amount of water and recycling of waste water etc.

- A similar concept is natural building, which is usually on a smaller scale and tends to focus on the use of natural materials that are available locally. So, as we saw in the previous presentation this point talks about the transportation charge, which is involve while transporting the building material from the factory to the usage site.

How to make a Building Green?

A green building is a structure that is environmentally responsible and resources efficient throughout its life-cycle. So it's not just from producing are its usage. It is actually calculated like a life-cycle assessment from the way this manufacture from being the product to the end product, which again recyclable. These objectives expand and complement the classical building design, concerns of economy, utility, durability and comfort. So, just because we are doing the green building does in mean we are compromising on the comfort or looks or utility or durability of the building we are also taking care of all this aspects and making the building actually better compare to the regular conventional once.

Importance of Green Building

Nowadays, we should make a way to maximize our natural resources to get some relief since pollution is everywhere plus the Global warming that we are all experiencing. The lot of service being taken around the world, which says the temperature is been increasing from point .89 degree Celsius or 1 degree Celsius throughout some for the pass for two, three decades. Which is all due to what we are impacting from the building sector as well. So, we have to start reacting to it from now. So we have to depend more and renewable energy resources available abundant in nature and Non-renewable energy is expensive and unsafe but did you know that through

green building we can save a lot of energy actually. We have to make our buildings more dependent on renewable energy sources.

Before that, let's define first the meaning of green building(known also as green construction) is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle: from siting to design, construction, operation, maintenance, renovation and deconstruction. As we said in the previous slide not only takes care of creating a structure but it also being studied for a whole life –cycle assessment.

The importance of this is to lessen the consumption of energy and pollution as well because the more we use non-renewable energy the higher the risk of pollution. For school buildings day-lighting is very essential and we have to make it so that the desk level is being lit at least to minimum of 300 lux level to reduce the usage of conventional electric sources.

Why Green Building?

Now the global concern is due to global warming this climate change which results in floods, droughts and increasing temperature which results in melting of ice gracious, which increasing sea water levels.

1. **Threats of Climate Change**

These are some of the results which will happen the climate is changing global warming is happening which results in thinks like floods, fire, others and severe winter storm, hurricane, tornado, tornado and flood, severe storms. These are the natural calamities. Which is being formed because of climate change and global warming? So, again these are some of the thinks which being again listed.

2. **Root Cause**

So, what is the root cause of this type of climate change which is being happening? Is recently is energy consumption. So, whatever we are using energy this producing certain amount of hazardous gases which is increasing the green house effect and increasing the temperature eventually which changes the climate. This is due to green house gas emission and which is due to environmental pollution.

3. **Sustainability and Building Sector**

So, 50% of materials resources taken from nature are building related. So, whatever natural resources that we see around as 50% is being destroyed just by the building sector alone. And over 50% of national waste production comes from the building sector. As a building in an individual it may seem to be a small number but, when you look at this problem globally. It is 50% of the entire ways has been produced globally just from a building sector. So, we need to consider this type of sustainable usage, which can be leg when a resource from a forest and then it's been construct as a building and the waste has been usable for again recycle or reusable. So, it does in provide hazarder to the earth that we live.

4. Pollution and energy consuming sector

As we seen this short which is less the major three sector which is been reducing more energy consumptions. Which is building, transportation and industry. When you see from the year 1950's the building sector which is been growing more which is more becoming more polluting and more energy consumption even compare to the industrial sector and transportation sector. So, as you see industry contributes just 25% and transportation to 27% but building contributes almost to 48% of this pollution and energy consumption.

- That way using 40% of global energy consumption is building related.
- 50% of global green house emission is due to buildings.

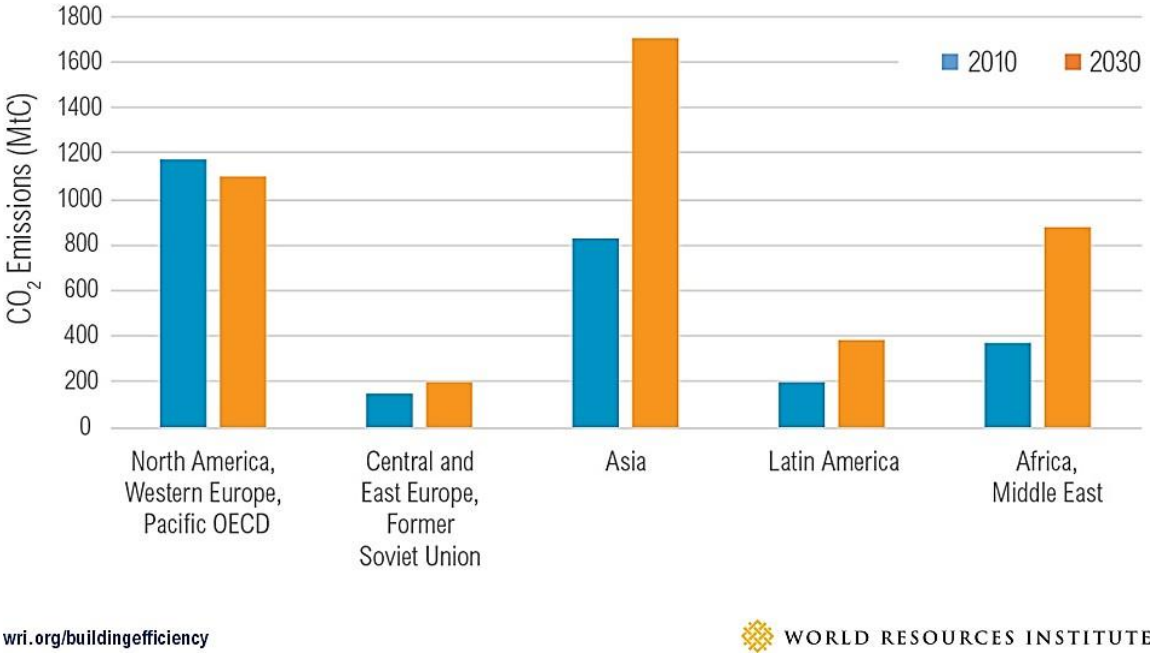

Fig 1

Since, the building are becoming more and more, the appliances that We use and different materials that we using electronic materials that way using to keep the building with in comfort level is emitting lot of carbon dioxide and other gasses which is hazardous which is accounting to 50% of global green house emission effect.

Would you to continue like this---?

Unknowingly, architecture and building community is responsible for almost half of green emission annually.

Green Building Or Sustainable Habitat

So, this using green building sustainable aspect is like from the start of design not only just usage of materials but from the starting to analyze the climate and the usage and the usage pattern of a building and appliances which will go with in the building all can account to reduction and usage of energies. The objective is to evolve a strategy to reduce energy use in building so as to reduce energy costs and green house gas emission into the earth's atmosphere.

A green building is designed, constructed and operated to minimize the total environmental impacts while enhancing use comfort and productivity. So, while a green building design has been considered, you should consider also to reduce the impact on global level also to individual level we need to consider producing good and comfortable visual and thermal comfortable environment for the end user's of that space.

Green Building Concept

1. Sustainable site planning

2. Building design optimization

3. Energy performance optimization

4. Renewable energy utilization

5. Water and waste management

6. Solid waste management

7. Sustainable building materials and construction technology

8. Health, well being and environmental quality

So, these are on a bigger picture when you design a green building. So, these are the aspects that has to be consider and this will be taken in to account while giving a building assessment or giving a building certification, if it is green or not. So, these are the points,

Green Building Rating System

 A green building rating system is an evaluation tool that measures environmental performance of a building through its life cycle. So, even from starting of the site plan to design product usage, metical usage and even after that a post occupants evaluation is made which shows how much people are comfortable and how this technique's which put into actually beneficial to the building sector. By maintaining their energy bills on comparing them to the conventional building of a same size and same usage pattern.

 Each criterion has pre-assigned points and sets performance benchmarks and goals that are largely quantifiable. So, this certification program has works and different criteria's. When covers all this points that we saw in the previous slide delighting

natural renewable energy sources, sustainable energy planning, ways management, recyclability, reusability and everything. And these work on there are some goals and some benchmark to which the building to has to meet to get that type of certification.

Successful International Rating Programs:

LEED which is leadership in Energy and Environmental Design (LEED) was developed and piloted in the US in 1998 as a consensus-based building rating system based on the use of existing building technology. So, it was developed in 1998 by US body to give a building a rating the main aim was to reduce energy usage. So, that will meet up to that target.

 The rating system addresses specific environmental building related impacts using a whole building environmental performance approach.

Building Standards

A **standard** is a set of guidelines and criteria against which a product can be judged. Common standards related to building practices are created through consensus processes by organizations such as ANSI, ASTM, or ASHRAE. Supporting the governance of standards and certifications is the International Standards Organization (ISO), which defines and develops worldwide standards that frequently become law or form the basis of industry norms. ISO defines a standard as: "a document, established by consensus, approved by a recognized body that provides for common and repeated use as rules, guidelines, or characteristics for activities or their results."
Requirements found in standards may either be prescriptive (identifying methods of achievement) or performance based (stating expectations of end results). Consensus based standards, those developed through a formal, voluntary consensus process that is exemplified by an open and due process have immediate buy-in, government support, and international influence. According to the National Technology Transfer and Advancement Act (NTTAA) federal agencies are required by law to adopt existing private-sector voluntary consensus standards instead of creating proprietary, non-consensus standards. Standards frequently serve as incentives for improved performance. Many of the green product standards available today are proprietary or regulatory standards that have been developed outside of the formal ANSI and ISO consensus process. These types of standards may be more or less stringent than consensus standards and can include some level of transparency and public comment. However, many of these types of standards are trusted because they are associated with a group that has strong environmental credentials.
The ANSI/ASHRAE/USGBC/IES Standard 189.1, *Standard for the Design of High Performance Green Buildings except Low-Rise Residential Buildings* provides minimum requirements for site, design, construction and operations in mandatory, code-enforceable language. This standard is comprehensive and includes chapters for site, water, energy efficiency, indoor environmental quality, and materials. For a detailed description on many other building codes and standards that address sustainability goals and requirements, see the Relevant Codes and Standards section below and Energy Codes and Standards.

Green Codes

Green building codes continue to be developed and adopted in the U.S. and abroad that seek to push the standard of building design and construction to new levels of sustainability and performance. Codes come in two basic formats: *prescriptive* and *performance*, with *outcome-*

based becoming a developing third option. A **Prescriptive** path is a fast, definitive, and conservative approach to code compliance. Materials and equipment must meet a certain levels of stringency, which are quantified in tables. **Performance-based codes** are designed to achieve particular results, rather than meeting prescribed requirements for individual building components. **Outcome-based codes** for example, establish a target energy use level and provide for measurement and reporting of energy use to assure that the completed building performs at the established level.

The unique difference between codes and building rating systems is that codes are mandatory. If green codes become adopted on a wide spread basis, their impact can change the building environment rapidly and extensively. When undertaking a project, whether it is new construction or a renovation, check to see if there is a state or local green code that will dictate the direction and scope your project must take.

International Code Council

- International Green Construction Code (IgCC). The IgCC is intended to be used as a jurisdictional and municipal building code for new construction and major renovations. it sets standards for energy conservation, water efficiency, and commissioning, and also includes enforcement procedures and guidelines for existing building renovations.

ASHRAE Standards

- ANSI/ASHRAE/USGBC/IES Standard 189.1, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* this standard provides minimum requirements for site, design, construction and operations in mandatory, code-enforceable language. A collaborative effort by ASHRAE, IES and USGBC, this standard is comprehensive and includes chapters for site, water, energy efficiency, indoor environmental quality, and materials. ASHRAE 189.1 can be used as a jurisdictional compliance path for the IgCC.
- ASHRAE Standard 55, *Thermal Environmental Conditions for Human Occupancy*
- ASHRAE Standard 62.1, *Ventilation for Acceptable Indoor Air Quality*
- ASHRAE Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings*

Water-Related Legislation And Codes

- Energy Independence and Security Act (EISA) Section 438 (stormwater)
- Energy Policy Act of 1992
- Energy Policy Act of 2005 (EPACT) Section 109 (process water)
- *International Plumbing Code* (IPC), (ICC)
- Uniform Plumbing Code 2006, (IAMPO)

Material-Related Legislation

- Farm Security and Rural Investment Act of 2002 (FSRIA)
- Resource Conservation and Recovery Act (RCRA)

Municipal Standards

Many cities, states, and U.S. Territories have also implemented green standards for public buildings. Every city's, state's, and U.S. Territory's energy goals and requirements are listed, highlighting LEED, Green Globes, and carbon emission reduction goals. New York City and California are two examples of governments that have implemented green standards for public buildings.

CALIFORNIA

California has implemented green building standards for all major renovations and new construction of public buildings. Executive Order S-3-05 calls to reduce greenhouse gas emissions 80% below 1990 levels by 2050. To accomplish this goal, Executive Order S-20-04 requires all state buildings to reduce energy usage by 20% and achieve a minimum of a Silver LEED rating.

- Assembly Bill 32: California Global Warming Solutions Act
- California Green Building Strategy
- California Executive Order S-3-05
- CalGREEN code

- ICC 700 National Green Building Standard. The standard defines green building for single-family and multi-family homes, residential remodeling, and site development projects while allowing enough flexibility to incorporate regionally appropriate best green practices.

Code Council (ICC) in association with cooperating sponsors ASTM International (ASTM) and the American Institute of Architects (AIA)

Green Product Certifications

A **certification** is a confirmation that a product meets defined criteria of a standard. ISO defines certification as: "any activity concerned with determining directly or indirectly that relevant requirements are fulfilled."
Green product certifications are intended to outline and confirm that a product meets a particular standard and offers an environmental benefit. Many product labels and certification programs certify products based on life-cycle parameters, making them *multi-attribute* programs. These parameters include energy use, recycled content, and air and water emissions from manufacturing, disposal, and use. Others focus on a *single attribute*, such as water, energy, or chemical emissions that directly impact IEQ.
A green product certification is considered most respected when an independent third party is responsible for conducting the product testing and awarding the certification. Third-party means they are independent of the product manufacturer, contractor, designer, and specifier. Third-party labels and green product certification programs can be helpful in evaluating the attributes of green products because they validate that the product meets certain industry-independent standards. They can also offer greater assurance to consumers, designers, specifiers, and others that a product's marketing claims accurately reflect its green attributes. Many product certifications are also recognized within comprehensive green building rating systems such as LEED, Green Globes, and the National Green Building Standard. As a result, green product certifications are on the rise as market conditions change and the demand for greener products continues to increase. It is important to note that **green-washing**, which is

defined as the use of green claims that are not true or are unverifiable but used to sell products or a corporate image, has become commonplace as companies try to stay competitive in the green marketplace.

To fully understand what a green certification represents and the quality of information it provides, the details of its requirements need to be reviewed carefully. The ISO defines different types of labels that can be used for products. Below is an outline of the ISO-defined labels and what is being claimed. Product certifications available in the U.S. are mostly Type I and Type II labels while Type III labels are now required in France and becoming more common in Europe and for those U.S. manufacturers with an international focus.

TYPE	ISO NUMBER	WHAT THE LABEL DOES
Type I	ISO 14024	Seal of approval for multi-attribute requirements
Type II	ISO 14021	Verifiable single-attribute environmental claims for issues such as energy consumption, emissions, or recycled content. Can be first-party, self-declared manufacturer claims. However many manufacturers are beginning to seek third-party verification of those claims in response to industry demand.
Type III	ISO >14025	Comprehensive environmental product disclosure and detailed product information. Similar to an Environmental Product Declaration (EPD)

PRODUCT CERTIFICATION	SINGLE- OR MULTI-ATTRIBUTE	TYPE OF STANDARD OR CERTIFICATION	MANAGING ORGANIZATION	ISSUE OF FOCUS
Energy Star	Single-Attribute	Government certification relying on manufacturer-provided data or third-party testing	U.S. EPA and U.S. DOE	Energy consuming products

PRODUCT CERTIFICATION	SINGLE- OR MULTI-ATTRIBUTE	TYPE OF STANDARD OR CERTIFICATION	MANAGING ORGANIZATION	ISSUE OF FOCUS
WaterSense	Single-Attribute	Government label based on third-party testing	U.S. EPA	Showerheads, toilets, faucets, urinals, and valves
Forest Stewardship Council	Single-Attribute	Third-party certification	Forest Stewardship Council (FSC)	Forests and forestry products
SCS Global Services	Multi-Attribute	Third-party certification	SCS Global Services	Wide range of products (i.e. carpets, textiles, wood products, insulation, and more)
Green Seal	Multi-Attribute	Third-party ISO Type 1 certification	Green Seal	Wide range of sectors (paints, adhesives, lamps, electric chillers, windows, window films, occupancy sensors)
Cradle to Cradle	Multi-Attribute	Third-party certification, Cradle to Cradle Certified^{CM} Product Standard is managed and updated by the Institute's Certification Standards Board	Cradle to Cradle Products Innovation Institute C2CPII	Building materials, interior design products, textiles and fabrics, paper and packaging, and personal and homecare products

PRODUCT CERTIFICATION	SINGLE- OR MULTI-ATTRIBUTE	TYPE OF STANDARD OR CERTIFICATION	MANAGING ORGANIZATION	ISSUE OF FOCUS
GREENGUARD	Multi-attribute	Third party certification	UL Environment	Indoor air quality, children and schools focus
Green Squared	Multi-attribute	Third-party ISO Type 1 environmental labeling and declaration requirements (ISO 14024)	TCNA	Tiles and tile installations

Summary Of Green Building Rating And Certification Systems

The following table and the expanded information directly below it outlines several of the most commonly used and respected green building rating and certification systems in the U.S. marketplace.

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
Building Research Establishment Environmental Assessment	Multi-Attribute	Green building rating and certification system through on-site independent third-party verification for:	BRE Global	Performance in: • Energy • Health & Well-being • Transport

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
Method (BREEAM)		• New Construction • In-Use • Refurbishment & Fit Out • Communities		• Water • Materials • Waste • Land Use & Ecology

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
		Infrastructure		• Management • Pollution No prerequisites for In-Use

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits

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BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
		• New Construction (NC) • Existing Buildings, Operations &		• Materials & Resources • Indoor Environmental Quality

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
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		Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS)		• Locations & Linkages • Awareness & Education • Innovation in Design

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
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		• Schools (SCH) • Retail • Healthcare (HC) • Homes		• Regional Priority through a set of prerequisites and credits

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		• Neighborhood Development (ND)		

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BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
Green Globes	Multi-Attribute	Green building guidance and assessment program for: • Existing buildings	Green Building Initiative in the U.S. BOMA Canada	Environmental assessment areas to earn credits in: • Energy • Indoor Environment

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
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		• New construction		• Site • Water • Resources • Emissions

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
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				• Project/Environmental Management No prerequisites

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
Living Building Challenge	Multi-Attribute	Performance-based standard, and certification program for: • Landscape and	International Living Future Institute	Performance areas include: • Site • Water • Energy

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
		• infrastructure projects • Partial renovations and complete building renewals		• Materials • Health • Equity • Beauty

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
		• New building construction • Neighborhood, campus and community design		All areas are requirements.

NZEB	Multi-Attribute	Certification program using the structure of the Living Building Challenge which can be applied to any building type.	International Living Future Institute	One hundred percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion. NZEB certified buildings must also meet the following requirements of the Living Building Challenge: • the first half of Imperative One, Limits to Growth, dealing with appropriate siting of buildings • Imperative 19, Beauty and Spirit • Imperative 20, Inspiration and Education
Passive House Institute US	Multi-Attribute	Performance based passive building standard • Third-party RESNET approved quality assurance/quality control • Earns U.S. DOE Zero Energy Ready Home status • Includes HERS rating	Passive House Institute US	Any type of building. New focus areas include: • air tightness requirement • source energy limit • space conditioning criteria

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
SITES	Multi-Attribute	Third party verified rating system for development projects located on sites with or without buildings.	Administered by GBCI	Performance criteria in the areas of: • Water • Wildlife Habitat • Energy

Leadership in Energy and Environmental Design (LEED)	Multi-Attribute	Green building rating and certification system through independent third-party verification for: • New Construction (NC) • Existing Buildings, Operations & Maintenance (EB O&M) • Commercial Interiors (CI) • Core & Shell (CS) • Schools (SCH) • Retail • Healthcare (HC) • Homes • Neighborhood Development (ND)	U.S. Green Building Council	Performance in: • Sustainable Sites • Water Efficiency • Energy & Atmosphere • Materials & Resources • Indoor Environmental Quality • Locations & Linkages • Awareness & Education • Innovation in Design • Regional Priority through a set of prerequisites and credits
BUILDING RATING OR CERTIFICATION SYSTEM	**SINGLE- OR MULTI-ATTRIBUTE**	**TYPE OF STANDARD OR CERTIFICATION**	**MANAGING ORGANIZATION**	**ISSUES / AREAS OF FOCUS**
				• Air Quality • Human Health • Outdoor recreation opportunities

WELL Building Standard	Multi-Attribute	Performance based standard and certification program for • New and Existing Buildings • New and Existing Interiors • Core and Shell Retail • Education Facilities • Restaurant • Commercial Kitchen • Multifamily Residential	Administered by the International WELL Building Institute™ (IWBI)	Measures attributes of buildings that impact occupant health by looking at seven factors: Air, Water, Nourishment, Light, Fitness, Comfort, Mind
INTERNATIONAL PROGRAMS				
BCA Green Mark Scheme (Singapore)	Multi-Attribute	Benchmarking scheme that aims to achieve a sustainable built environment by incorporating best practices in environmental design and construction, and the adoption of green building technologies.	Building and Construction Authority (BCA)	Rates buildings according to five key criteria: • Energy efficiency • Water efficiency • Environmental protection • Indoor environmental quality, and • Other green and innovative features that contribute to better building performance.

Beam (Hong Kong)	Multi-Attribute	Comprehensive standard and supporting process covering all building types, including mixed use complexes, both new and existing to assess, improve, certify, and label the environmental performance of buildings	Business Environment Council	Performance and assessment in: • Site aspects • Material aspects • Water use • Energy use • Indoor environmental quality • Innovations and additions
CASBEE (Japan)	Multi-Attribute	Building assessment tools for • Pre-design • New Construction • Existing Building and • Renovation	JSBC (Japan Sustainable Building Consortium) and its affiliated sub-committees	Assessment areas include: • Energy efficiency • Resource efficiency • Local environment, and • Indoor environment
EDGE	Multi-Attribute	A universal standard and a certification system for residential and commercial structures.	International Finance Corporation (IFC), a member of the World Bank Group	Assessment areas include: • Energy • Water • Materials

Green Star SA (South Africa)	Multi-Attribute	Green building rating system for: • Office • Retail • Multi-unit residential	Green Building Council of South Africa administers program Independent assessors to assess and score projects	Categories assessed in: • Management • Indoor Environmental Quality • Energy • Transport • Water • Materials • Land Use & Ecology • Emissions • Innovation
Pearl Rating System for Estidama (UAE)	Multi-Attribute	Green building rating system for: • Community • Buildings • Villas • Temporary Villas and Buildings	Abu Dhabi Urban Planning Council	Assessment of performance in: • Integrated Development Process • Natural Systems • Livable Communities • Precious Water • Resourceful Energy • Stewarding Materials • Innovating Practice

Rating System In India:

In India, there are few primary rating systems, namely:

GRIHA (Green Rating for Integrated Habitat Assessment): GRIHA is jointly developed by TERI and the Ministry of New and Renewable Energy, Govt. of India. It is India's own rating system. GRIHA has a three tier process for rating any building.
The GRIHA Rating System contains 34 evaluation criteria with 100 points. These criteria have been categorized into (i) Site Planning including conservation and efficient utilization of resources, health and wellbeing during building planning and construction stage (ii) Water Conservation (iii) Energy Efficiency including energy embodied & construction and renewable energy (iv) Waste Management including waste minimization, segregation, storage, disposal and recovery of energy from waste and (v) Environment for good health and wellbeing.

Commonwealth Games Village, New Delhi, Fortis Hospital, New Delhi, CESE (Centre for Environmental Sciences & Engineering) Bldg, IIT Kanpur have received GRIHA ratings.

Leadership in Energy & Environmental Design India

LEED is an internationally recognized green building certification system, providing third-party verification that a building or community was designed and built using strategies aimed at improving performance across all the metrics that matter most: Energy savings, water efficiency, CO_2 emissions reduction, improved indoor environmental quality and stewardship of resources and sensitivity to their impacts.

The Indian Green Building Council has adapted LEED system and has launched LEED India version for rating of new construction.

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 has received BEE 5 star ratings.

IGBC (Indian Green Building Council): IGBC is a non-profit research institution formed by Confederation of Indian Industry (CII) in 2001. IGBC has licensed the LEED green building rating standard from USGBC. LEED-INDIA approach for green building is divided into five key areas namely, 1) Sustainable site development, 2) Water saving, 3) Energy efficiency, 4) Material selection and 5) Indoor environment quality

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – II –GREEN RATING SYSTEMS IN INDIA– SARA5333

I. Introduction

GREEN BUILDINGS PARAMETERS

Some of the key attributes of Green Buildings are as under:

Energy efficiency and renewable energy

- Building orientation to take advantage of solar access, shading, and natural lighting
- Effects of micro-climate on building
- Thermal efficiency of building envelope and fenestration
- Properly sized and efficient heating, ventilating, and air-conditioning (HVAC) system
- Alternative energy sources
- Minimization of electric loads from lighting, appliances, and equipment
- Utility incentives to offset costs

Direct and indirect environmental impact

- Integrity of site and vegetation during construction
- Use of integrated pest management
- Use of native plants for landscaping
- Minimization of disturbance to the watershed and additional non-point-source pollution
- Effect of materials choice on resource depletion and air and water pollution
- Use of indigenous building materials
- Amount of energy used to produce building materials

Resource conservation and recycling

- Use of recyclable products and those with recycled material content
- Reuse of building components, equipment, and furnishings
- Minimization of construction waste and demolition debris through reuse and recycling
- Easy access to recycling facilities for building occupants
- Minimization of sanitary waste through reuse of grey-water and water-saving devices
- Use of rainwater for irrigation
- Water conservation in building operations
- Use of alternative wastewater treatment methods

Indoor environmental quality

- Volatile organic compound content of building materials
- Minimization of opportunity for microbial growth
- Adequate fresh air supply
- Chemical content and volatility of maintenance and cleaning materials
- Minimization of business-machine and occupant pollution sources
- Adequate acoustic control
- Access to daylight and public amenities

Community issues

- Access to site by mass transit and pedestrian or bicycle paths
- Attention to culture and history of community
- Climatic characteristics as they affect design of building or building materials
- Local incentives, policies, regulations that promote green design
- Infrastructure in community to handle demolition-waste recycling
- Regional availability of environmental products and expertise

In a nutshell, Green Buildings use less energy and water, generate fewer green-house gases, use materials more efficiently, and produce less waste than the conventional buildings over their entire life cycle.

Various green building rating systems used around the world

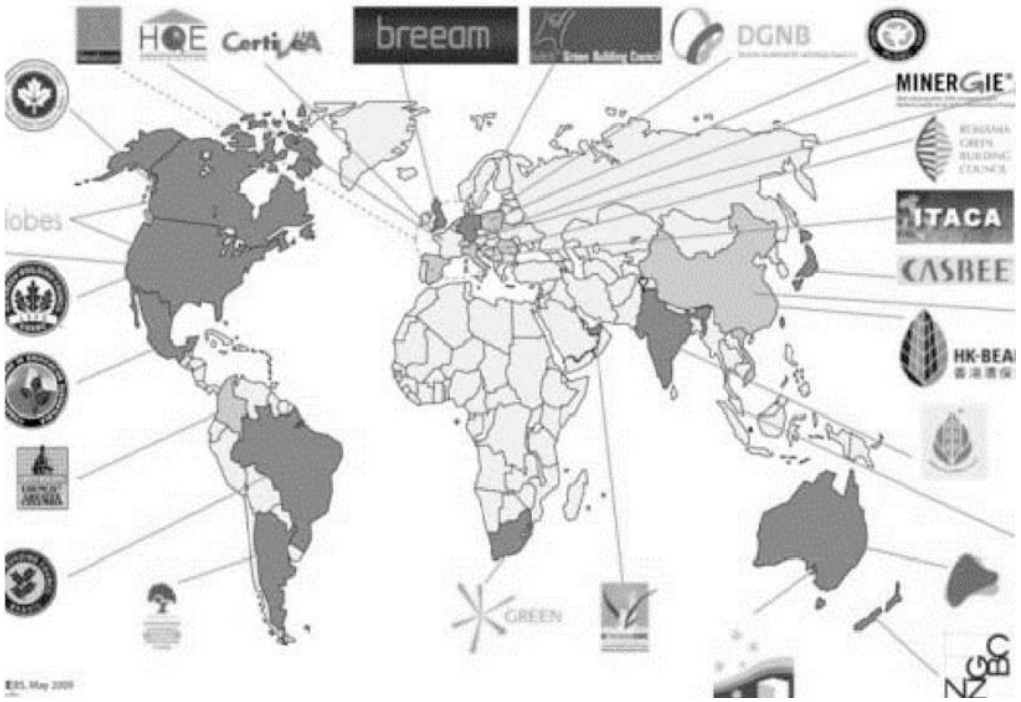
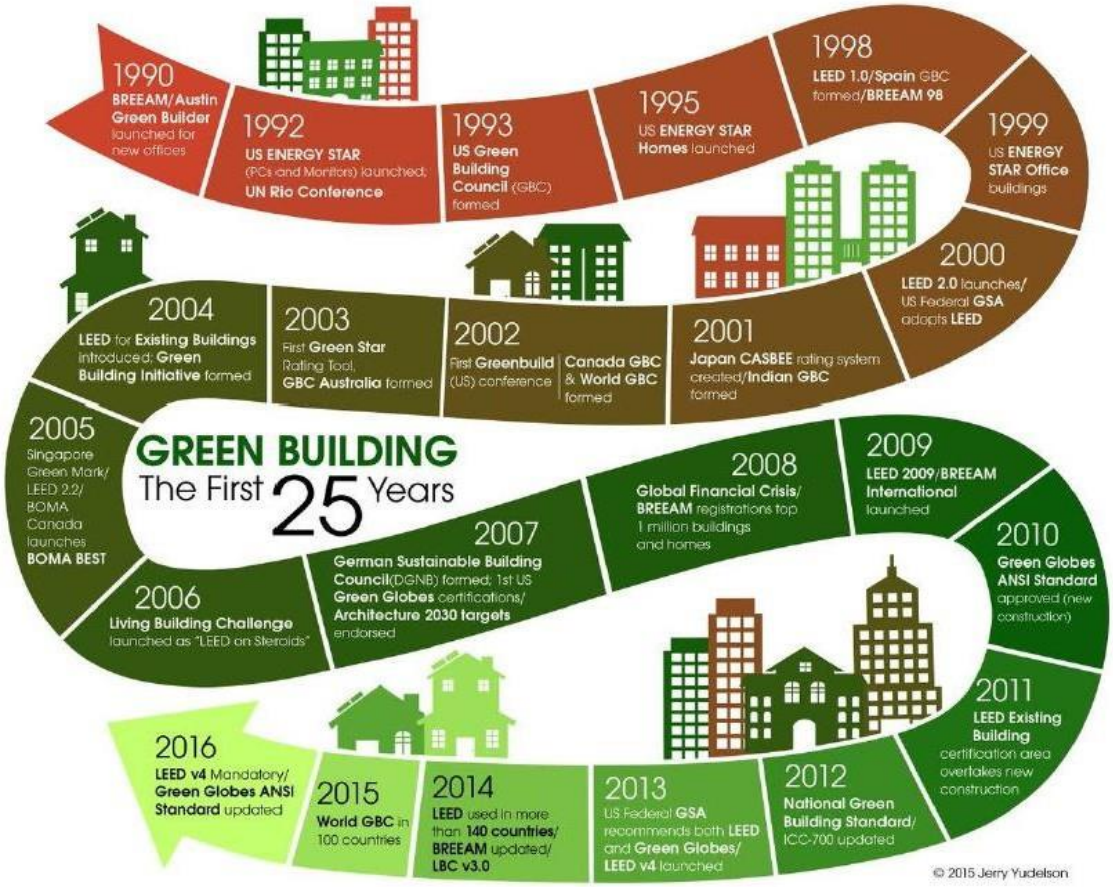


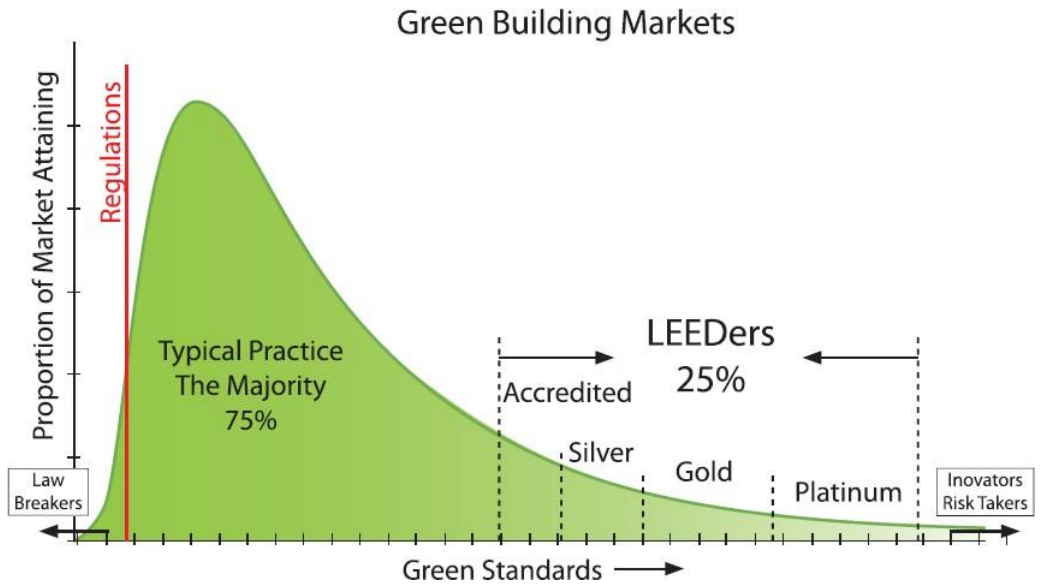
Fig 1

Country	Rating system
United States	Leadership in Energy & Environmental Design (LEED-United States)
	The Green Globe Rating System
	Energy Star (United States Environment Protection Agency)
Canada	Leadership in Energy & Environmental Design — Canada (LEED-Canada)
Australia	Green Star
	Australia Greenhouse Building Rating (AGBR)
United Kingdom	Building Research Environment Assessment Method Consultancy (BREEAM)
Europe	European Environment Agency rating
Hong Kong	Building Environment Assessment Method- Hong Kong (HK-BEAM)
Japan	Comprehensive Assessment System for Building Environment Efficiency (CASBEE)
Taiwan	Ecology, Energy Saving, Waste Reduction and Health (EEWH) (Taiwan)
Singapore	BCA Green Mark
Philippine	Philippine Green Building Council
South Korea	Green Building Council (Korea)
India	GRIHA
	India Green Building Council

Table 1

Green rating system history and development





Economic Benefits

- Reduced operating costs of 9% on average
- Improved employee productivity and satisfaction
- Increased building value by an average of 7%
- Increased rent values by a 3% average (World Green Building Council, 2008)

Environmental Benefits

- Decreased fuel use
- Decreased fresh water use
- Decreased waste output
- Decreased raw material use
- Decreased greenhouse gas emissions

LEED Leadership in Energy and Environmental Design

Leadership in Energy and Environmental Design (LEED®) was developed and piloted in the US in 1998 as a consensus based building rating system based on the use of existing building technology. Successful International Rating Programs: LEED

•The rating system addresses specific environmental building related impacts using a whole building environmental performance approach

LEED was created in 2000 by the U.S. Green Building Council (USGBC), for rating design and construction practices that would define a green building in the United States. LEED is used throughout North America as well as in more than 30 countries with over 6,300 projects currently certified across the globe and over 21,000 projects registered. As of September 2010, over 35 state governments, 380 cities and towns, and 58 counties have enacted sustainable legislation, ordinances, or policies, many of which specifically call for LEED certification.

LEED consists of credits which earn points in 7 categories: *Site Selection, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality, Regional Priority, and Innovation in Design*. One hundred points are available across these categories with mandatory prerequisites such as minimum energy and water-use reduction, recycling collection, and tobacco smoke control. Within each category are credits that pertain to specific strategies for sustainability, such as the use of low-emitting products, reduced water consumption, energy efficiency, access to public transportation, recycled content, renewable energy, and daylighting. Since its inception, LEED standards have become more stringent as the market has changed and expanded to include distinct rating systems that address different building types: New Construction, Existing Buildings, Commercial Interiors, Core & Shell, Schools, Retail, Healthcare, Homes, and Neighborhood Development.
The LEED certification process takes place at LEED Online. Project teams are required to compile documentation to show compliance with LEED requirements and upload this documentation to the LEED Online website. The documentation is then reviewed by the Green Building Certification Institute (GBCI); a LEED certification is earned if all prerequisites and a sufficient number of credits are earned. There are four levels of LEED certification: Certified, Silver, Gold, and Platinum. There are no on-site visits required and certification can occur upon completion of construction.

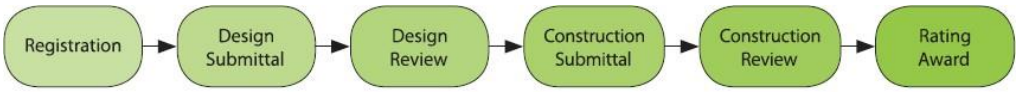


Figure 3. LEED Assessment Process

BREEAM (Building Research Establishment Environmental Assessment Method)

A voluntary green building sustainability rating system established in the UK for assessing the environmental performance of buildings.

BREEAM is the world's leading sustainability assessment method for master planning projects, infrastructure and buildings. It addresses a number of lifecycle stages such as new construction, Refurbishment and in-use.

BREEAM is used not only for building but also for master planning and infrastructure developments, which considers new construction, refurbishment and also in-use. So, if you want to make a BREEAM assessment for a building it need not be newly constructed. It can be building already been used or some building which is been used for something else before and we have done some changes and you have refurbished and made into a new building those are also can come under BREEAM category.

Globally there are more than 536,300 BREEAM certified developments, and almost 2,229,500 buildings registered for assessment since it was first launched in 1990.

So, it has over 536,341 certification and more than 2 million registered buildings and it has over 73 countries.

BREEAM WORKING

The BREEAM assessment process evaluates the procurement, design, construction and operation of a development against targets that are based on performance benchmark. BREEAM is one of the same categories which have different benchmark and different goals for the building to get this type of certification. There are different set goals and benchmark which has to be met.

Assessments are carried out by independent, licensed assessors, and developments rate and certified on a scale shown below in table

when you want to get a BREAM certification there are assessors who do this kind of different levels of rating which is been go throw completely from its requirements to complete state and post occupant evaluation to there are different scale in which this BREEAM certification works is it has scales of pass, good very good excellent and outstanding depending on the building's performance.

BREEAM measures sustainable value in a series of categories, ranging from energy to ecology. So, it does not confine to built environment energy been used. It also takes into account from the by product how much it is the building is completely affecting the ecology and ecosystem around it.

Each of their categories addresses most influential factors, including low impact design and carbon emissions reduction; so, the main criteria which is low impact design and the low impact design is reducing emission and carbon dioxide and other hazarded cycle which is produce while creating buy product or them material still construction. So, all this even the embodied energy also calculated in this type of certification program and carbon reduction emission; design durability and resilience; adaption to climate change; and ecological value and biodiversity protection. So, it looks more on a global scale it takes into an account even ecosystem, ecology biodiversity and everything together not just the building.

Scoring and rating

There are a number of elements that determine the overall performance of a development assessed using BREEAM Communities. These are as follows:

1. the mandatory BREEAM Communities standards
2. the BREEAM Communities assessment issues and credits
3. awarding credits for innovation
4. the category and assessment issue weightings
5. the BREEAM rating level benchmarks.

How these elements combine to produce a BREEAM rating is summarised on the following pages. This is followed by a description and example describing the methodology for calculating a rating.

AWARDING OF CREDITS

BREEAM Rating	% score
OUTSTANDING	≥ 85
EXCELLENT	≥ 70
VERY GOOD	≥ 55
GOOD	≥ 45
PASS	≥ 30
UNCLASSIFIED	< 30

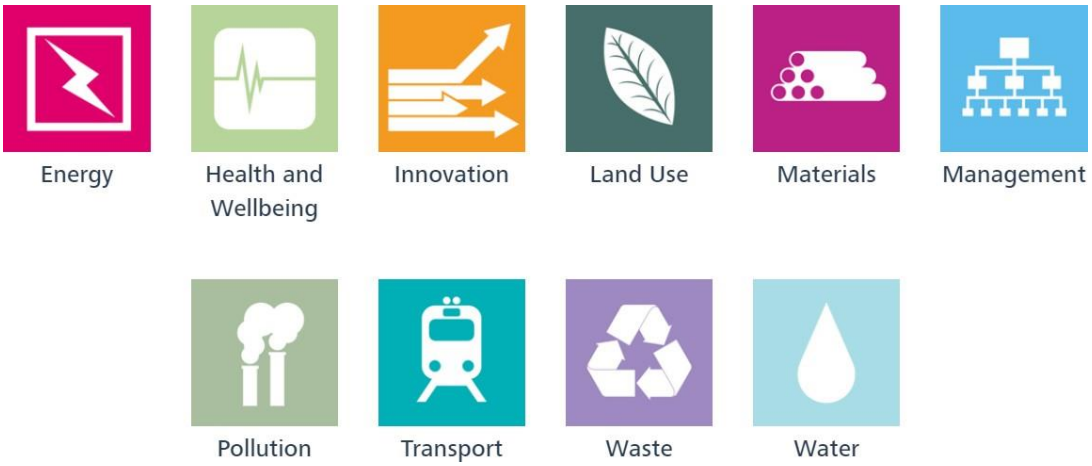
Start point

End point

BREEAM category issues and aims

BREEAM measures sustainable value in a series of categories, ranging from energy to ecology. Each of these categories addresses the most influential factors, including low impact design and carbon emissions reduction; design durability and resilience; adaption to climate change; and ecological value and biodiversity protection.

Learn about some of the challenges BREEAM aims to address by visiting each of the category icons below.



https://www.breeam.com/discover/how-breeam-certification-works/

CASE STUDY – ONE EMBANKMENT PLACE, LONDON (source NPTEL)

So, now moving on to a case study its one embankment place in London. So, this is the building which is located along the embankment of the river.

One embankment place is a commercial office building constructed in the early 1990s. Constructed above Charing Cross station, it is the first air rights building in the UK.

So, this building is constructed 1990 and it's constructed over this metro station called Charing Cross. So, there is Charing Cross metro station above which this building is been constructed. This is the first building which happens in this type.

Approximately 40,000m^2 total floor area comprising a ground floor below the station and floor 1 to 9 above with structure, services and lifts passing through Charing Cross station. So, they have totally 40,00m^2 of area which is including Charing Cross station which is on the ground floor and from 1 to 9th floor of the embankment place station there is lifts in other service area which also pass though this station.

The current occupier PwC desired a high BREEAM rating as part of their high as part of their corporate policy along with a good EPC score and considered this high on the priorities at concept stage. So, this building was perceived from the beginning of the concept stage to get the certification. So, it will be like a pride for a building it was designed on the basis of following the BREEAM requirements and goals, with the BREEAM requirements featuring high on the list next to space planning and cost analysis.

KEY FACTS

BREEAM RATING: Outstanding
Score: 96.31%
Size: 39936 m^2. Which approximately 40,000m^2
Stage: Post-Construction
BREEAM version: BREEAM 2008 offices.

So, BREEAM under 2008 office building this building was assets.

OVERVIEW OF ENVIRINMENTAL FEATURES

- Bio fuel CCHP with and absorption chillers.

- Bio fuel is sourced from locally collected and refined waste vegetable oil. So, the fuel that's been used for the chillers and the plants for space heating and space cooling are from fuel which has been used waste vegetable oils.
- Green walls and landscaped garden planting. So, this type of plantation reduces heat which during the summer months to penetrate inside, which eventually increases the air conditioning capacity.
- Waterless urinals and low flush toilets. So, this points for assets water efficiency since they have waterless urinals and they use low flush toilets.
- Comprehensive metering strategy and BMS. So, as we discuss before they have good building management service department which takes care and supervises all the different strategies to check the requirements to meet up to BRREAM.
- Interactive screen in reception confirming building energy usage. So, they have a screen in which tells how much energy it's been used. So, when it's exceeding we will can be alerted immediately to reduce its usage.
- An innovation credit was achieved for the responsible sourcing of materials. More than >95% of materials used within the construction were responsibly sourced with an ISO 14001 certificate as a minimum. So, the material used for that construction which also met this ISO standards minimum standard of 14001 building code. So, which added the points to the BREEAM certification of this building
- Staircase installed within the atria to promote vertical movement without the use of lifts. So, when you see usually on a tall building usually they keep an escalator or lift in the central code so, people when they come use the lift. But when the lifts are moved when the staircase is placed in front people using people are more enraged to use the staircase rather than using lifts in escalator. Which run on an energies.

THE BREEAM ASSESSMENT

So, for this building one embankment place BREEAM as certified,

Management 100.00%

Transportation 100%. Since mainly it located just below the Charring Cross people would be more using the charring cross station.

- Materials has 100.00%
- Energy uses 95.65%
- Waste is used for 85.71%. Since they are using more of recyclable waste and they are created awareness among the employees to use such type of methods and storing and reusing the materials and dumping the waste also.
- And water efficiency as we seen water less urinals and less water fleshing toilets are used which has given this building a used 83.33% of BREEAM assessment.
- Land usage 80%
- Innovation 80.00%

BUILDING SERVICES

- The base load of the chilled water demand is via two kW adsorption chillers driven by the hot water generated by two 520 (KWe – electrical output) biodiesel combined heat and power units. So, they are using majorly two chillier plants which has been access bio fuels which comes from the waste vegetable oils. So, the source which goes in for the chillers basically very green and it reduces the impact on the environment.

 The remaining cooling duty is met by three 1.5 MW screw chillers (two duty and one standby). To provide resilience in the system, the capacity of the screw chillers has been sized to maintain the total peak load of the building via two units, also providing backup in case CCHP is not operating for maintenance. So, they have one screw chillers for a hotter months which is 1.5 kW and there is one which is stand by which can be used when their is any problem which is been happening so they a good backup system which is been maintained by building management services again. And so this is one of image. So, as you see in the main atrium here there is a staircase which is provided which encourage the users to access to the office building on the above floors to use the staircase and rather than prefer lifts and escalator.

 Boilers provide heating to the low grade hot water circuit serving the 4-pipe chilled beams within the office floor plates and the trench heaters system plus the Constant Temperature LTHW circuit serving all air handling units and fan coil circuits on the floors and the hot water service generation plant. So, they have four main pipes chilled been which is been to circulated throw the building to create this to meet to the requirements to the chilled towers. Which is catering to the air handling unit's requirements so, this is the image. So, the lobby looks.

GREEN STRATEGY

The different green strategies

 Biomass fuel has been locally sourced via Uptown Biodiesel. This is also located in London.PwC entered into a knowledge partnership with London South Bank University. This has resulted in the bio fuel being certified to EN14214. The collaboration has allowed PwC to run its CHHP engine with clean carbon neutral fuel, thus reducing the buildings EPC to 11 representing an A rating. So, the biomass fuel which has been is out sourced by a knowledge transfer program. So, the new innovation has been used in the building can be given a copy right or transferred as a knowledge to this another body from the uptown biodiesel. Which maintain these building chillier units and also uses the same knowledge to develop its further

 PwC engaged a BREEAM AP and energy modelling specialist at RIBA stage B to develop options to achieve the desired BREAM rating of Excellent with an aspiration for Outstanding.

Some of the most commonly-used green rating systems include the following:

BUILDING RATING OR CERTIFICATION SYST EM	TYPE OF STANDARD OR CERTIFICATION	ISSUES/AREAS OF FOCUS
BCA Green Mark Scheme (Singapore) MANAGING ORGANISA TION	Benchmarking scheme that aims to achieve a sustainable built environment by incorporating best practices in environmental design and construction, and	1 Rates buildings according to five key criteria: 2 Energy efficiency. 3 Water efficiency. 4 Environmental protection.

Building and Construction Authority (BCA)	the adoption of green building technologies.	5 Indoor environmental quality. 6Other green and innovative features that contribute to better building performance.
BREEAM (UK) BRE Global	Certification system is a multi-tiered process with pre-assessment, third-party consultant guidance through an assessment organisation for: 1. New construction. 2. Communities. 3. In-use buildings. 4. Eco-homes.	Assessment uses recognised measures of performance, which are set against established benchmarks in: 1. Energy and water use. 2. Internal environment (health and well-being). 3. Pollution. 4. Transport. 5. Materials. 6. Waste. 7. Ecology. 8. Management processes.
EDGE International Finance Corporation (IFC).	A universal standard and a certification system for residential and commercial structures.	Assessment areas include: 1 Energy. 2 Water. 3 Materials.
Energy Star (USA) U.S. EPA and U.S. DOE.	Government certification using a benchmarking method.	Building energy and water use.
Green Globes (USA) Green Building Initiative in the U.S.BOMA Canada.	Green building guidance and assessment program for: 1 Existing buildings. 2 New construction.	Environmental assessment areas to earn credits in: 1 Energy. 2 Indoor environment. 3 Site. 4 Water. 5 Resources.

		6 Emissions. 7 Project / environmental management.
Leadership in Energy and Environmental Design (LEED) (USA) U.S. Green Building Council	Green building rating and certification system through independent third-party verification for: 1 New Construction (NC). 2 Existing Buildings, Operations & Maintenance (EB O&M). 3 Commercial Interiors (CI). 4 Core & Shell (CS). 5 Schools (SCH). 6 Retail. 7 Healthcare (HC). 8 Homes. 9Neighborhood Development	Performance in: Sustainable sites. 1 Water efficiency. 2 Energy & atmosphere. 3 Materials & resources. 4 Indoor environmental quality. 5 Locations & linkages. 6 Awareness & education. 7 Innovation in design. 8 Regional priority through a set of prerequisites and credits.
Living Building Challenge (USA) International Living Future Institute	Performance-based standard, and certification programme for: 1 Landscape and infrastructure projects. 2Partial renovations and complete building renewals. 3 New building construction. 4 Neighborhood, campus and community design.	Performance areas include: 1 Site. 2 Water. 3 Energy. 4 Materials. 5 Equity.
Pearl Rating System for Estidama (UAE) Abu Dhabi Urban Planning Council	Green building rating system for: 1 Community. 2 Buildings. 3 Villas. 4 Temporary villas and buildings.	Assessment of performance in: 1 Integrated development process. 2 Natural systems. 3 Livable communities. 4 Precious water. 5 Resourceful energy.

		6 Stewarding materials. 7 Innovating practice.
WELL Building Standard (USA) Administered by the International WELL Building Institute™ (IWBI)	Performance-based standard and certification programme for new and existing buildings. 1 New and existing interiors. 2 Core and shell retail. 3 Education facilities. 4 Restaurant 5 Commercial kitchen. 6 Multi-family residential.	Measures attributes of buildings that impact occupant health by looking at seven factors: air, water, nourishment, light, fitness, comfort,

GRIHA (Green Rating for Integrated Habitat Assessment)

Indigenous Rating system focusing on non air conditioned or partially conditioned buildings

GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions, and indigenous solutions by integrating all relevant Indian codes and standards for buildings.

GRIHA stresses on passive techniques.

GRIHA V 3 rating system consists of 34 criteria covering various subjects such as sustainable site planning, energy and water optimization, sustainable building materials, waste management and building operations & maintenance. There are bonus points for strategies implemented over and above the listed GRIHA Criteria.

Eligibility

All buildings, which are in the design stage and have built up area more than 2,500 m2, m2, which are in the design stage, are eligible for certification under GRIHA. Building types include but are not limited to offices, retail spaces, institutional buildings, hotels, hospital buildings, healthcare facilities, residences, and multi-family high-rise buildings.

Criteria and their weightage

GRIHA is a performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criterion has certain points assigned to it. It means that a project demonstrating compliance with a criterion would achieve the associated points.

GRIHA is a 100-point system consisting of some core points, which are mandatory, while the rest are optional. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification are 50.

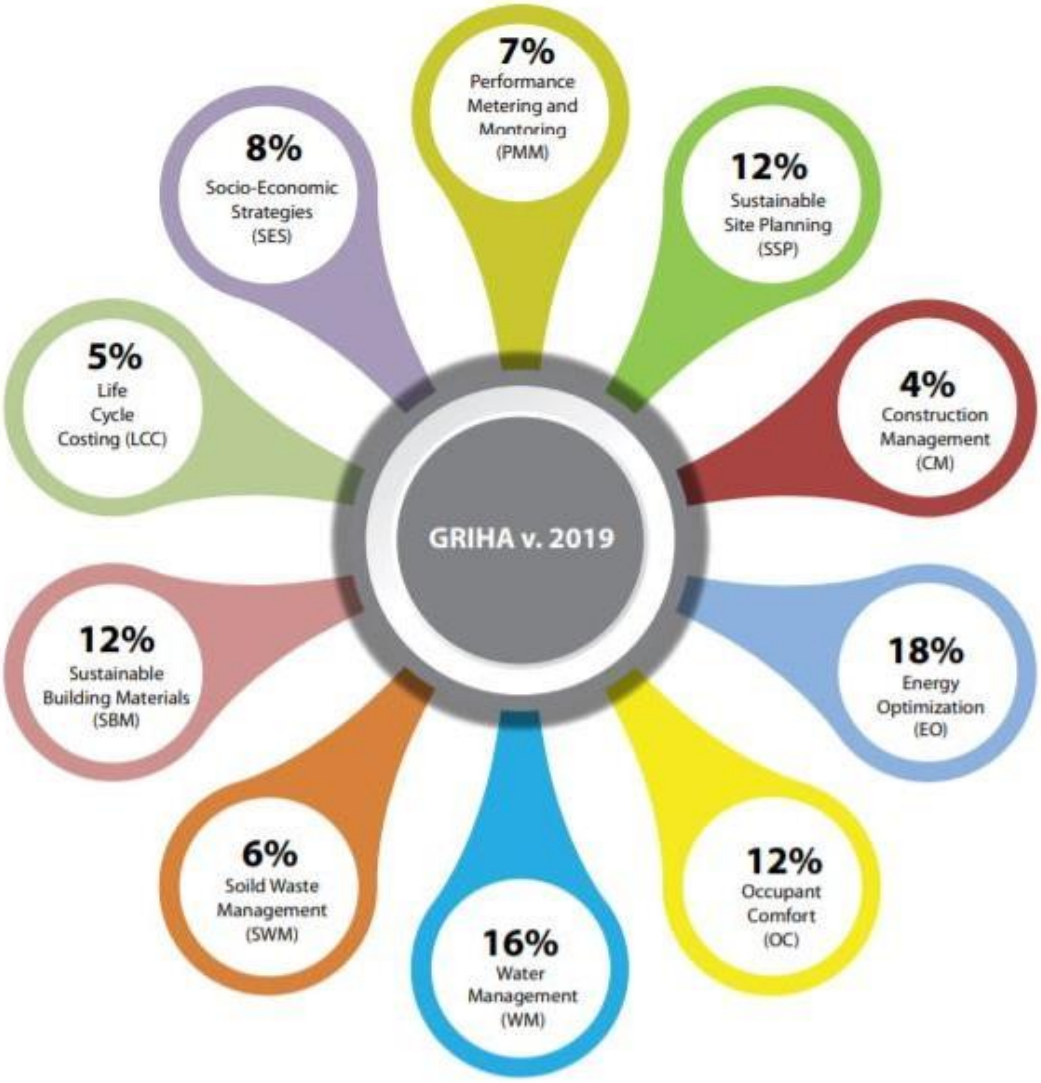


Figure 1 Section weightages

Percentile threshold	Achievable stars as per GRIHA v. 2019
25–40	★
41–55	★★
56–70	★★★
71–85	★★★★
86 and more	★★★★★

GRIHA V2019

GRIHA v.2019			
Section	**Criterion No.**	**Criterion Name**	**Maximum Points**
1. Sustainable Site Planning (SSP)	1	Green Infrastructure	5
	2	Low Impact Design Strategies	5
	3	Design to Mitigate UHIE	2
2. Construction Management (CM)	4	Air and Soil Pollution Control	1
	5	Topsoil Preservation	1
	6	Construction Management Practices	2
3. Energy Optimization (EO)	7	Energy Optimization	12
	8	Renewable Energy Utilization	5
	9	Low ODP and GWP Materials	1
4. Occupant Comfort (OC)	10	Visual Comfort	4
	11	Thermal and Acoustic Comfort	2
	12	Maintaining Good IAQ	6
5. Water Management (WM)	13	Water Demand Reduction	3
	14	Wastewater Treatment	3
	15	Rainwater Management	5
	16	Water Quality and Self-Sufficiency	5
6. Soild Waste Management (SWM)	17	Waste Management– Post Occupancy	4
	18	Organic Waste Treatment On-Site	2
7. Sustainable Building Materials (SBM)	19	Utilization of Alternative Materials in Building	5
	20	Reduction in GWP through Life Cycle Assessment	5
	21	Alternative Materials for External Site Development	2
8. Life Cycle Costing (LCC)	22	Life Cycle Cost Analysis	5
9. Socio-Economic Strategies (SES)	23	Safety and Sanitation for Construction Workers	1
	24	Universal Accessibility	2
	25	Dedicated Facilities for Service Staff	2
	26	Positive Social Impact	3
10. Performance Metering and Monitoring (PMM)	27	Commissioning for Final Rating	7
	28	Smart Metering and Monitoring	0
	29	Operation and Maintenance Protocol	0
Total Points			**100**
11. Innovation	**30**	**Innovation**	**5**
Grand Total			**100 + 5**

GRIHA V3

Criterion 1	**Site Selection**
Criterion 2	Preserve and protect landscape during construction/compensatory depository forestation.
Criterion 3	Soil conservation (post construction)
Criterion 4	Design to include existing site features
Criterion 5	Reduce hard paving on site
Criterion 6	Enhance outdoor lighting system efficiency
Criterion 7	Plan utilities efficiently and optimize on-site circulation efficiency
Criterion 8	Provide minimum level of sanitation/safety facilities for construction workers
Criterion 9	Reduce air pollution during construction
Criterion 10	Reduce landscape water demand
Criterion 11	Reduce building water use
Criterion 12	Efficient water use during construction
Criterion 13	Optimize building design to reduce conventional energy demand
Criterion 14	Optimize energy performance of building within specified comfort limits
Criterion 15	Utilization of fly-ash or equivalent industrial/agricultural waste as recommended by BIS in building structures
Criterion 16	Reduce embodied energy of construction is reduced by adopting material efficient technologies and/or low-energy materials
Criterion 17	Use low-energy materials in Interiors
Criterion 18	Renewable energy utilization
Criterion 19	Renewable energy based hot water system
Criterion 20	Waste water treatment
Criterion 21	Water recycle and reuse (including rainwater)
Criterion 22	Reduction in waste during construction
Criterion 23	Efficient Waste segregation

Criterion 1	Site Selection
Criterion 24	Storage and disposal of wastes
Criterion 25	Resource recovery from waste
Criterion 26	Use of low-VOC paints/adhesives/sealants
Criterion 27	Minimize ozone depleting substances
Criterion 28	Ensure water quality
Criterion 29	Acceptable outdoor and indoor noise levels
Criterion 30	Tobacco and smoke control
Criterion 31	Provide at least the minimum level of accessibility for persons with disabilities
Criterion 32	Energy audit and validation
Criterion 33	Operation and Maintenance
Criterion 34	Innovation Points

Source: GRIHA Manual

Rating Process

- **Online registration**: The project team can initiate the registration process by filling the EOI Form available on the GRIHA website. The process of registration is completed after the successful payment of registration fees by the project team. Once the project is registered, the project team is provided with a username and password for submitting the documentation on the GRIHA online panel.
- **Orientation workshop**: The registration is followed by an orientation workshop conducted by GRIHA Council officials, which intends to provide detailed information of the rating along with an elaborate explanation to all the criteria, and post addressing project-specific queries of the teams.
- **Due diligence I**: The site visit shall be conducted by GRIHA Council officials to validate sustainable measures adopted during the construction phase. It will be scheduled post the project has reached its plinth level.
- **Due diligence II**: The second site visit shall be conducted by the GRIHA Council officials to validate internal finishes, electrical, plumbing, and mechanical

components installed during the construction phase. It is scheduled post completion of the building structure work.

- **Submission of documents**: As the project is nearing completion, the project proponent will upload the documents for all criteria on the online panel using the username and password provided at the time of registration.
- **Preliminary evaluation**: Preliminary evaluation is carried out by a team of professionals from GRIHA Council and external evaluators, who are experts in their respective fields recognized by GRIHA Council.
- **Final due diligence**: The final site visit shall be conducted by the GRIHA Council officials to verify the submitted documentation with on-site implementation. The visit is done once the project is complete and all equipment and systems are installed and commissioned.
- **Final evaluation**: The GRIHA Council officials along with external evaluators shall then evaluate the final round of submitted documentation and the final site visit report in response to the preliminary evaluation. The final rating is awarded based on the final evaluation and is valid up to 5 years.
- **Additional due diligence Green awareness drive**: The GRIHA Council conducts an additional due diligence visit post the final rating, for green awareness and education amongst project occupants. This visit aims to impart basic knowledge and understanding on green buildings and their way of working.
- **Rating renewal**: There are two ways in which the rating can be renewed and the project gets to enjoy the perks of being called a rated building. This can be done either by submitting an audit data report (over a span of three consecutive years) comprising energy, water, and waste (report to be prepared by BEE-certified energy auditor), or by enrolling the project for GRIHA EB rating to maintain its certification for the next cycle of 5 years.

Building typology

Healthcare Facility	Hospitality	Institutional	Offices	Residential	Retail	Transit Terminal
Hospitals	Hotels	Universities	Core & shell buildings	Multi-dwelling unit projects	Shopping complexes	Airports
Clinics	Guest houses	Schools	IT buildings	Hostels	Banquets/ wedding halls	Heliports
Medical colleges	Service apartments	Colleges	Owner-occupied buildings	Bungalows	Restaurants	Bus stands
Dispensaries		Libraries	Co-working spaces	Villas	Food courts	Railway stations
		Institutes	Industries	Mansions	Cafeterias	Metro stations
		Sports complexes			Multiplexes	

REFER THE GRIHA MANUAL FOR DETAILED CRITERIA POINTS IN LMS

GRIHA evaluation process

The buildings shall be evaluated and rated in a three-tier process. The process that would be followed has been explained previously. The GRIHA team shall first review the mandatory criteria and reject a project in the event of non-compliance with such criteria. The team shall then check the documentation submitted for the optional criteria. The checking is done by the GRIHA team to ensure that all templates and drawings are filled-in and to ensure that the documentation is complete in all respects (for the attempted criteria). All documents shall be checked and vetted through the appraisal process as outlined by GRIHA. The GRIHA team compiles the fi rst evaluation report and sends to the client. The client is then required to resubmit details as requested for by the Secretariat in the first evaluation report. The documentation shall now be sent to the GRIHA evaluators comprising of renowned sector experts from landscape architecture, lighting and HVAC design, renewable energy, water and waste management, and building materials. The evaluators shall vet the documentation and independently review the documents for the award of points. The evaluator shall award provisional points (if documentation is in order as per his/her evaluation) and also comment on specific criteria, if need be. The evaluation report shall be sent to the project proponent to review the same and, if desired, take steps to increase the score. The report shall elaborate on the results of the evaluation committee along with its comments. The report shall also list the criteria for which the documentation is incomplete/inadequate/inconsistent, detailing all the required information. The client shall then be given one month to resubmit the document with necessary modifications. The resubmitted report should comprise only of additional documents/information desired in the evaluation report, which shall again be put through the

vetting process as described above. The evaluation committee shall then award the final score, which shall be presented to an advisory committee comprising of eminent personalities and renowned professionals in the field for approval and award of rating. Provisional rating is awarded that is converted to final confirmed rated on meeting compliance as per Criterion 32. The rating shall be valid for a period of five years from the date of commissioning of the building. GRIHA reserves the right to undertake a random audit of any criteria for which points have been awarded.

CASE STUDIES OF GRIHA REGISTERED/RATED BUILDINGS

CASE STUDY 1: Common Wealth Games Village, New Delhi Project Management/Project In-charge Maj Gen (Retd)

A K Singh Design / Architect (In-house) Mr Nishant Sabharwal GRIHA Facilitator Mr Devendra Mahajan Ms Swati Mahashabdey Architect Sikka Associates – Mr Raman Sikka Landscape consultant Integral Designs: Mr Samir Mathur MEP consultant Spectral: Mr Sanjay Piplani Energy consultant TERI The Common Wealth Games 2010 is being scheduled to be held in the capital city of New Delhi.

The games village shall accommodate the players during the games and shall be occupied by individual private homeowners after the games. A 47.3 hectare (118 acre) picturesque site has been selected on the banks of holy river Yamuna for the purpose of construction of the games village.

The project site is within the immediate vicinity of heritage monuments and historical landmarks, combined with dense green natural covers on the sides.

2.1.1 Site and landscape the proposed development consists of 4000 bedrooms spread across 34 towers varying in heights (such as; 7 storeys to 9 storeys high). The proposed apartment blocks have been arranged on site in a way so as to create visual links with heritage sites in the vicinity. The topsoil of the entire excavated site has been collected and stored separately and special measures have been taken for soil stabilization, such as- stockpiling, mulching, and so on. Pervious paving has been provided extensively on the site. All the service lines and utility corridors on the site are well aggregated and ensure minimum disruption during future maintenance work.

2.1.2 Health and well-being the sanitation/safety facilities for the construction workers have been provided as per National Building Code 2005. These include provision of clean and hygienic accommodation, toilet facilities, purified drinking water, general store, a subsidized canteen, medical facilities, day care centre and onsite safety equipment, and so on. Significant measures have been taken to reduce air pollution during construction, such as – site roads are regularly sprayed with water; wheels of all vehicles are washed, and so on

2.1.3 Water efficient landscaping is being practiced to minimize post construction water usage. This is being done by providing native species, efficient irrigation systems and by limiting lawn areas. The building water consumption also has been reduced by use of high efficiency low-flow fixtures. The construction water management on site is very efficient in terms of reuse of waste water and less utilization of potable water in construction.

Figure 1 Site plan

Figure 2 Toilet facilities for workers

Figure 3 Safety wears during construction

Figure 4 Safety nets at construction site

Figure 5 Worker's accommodation facilities

2.1.4 Building design and energy The building design has also included the existing site features, such as, the visual linkages with historical monuments, solar geometry, and so on. Due to high density planning requirements, the design did not permit optimum orientation for all apartment blocks. As a result, the apartment blocks have equal exposure towards all cardinal directions. However, the critical facades are shaded and have high performance glazing to negate impact of direct incident radiation. The buildings are fully compliant with the Energy Conservation Building Code 2007. Several energy effi ciency measures such as roof insulation, high performance glazing, energy effi cient lighting and variable refrigerant volume (VRV)

based air conditioning system have been provided to reduce the energy consumption of the apartments significantly.

Figure 6 Snapshot of CommonWeatlh Games Village

2.1.5 Renewable energy Solar photovoltaic system has been proposed to meet 10% of total energy requirements for internal lighting. 31% of outdoor lighting has been provided through solar energy. Solar hot water systems have been provided to meet part of water heating needs.

2.1.6 Other features Waste water recycling and solid waste management for the entire campus has been planned by the Delhi Jal Board at a macro level for the village as well as adjoining properties

CASE STUDY 2 Centre for Environmental Science and Engineering building (CESE) at IIT, Kanpur

Architect	Kanvinde Rai and Chowdhury Architects and Planners
Energy consultant	TERI (The Energy and Resources Institute)
HVAC consultant	Gupta Consultants and Associates
Electrical consultant	Kanwar Krishen Associates Pvt. Ltd
Landscape architect	Mr Yogesh Kapoor

Centre for Environmental Science and Engineering Building at IIT, Kanpur has been taken as an example to illustrate how the building attempted various GRIHA criteria to make it into a green building.

Sustainable site planning

In order to minimize impact of site development on the environment and surroundings, several best practice guidelines were adopted like demarcation of site for construction, installation dust screen around the disturbed area to prevent air pollution and spillage to undisturbed site area. Top soil was excavated, stored and preserved outside the disturbed construction site. Erosion control systems were adopted and several trees on site were protected. To increase the perviousness of site and to reduce heat island eff ect caused due to hard paving around

the building, total paving around the building was restricted to 17%, and more than 50% of the paving is either pervious or shaded by trees. Irrigation water demand has been reduced by more than 50% in comparison to GRIHA benchmark. Adequate health and safety measures related to construction were taken.

Figure 9 Tree preservation

Figure 10 Sedimentation tank

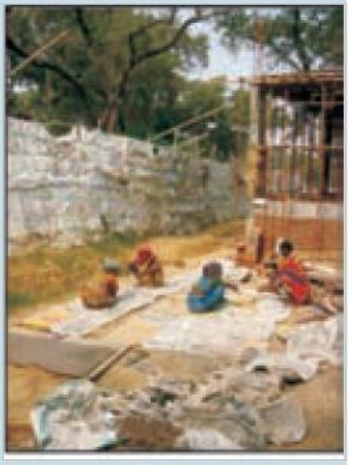


Figure 11 Air pollution control

Water conservation

There are two ways of conserving water during post construction and after the building is occupied.

One is landscape water demand and second is building water demand. In this building, reduction in landscape water demand by more than 50% was achieved by use of minimum grass/lawn area, maximum green area under native vegetation and native trees. Low flow plumbing fixtures are used in the building resulting in reduced water consumption from GRIHA's benchmark by 62%.Waste water is treated and reused for irrigation. Rain water harvesting system has been designed.

Conservation and efficient utilization of resource: energy

Maximum points weightage in GRIHA is given for energy conservation. The criteria and commitment for energy conservation could be divided into three parts.

a. Energy: end use

b. Energy: embodied and construction

c. Energy: Renewable energy utilization

Energy: end use

The objective is to reduce annual energy consumption of the building. This has been achieved in CESE building at IIT, Kanpur by adopting following strategies.

1. Architectural design optimized as per the climate of Kanpur, sun path analysis, predominant wind direction, and existing vegetation.

2. Optimized building envelope to comply with the Energy Conservation Building Code, to reduce cooling load in the air conditioned spaces and to achieve thermal comfort in the non-air conditioned areas.

3. Efficient window design by selecting efficient glazing, external shading to reduce solar heat gain but at the same time achieve glare free natural daylight inside all the laboratory spaces of the building.

4. Roof shaded by bamboo trellis and green cover to reduce external solar heat gains from the roof.

5. Common circulation areas are day lit and naturally ventilated through integration of skylights and ventilators.

6. Selection of water cooled chiller that complies with the efficiency recommended by the Energy Conservation Building Code.

7. Variable Frequency Drive installed in the Air Handling Units (AHUs).

8. Low energy strategies such as replacement of water cooler by water body to cool the condenser water loop, integration of thermal energy storage and earth air tunnels enabled reduction in chiller capacity.

9. Integration of energy efficient lighting design that complies to the recommendations of ECBC.

10. Integration of daylight with artificial lighting.

11. Optimized architectural design and integration of energy efficient fixtures has resulted in the reduction in annual energy consumption by 41% from GRIHA's benchmark.

Energy: embodied and construction

GRIHA encourages replacement of high energy intensive materials with low energy intensive materials, to utilize regionally available materials, materials which use low energy in their manufacturing process. Following are the measures incorporated at CESE building, IIT, Kanpur:

1. Portland Pozzolona Cement (PPC) with fl y-ash content is used in plaster and masonry mortar.

2. Wood for doors is procured from commercially managed forests. Modular furniture made from particle board is used for interiors.

Energy: renewable energy utilization

Following are the measures incorporated at CESE building, IIT, Kanpur to integrate renewable sources of energy with the building:

1. Renewable energy from photovoltaic panels provide annual energy requirements equivalent to 30% of internal lighting connected load.

2. Hot water demand is met by solar hot water system.

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SAR5622_GREEN BUILDING RATING SYSTEMS

FACULTY: AR.SHEETAL AMRAOTKAR

UNIT II
STUDY OF IGBC RATING

IGBC

An Overview of the Indian Green Building Council Rating System

Green building refers to both a **structure** and the using of **processes** that are **environmentally responsible** and **resource-efficient** throughout a **building's life-cycle:** from **siting to design, construction, operation, maintenance, renovation and demolition.**

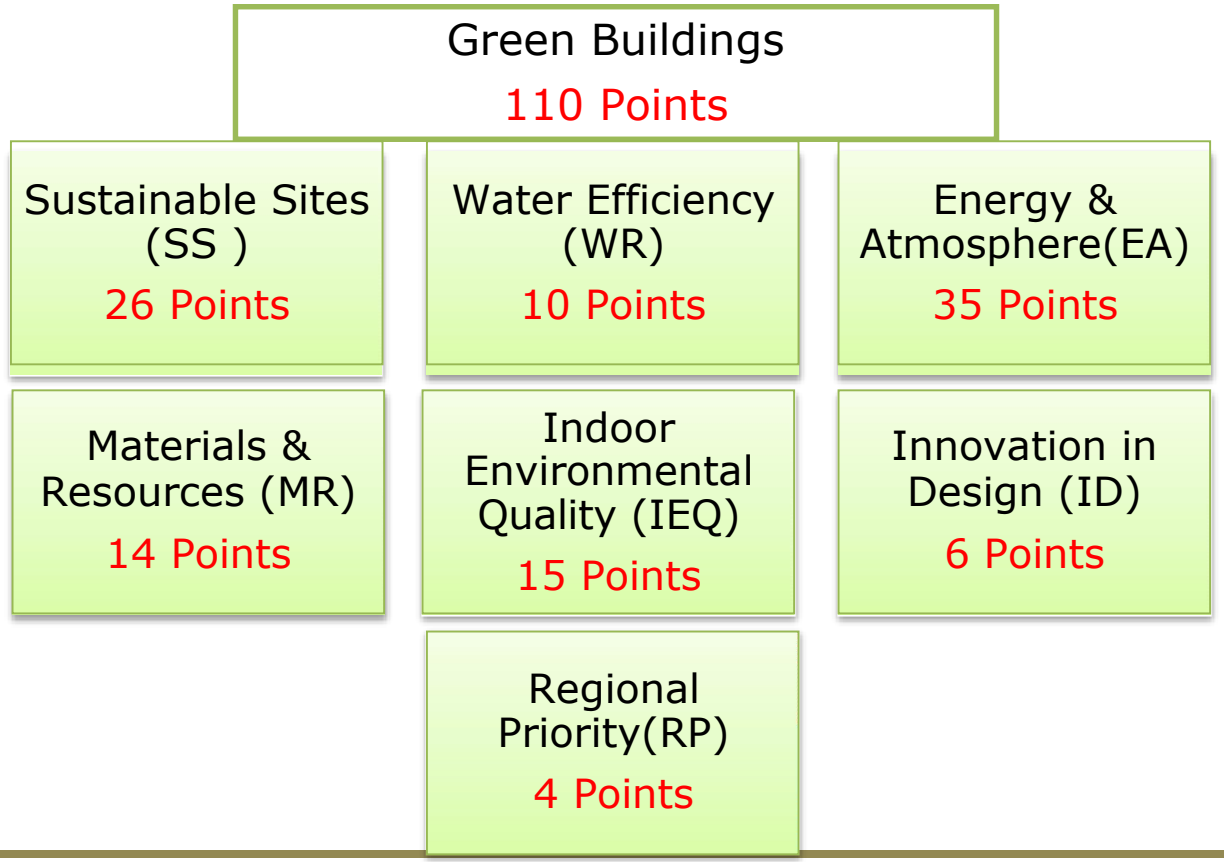
Indian Green Building Council (IGBC) does the Green Building Certification in India.

GREEN BUILDINGS

- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy & Atmosphere (EA)
- Materials & Resources (MR)
- Indoor Environmental Quality (IEQ)
- Innovation in Design Process(ID)
- Regional Priority(RP)

Green Buildings – Rating System

Rating	New Construction
Certified	40-49
Silver	50-59
Gold	60-79
Platinum	80 & Above



Source:
IGBC – Indian Green Building Council

SUSTAINABLE SITES

‘Sustainable Sites’ is about adopting Sustainable principles at the Site Level .Emphasizing on the site selection ,Connectivity to the Site & from the site.

SUSTAINABLE SITES

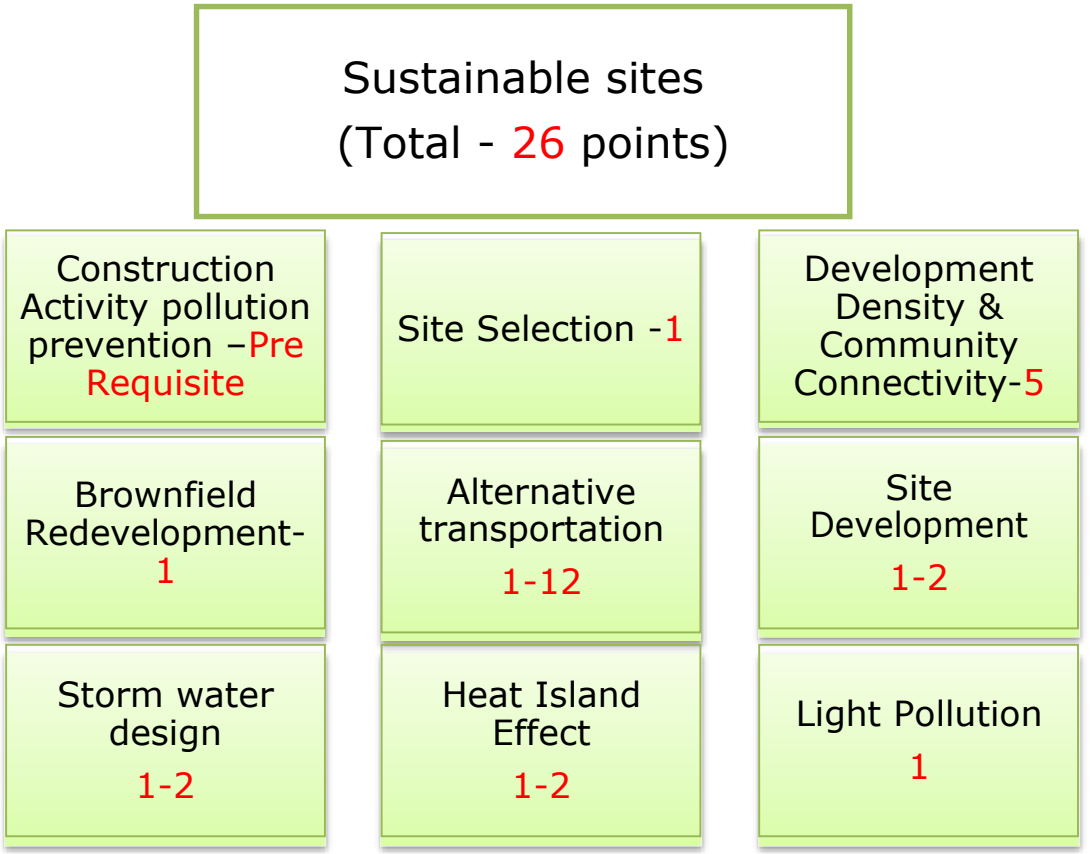
- Construction Activity pollution prevention –Pre requisite
- Site Selection
- Development density & Community Connectivity
- Brownfield redevelopment
- Alternative transportation
- Site development
- Storm water design
- Heat island Effect
- Light Pollution

Source:
IGBC – Indian Green Building Council

Sustainable Sites

- The design process evolves from the site .
- Sustainability & adapting sustainable principles should be started right from the site

IGBC allotted points



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Source:
IGBC – Indian Green Building Council

PREREQUISITE

- Controlling Soil erosion - Landscaping temporary & permanent to prevent soil erosion .
- Sedimentation control
- Control airborne dust generation

--- Exposed soils on a construction site

Erosion Prevention Measures

Dust control measures can be used to prevent dust from being transported by wind (Source: Dust Pro, Inc., no date)

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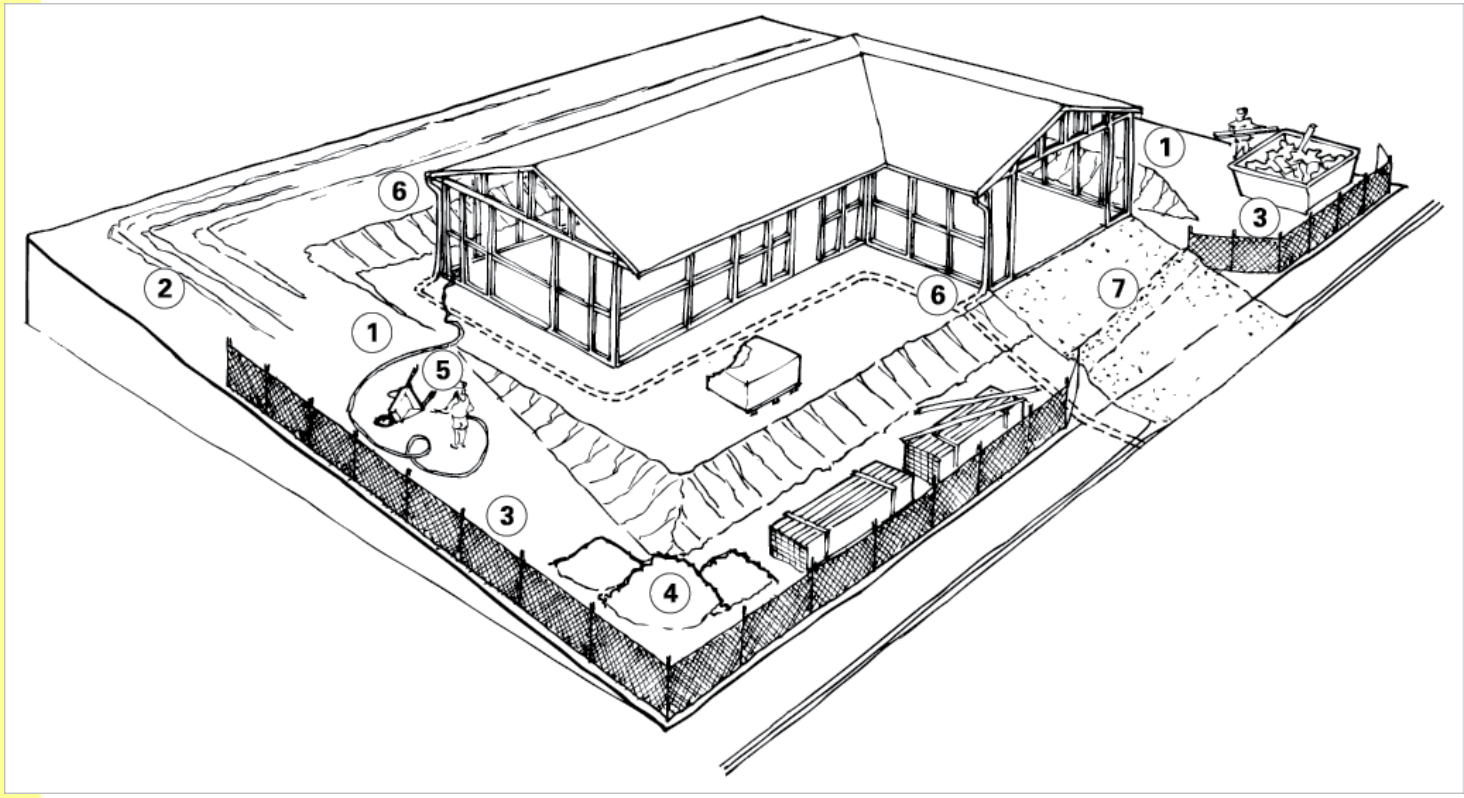
Source:
IGBC – Indian Green Building Council

Preventing Soil Erosion & Sedimentation Control Measures



1 minimize disturbance, 2 diversion devices, 3 sediment barriers, 4 secure stockpiles, 5 other containments, 6 early stormwater connection, 7 controlled access point

Strategies to control Erosion and Sedimentation:

- Temporary or permanent Seeding to stabilize the soil
- Mulching using hay, grass or gravel to hold the soil
- Earth dike to divert runoff into sediment traps
- Straw bales
- Silt fence
- Erosion control blankets

Silt fence

Erosion control blankets

Matching

Note that Schools and Healthcare projects are required to conduct a phase 1 Environmental Site Assessment

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Source:
IGBC – Indian Green Building Council

SITE SELECTION

- Inappropriate sites must not be selected, which includes farm land , habitat to endangered species ,proximity to wet lands , site prone to floods.

Farm land

SITE SELECTION requirements

The first credit is part of the integrative process and logically deals with determining existing site conditions.

This credit requires that the natural conditions be evaluated and include:

1. **Topography** - Contour mapping and slope stability risks.
2. **Hydrology** - Flood hazard areas, delineated wetlands and other bodies of water
3. **Climate** - Solar exposure, heat island effect potential, sun angles, winds, precipitation and temperature
4. **Vegetation** - Plant types, tree mapping, threatened or endangered species, and unique habitat
5. **Soils** - prime farmland, healthy soils, previous development, disturbed soils
6. **Human use** - Views, transportation infrastructure, adjacent properties and materials effects
7. **Human health effects** Proximity of vulnerable populations, and proximity to sources of air pollution

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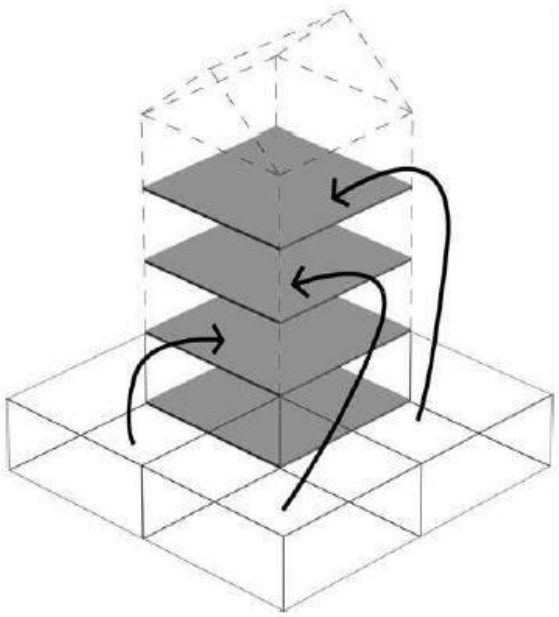
Source:
IGBC – Indian Green Building Council

DEVELOPMENT DENSITY

- Development density & community connectivity
- Development density - **density of 60,000sq ft/acre** both within & outside the site **(FAR/FSI- 1.38) within a certain radius** (3 √(site area in acres X 43560)
- Empty site area within the radius has to be considered
- Public places, roads within the radius need not be considered in calculating the density.



Concept of FAR

SUSTAINABLE SITES

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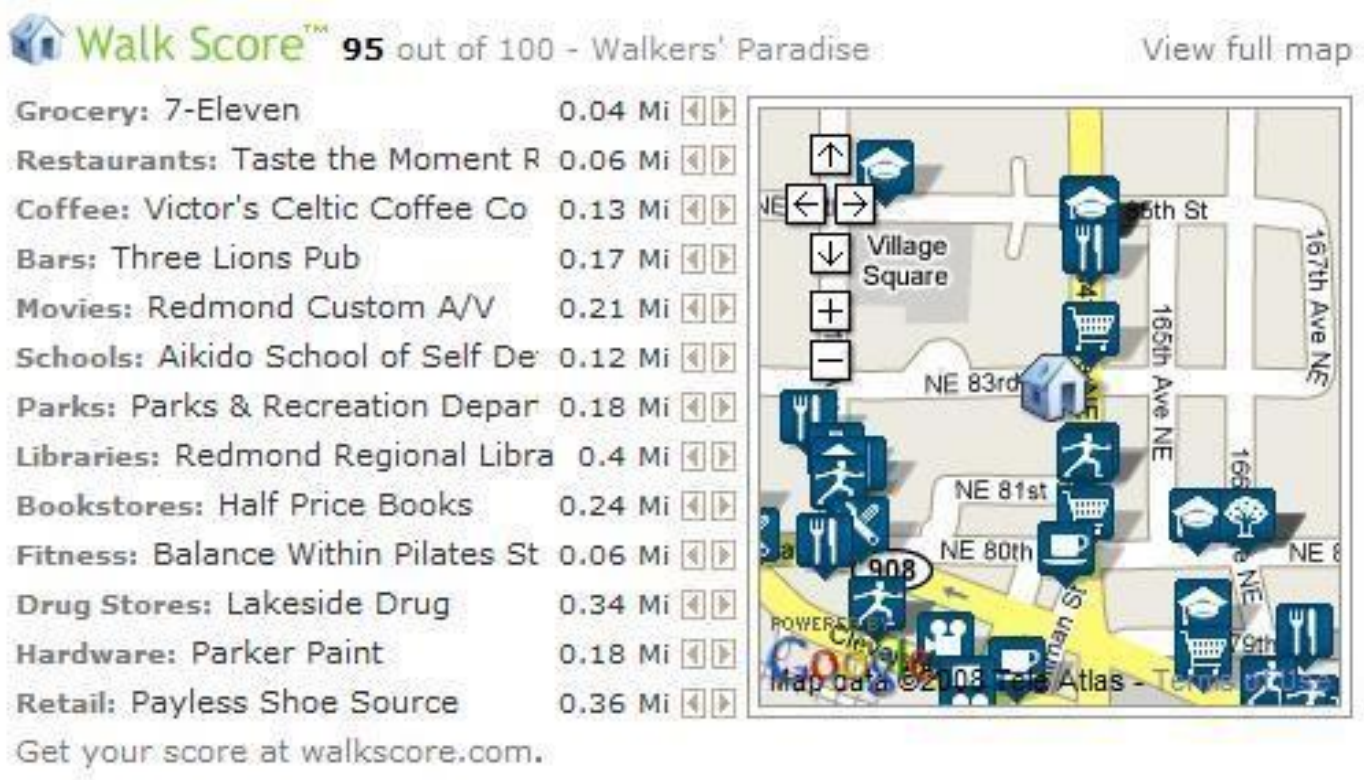
Source:
IGBC – Indian Green Building Council

COMMUNITY CONNECTIVITY

- **10 basic amenities** with in **0.5 miles radius** with **pedestrian access**



Proximity to Basic amenities from the Site

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Source:
IGBC – Indian Green Building Council

BROWNFIELD REDEVELOPMENT

Rehabilitation of damaged sites before construction

Redevelopment of a Brownfield

Domestic waste dumped in a vacant Land

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Source:
IGBC – Indian Green Building Council

ALTERNATIVE TRANSPORTATION

Main motive to reduce pollution

- Building within **400 m (½ mile) walk** of **Railway transport station** & **1 or more bus stops** for **2 or more bus lines.**
- **Rikshaw /cab /van** facility within a **400m walk**.

Bicycle storage& changing room facility

- Secure **Bicycle racks** /storage within or **200m of building's entrance** for **5% or more** of all **building users (at peak periods)**
- **Shower & changing room** facilities with in the building , or 200m of building's entrance ,for **0.5 %** of full time equivalent **(FTE) occupants.**

Building footprint is the area defined by
the perimeter of the building plan. Non-building facilities such as pavements and landscaping are not included.

Development footprint is the area of the site including pavements, parking, landscaping, roads and other facilities as well as the building. It is essentially all alterations done to the site.

Property boundary is the total area within the legal boundaries of the site.

Full Time Equivalent (FTE)
Many prerequisites and credits require an estimated occupancy count and LEED accomplishes this through FTE calculations. One FTE is equal to a 40-hour work week. Thus if the sum of all 'people-hours' spent in the building over a week is 4000, we divide this be 40 to equal an estimated 100 FTEs in this building.

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- Light Pollution

Source:
IGBC – Indian Green Building Council

ALTERNATIVE TRANSPORTATION

- Usage of **Low emitting & fuel efficient vehicles**
- **Preferred parking** for low emitting & fuel efficient vehicles
- Electric charging/liquid or gaseous fuelling facilities should be installed.
- Provide **AFV**(Alternate Fuel Vehicle) for **3% of FTE** full time equivalent vehicle occupants
- Provide Low emitting or fuel efficient vehicle sharing program.

Parking facility

Provide parking capacity to meet ,but not exceed the standards set by the regulation.

Preferred parking for **carpools/vanpools/bike pools**

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- Light Pollution

Source:
IGBC – Indian Green Building Council

SITE DEVELOPMENT

Conserve existing Natural areas & restore damaged areas in the site

Protect or Restore Habitat

Green Field Sites

Limit all site disturbance to the following parameters

- **40 feet** beyond the **building perimeter**
- **10 feet** beyond **surface walkways, patios, surface parking**
- **15 feet beyond primary roadway curbs** and **main utility branch trenches**
- **25 feet** beyond **constructed areas with permeable surfaces.**

Previously developed or graded sites

- Protect or **restore 50% of site**(excluding building foot print)
- **20% of the total site area(**including building foot print)

Maximize open space

- Conserve existing natural areas and restore damaged areas to provide habitat & promote bio diversity
- **Open space** must **exceed Local zoning requirements by 25 %**
- **Vegetated open space** should be equal to **20 % of the project site area.**

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Source:
IGBC – Indian Green Building Council

STORM WATER DESIGN

Storm Water Design Intent

To limit disruption of natural hydrology Onsite infiltration, eliminating pollution from storm water run off and contaminants.

Quality control

Imperiousness = Surface area X Run-off co efficient

The intent is to limit disruption & pollution of natural water flows by managing storm water run off.

Sites with existing Imperviousness ≤50 %

•Post development peak discharge should not exceed pre development discharge.

Sites with existing Imperviousness >50 %

•Should achieve **25 % decrease** in volume of storm water run off.

Runoff coefficients for Typical Surface Types

S.No	Surface Type	Runoff Coefficient
1	Cemented / tiled Roof	0.95
2	Roof Garden	0.30
3	Pavement, Asphalt	0.95
4	Pavement , Pervious	0.60
5	Vegetation, average (1-3 % slope)	0.20
6	Pavement, concrete	0.95

SUSTAINABLE SITES

- Construction Activity pollution prevention –Pre requisite
- Site Selection
- Development density & Community Connectivity
- Brownfield redevelopment
- Alternative transportation
- Site development
- Storm water design
- Heat island Effect
- Light Pollution

Source:
IGBC – Indian Green Building Council

HEAT ISLAND EFFECT

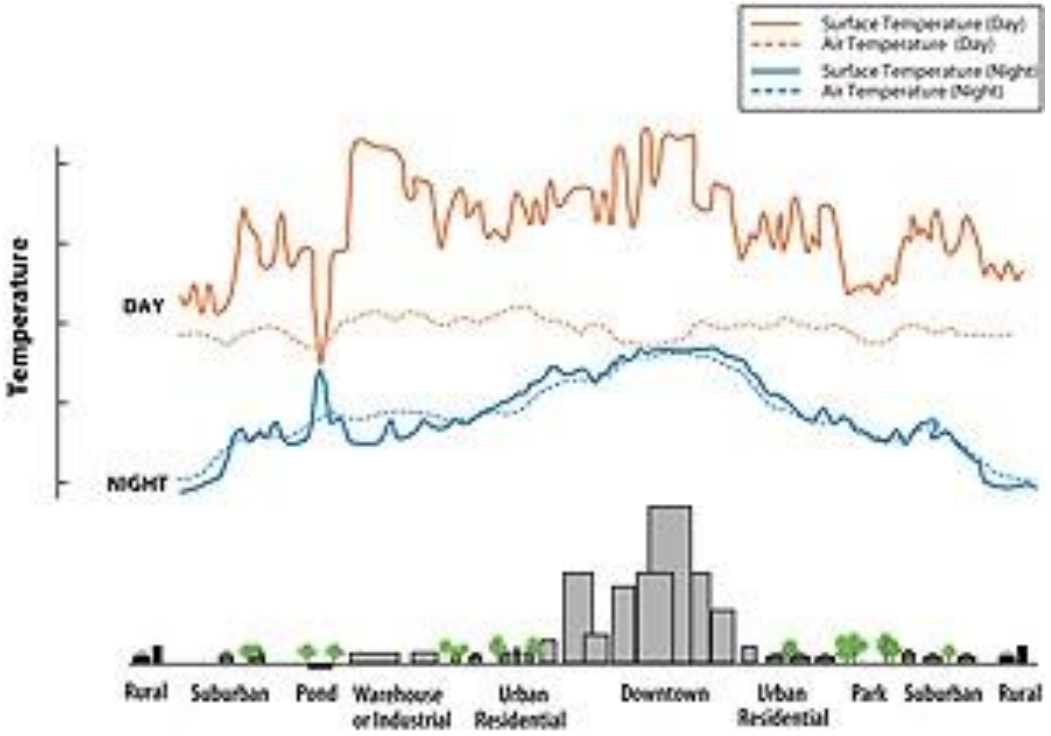
To minimize impacts on micro climate

Non Roof

- **Shade from the existing trees** or within 5 years of landscape installation.
- **Shade from** solar panels

Shade from **roof surfaces** having **SRI≥29**

- Use a open grid pavement system ≥50 % pervious



Strategies for reducing heat island effect:

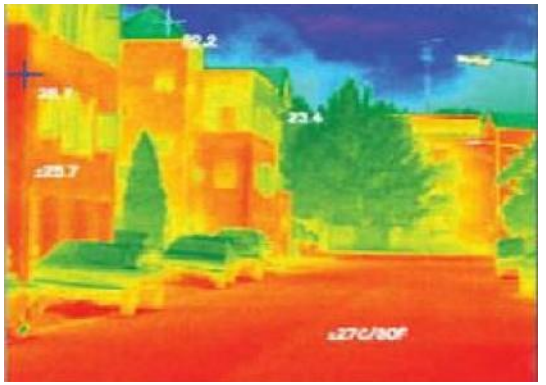
- Non roof

Hardscapes.' Decrease areas of impervious hardscape and use higher solar reflectance materials. Use cool pavements with three year aged SR of .28 (or Initial SR of 0.33) or higher, or open grid systems which are 50% or more pervious.

Shading. provide shading for 50% of the hardscape area by taking advantage of existing tree canopies OR new trees anticipating their size and shade within 10 years of installation

OR add shading structures covered by solar panels OR architectural features with SR .28 or higher.

Parking. locate 75%+ of parking spaces under roofs or shades with Initial SRI > 39 - or - 3 year aged SRI > 32, or a vegetative root or energy generation systems.



SUSTAINABLE SITES

- Construction Activity pollution prevention –Pre requisite
- Site Selection
- Development density & Community Connectivity
- Brownfield redevelopment
- Alternative transportation
- Site development
- Storm water design
- Heat island Effect
- Light Pollution

Source:
IGBC – Indian Green Building Council

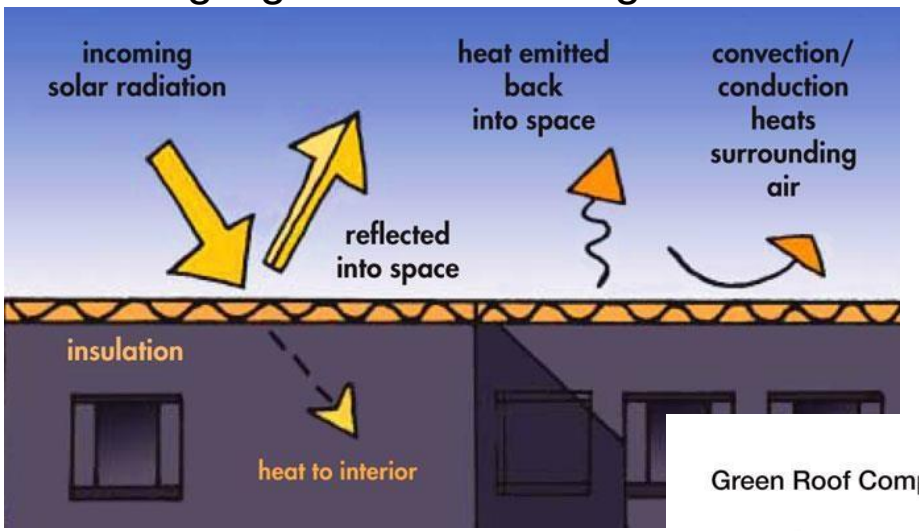
HEAT ISLAND EFFECT

Non Roof

- Minimum of 50% of the parking under cover

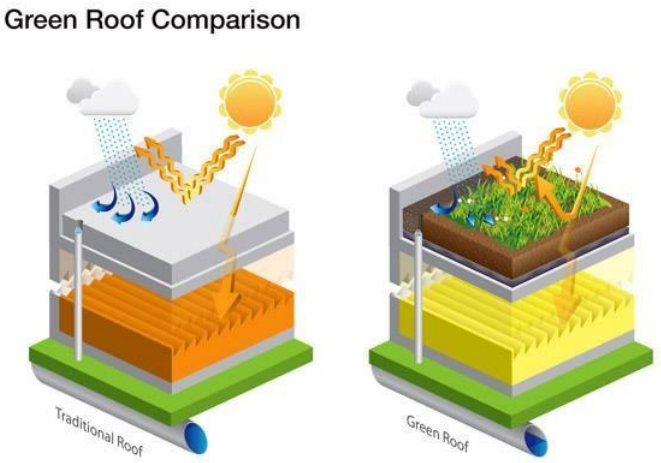
Roof

- Vegetated roof ≥50% of roof area,
- Installing high albedo and vegetated roof in combination.



75 % or more of the roof surface With the following SRI

Roof Type	Slope	SRI
Low sloped roof	≤2:12(15%)	78
Steep sloped roof	>2:12(15%)	29



SUSTAINABLE SITES

- Construction Activity pollution prevention –Pre requisite
- Site Selection
- Development density & Community Connectivity
- Brownfield redevelopment
- Alternative transportation
- Site development
- Storm water design
- Heat island Effect
- Light Pollution

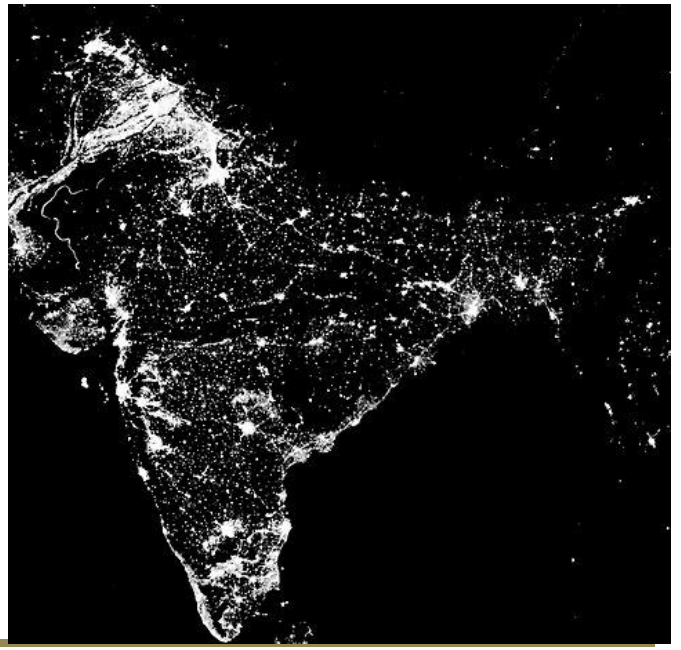
Source:
IGBC – Indian Green Building Council

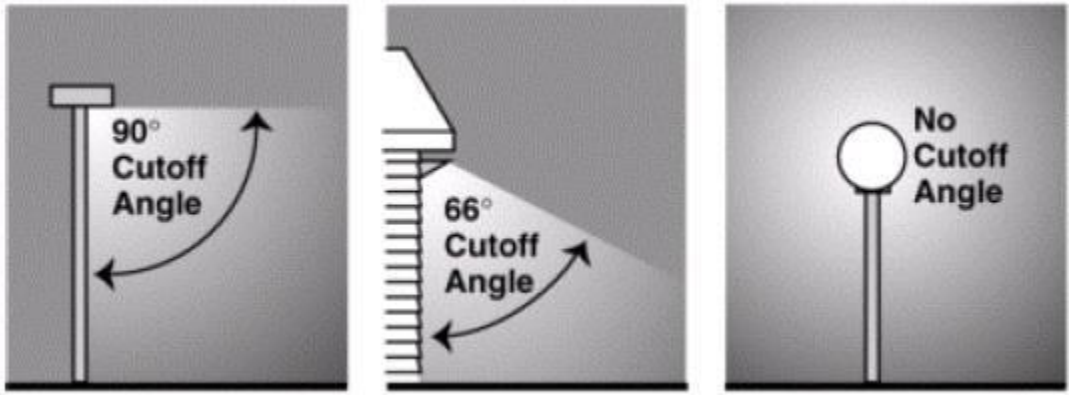
LIGHT POLLUTION

Light pollution is brightening of the night sky caused by street lights and other man-made sources, which has a disruptive effect on natural cycles and inhibits the observation of stars and planets.

Auto cut off at least **50 % non - emergency lights** between **11 pm & 5 am**
All openings in the envelope (translucent or transparent) **should be shielded** (manual or automatic between 11pm & 5 am)
Parking areas –0.15w/sft
Walkways – 1w/linear foot(rft)(<10 feet width)

Walkways – 2w/sft(>10 feetwidth)
Façade & landscape
.2 w/sft or 5w/linear foot.
Light Pollution.mp4





Lighting Zones created by the Model Lighting Ordinance:

Determine the project's lighting zone according to the requirements of IESNA RP-33 as follows:

1. LZ0 – No Ambient Lighting
2. LZ1 - Dark (park and rural settings)
3. LZ2 - Low (residential areas and neighborhood business districts)
4. LZ3 - Medium (commercial/industrial and high density residential)
5. LZ4 - High (major city centers and entertainment districts

WATER EFFECIENCY

Water Efficiency aims at Efficient Use of water
Reduce , Reuse & Replenish water resource .

WATER EFFECIENCY

- Water use reduction ,20% – Pre Requisite
- Rain water harvesting – Pre Requisite
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

Water Efficiency

Approach towards water efficiency has to be

- Reduce
- Recycle/reuse
- Recharge

IGBC allotted points

WATER EFFECIENCY(10)

Water Use Reduction,20% (Pre Requisite)	Rain water Harvesting (Pre Requisite)
Water Efficient landscaping (2-4)	Innovative waste water Treatment (2)

Water use reduction , 30-40% (2-4)

Source:
IGBC – Indian Green Building Council

Full Time Equivalents (FTEs)- the FTE of a project must be consistent across all credits. FTE is a regular building occupant who spends 40 hours per week in the project building. Parl time or overtime occupants have FTE values based on their hours inside the building per week divided by 40. FTEs are based on an 8 hour occupancy period per day. An 8 hour (5 days a week) full time occupant has an FTE value of 1.0. FTEs are needed to calculate the baseline, and design case water usage of a building

FTE identifies the total number of building occupants according to their occupany types:

- Full time staP
- Part time stat
- Peak Transients (students, volunteers, visitors, customers, etc.)
- Residents

Potable water- water that meets or exceeds EPAs drinking water quality standards, and is approved for human consumption by state or local authorities having jurisdiction.

GLOSSARY

Graywater (or greywater)- domestic wastewater from bathroom and laundry sinks, tubs, showers and washers. The Uniform Plumbing Code (UPC) defines gray water as untreated household wastewater that has not come in contact with toilet waste;

International Plumbing Code (IPC) defines graywater as wastewater discharged from lavatories, bathtubs, showers, clothes washers and laundry sinks. Most states will not allow
kitchen sinks or dishwashers to be included with graywater.

Blackwater- wastewater from toilets and urinals. Most jurisdictions consider water from kitchen sinks and
dishwashers to be blackwater and it cannot be reused

Process water- water used for industrial processes and building systems such as boilers, cooling towers and
chillers

Stormwater runoff- runoff water resulting from precipitation that flows over surfaces, and conventionally into
storm sewers or waterways

WaterSense

WaterSense- is an EPA sponsored program that promotes and certifies water-ePicient products, programs, and practices. WaterSense helps consumers identify water eñicient products, and programs that meet WaterSense water efficiency and performance criteria. Watersense fixtures must use some amount of water (IE. Waterless urinals do not comply)

Gallons per flush (gpg- the flow rate measurement unit for flush fixtures such as water closets and urinals.

Gallons per minute (gpm)- the flow rate measurement unit for flow fixtures such as faucets,showerheads, aerators, sprinkler heads

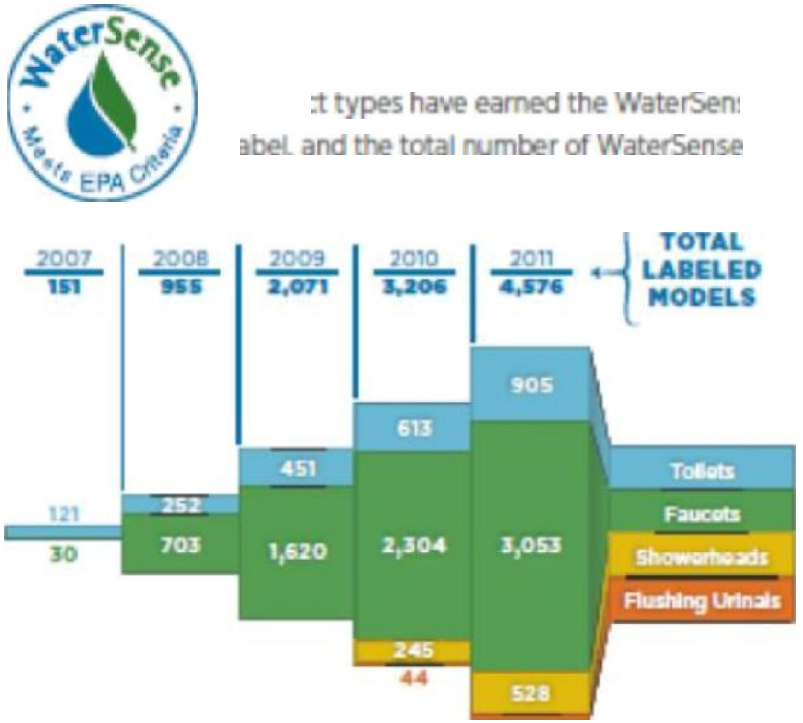


Figure 30

Waterless urinals- works completely without water or flush valves by passing urine through a liquid seal. There are two varieties of waterless urinal: cartridge based and non caFridge based units.

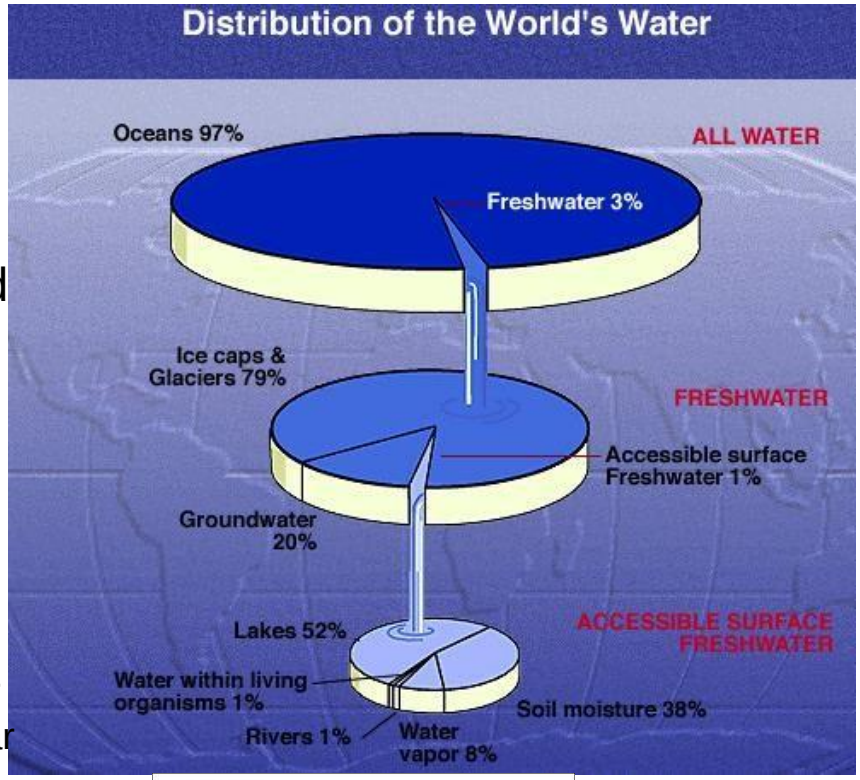
Dual flush- water closets use a full flush for solid waste and a half flush for liquid waste, Dual flush toilets can save around 2/3rd of water used for flushes.

WATER EFFECIENCY

- Water use reduction,20% – Pre Requisite
- Rain water harvesting – Pre Requisite
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

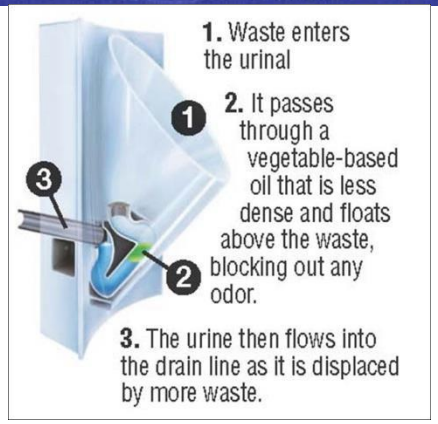
Water Efficiency

Water use reduction Intent–To Increase water efficiency within buildings to reduce the burden on municipal water supply and waste water systems By employing strategies to Reduce the water use by 20% than the water use baseline.



*At design water pressure: 4 bar
**At design water pressure: 5 bar

Fixture Type	Baseline Flow rates
Water Closets(LPF)	6.0
Urinals (LPF)	4.0
Lavatory facuets(LPM)*	2.0
Shower heads(LPM)**	9.5



Water less urinals

Bio Blocks for Urinals

Source:
IGBC – Indian Green Building Council

WATER EFFECIENCY

- Water use reduction,20% – Pre Requisite
- Rain water harvesting – Pre requisite
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

Rain water Harvesting

To increase the ground water table or to reduce the usage of water through effective and appropriate rainwater management.

Provide rainwater harvesting or **storage system** to capture **atleast 50% of the runoff volumes from the roof and non roof surfaces.** The storage volumes designed should **cater** to atleast **2-3 days of rainfall.**

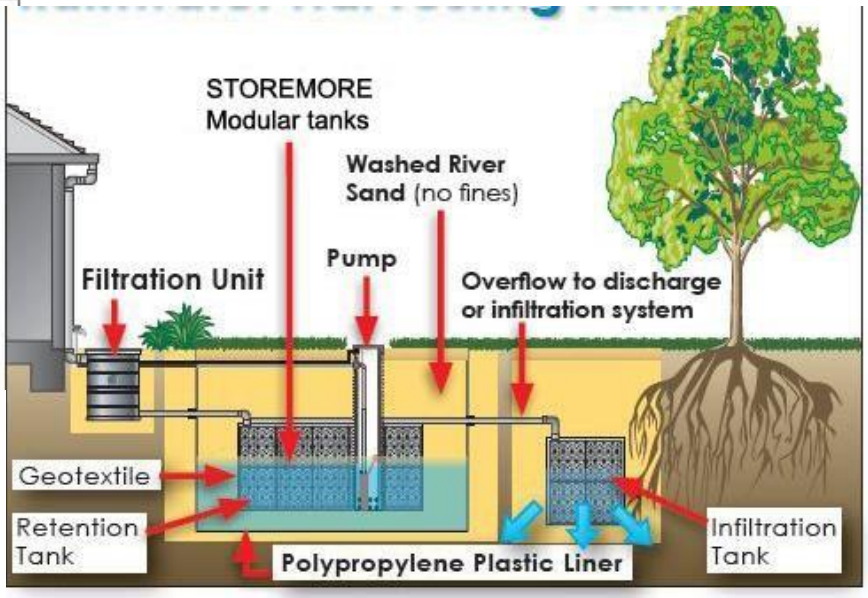
Runoff coefficients for Typical Surface Types

S.No	Surface Type	Runoff Coefficient
1	Cemented / tiled Roof	0.95
2	Roof Garden	0.30
3	Pavement, Asphalt	0.95
4	Pavement , Pervious	0.60
5	Vegetation, average (1-3 % slope)	0.20
6	Pavement, concrete	0.95

Points for Rainwater Harvesting

Rainwater Harvesting System to capture / recharge	Points
≥ 75% runoff from roof area	3
≥ 95% runoff from roof area	6

Rain water Harvesting



Source:
IGBC – Indian Green Building Council

WATER EFFECIENCY

- Water use reduction,20%– Pre Requisite
- Rain water harvesting – Pre requisite
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

Water Efficient Landscaping

To eliminate or limit the use of potable water

- **Reduce by 50% potable water consumption for irrigation by selecting the right species**
- **Efficient irrigation**
- Use of **captured rainwater, recycled waste water.**
- **Xeriscaping**

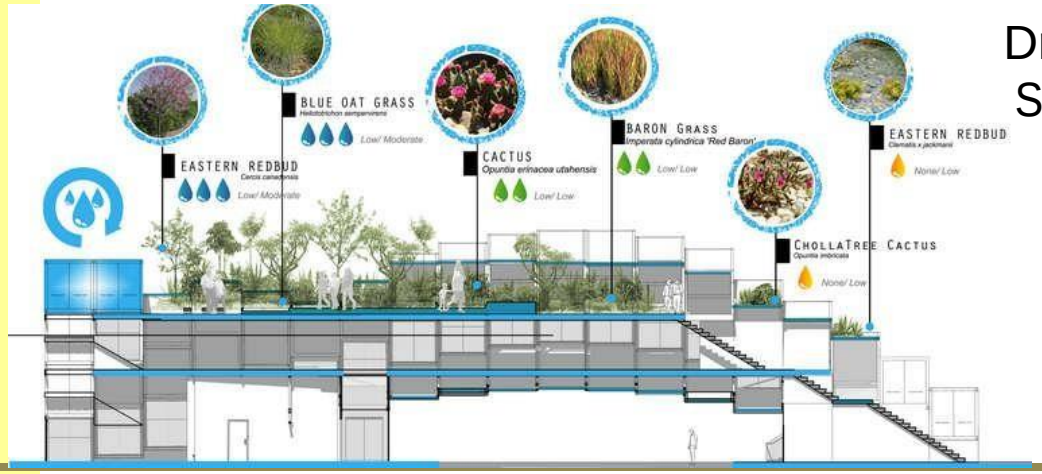
  Include landscaping which do not require permanent irrigation system.
- Limit Turf Area, 20%, 30%, 40%

Points for the use of drought tolerant species

Area of drought tolerant species as a percentage of total landscaped	Points
30 %	1
40 %	2

Points for Limited Use of Turf

Turf area as a percentage of total landscaped area	Points
≤ 20 %	3
≤ 30 %	2
≤ 40 %	1



Drought Tolerant Species, 30%, 40%

Xeriscaping

Source:
IGBC – Indian Green Building Council

WATER EFFECIENCY

- Water use reduction,20% – Pre Requisite
- Rain water harvesting – Pre requisite
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

Treatment of non-process water	Points
≥ 75 %	2
≥ 95 %	4

Source:
IGBC – Indian Green Building Council

Innovative Waste water treatment and reuse

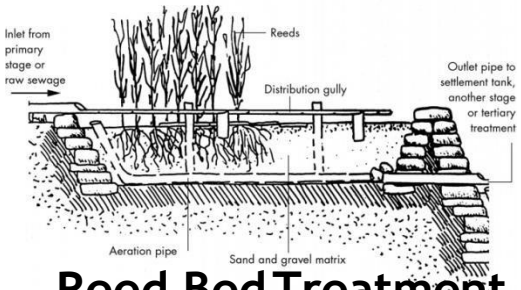
Intent - To reduce waste water generation & potable water demand while increasing the local aquifer recharge.

- **Treat 100% waste water** on site & the Treated water must be infiltrated or used on site (OR)

Use **treated waste water** or **captured rain water**

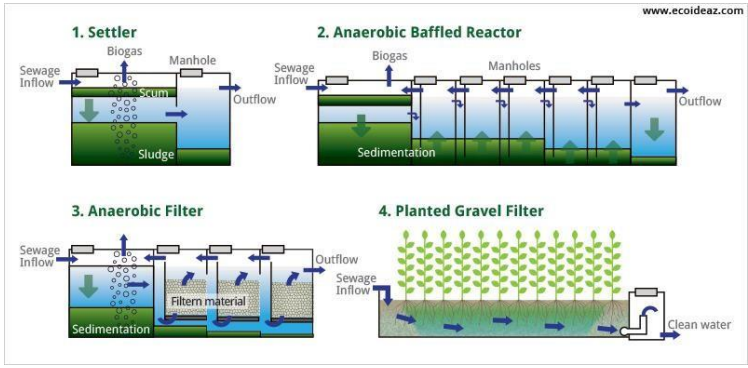
- Atleast 50 % of air conditioning make up
- Atleast 50 % of building sewage conveyance.

Use of **Dual plumbing line**.



Reed Bed Treatment

Somerton reed bed.mp4



Root Zone treatment

Root Zone Treatment.AVI.mp4

Reed bed treatment

Sewage/ effluent passes horizontally through a bed of soil or gravel media.

Common reeds **(phragmites australis)** grown on the bed.

Root Zone treatment

Common plants used canna,cyperus,colosia ,plumeria,pisonia,etc.

WATER EFFECIENCY

- Water use reduction,20% – Pre Requisite
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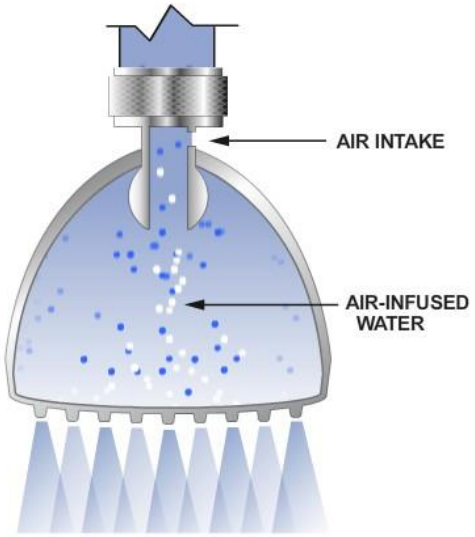
- Water Efficient Landscaping
- Innovative Waste Water treatment and reuse
- Water Use Reduction,30 %-40%

Source:
IGBC – Indian Green Building Council

Water Use Reduction

Water use reduction
Reduce water consumption with respect to the base line
Flow requirements to **be atleast 30% better** than the **baseline.**
Ultra low flow fixtures
Use of **aerators**
Variant pressure bar

Water Reduction	Points
30%	2
35%	3
40%	4



Aerators

ENERGY & ATMOSPHERE

Reducing the Energy Demand by adapting efficient design principles & effective use of renewable source of power .

Energy generating electricity
from fossil fuel such as natural gas, oil and coal negatively affects the environment throughout its life cycle. The damage begins with extraction and transportation, followed by refining and distribution and concluding with consumption (burning).

The core of the Energy and Atmosphere category addresses the following topics:

- Energy demand
- Energy efficiency
- Renewable energy
- Ongoing energy performance

Commissioning

Commissioning is a process used to verify that the project's energy related systems were installed, calibrated and are performing according to the owner's project requirements, basis of design and construction documents. Commissioning ensures that the building owner gets the performance out of the efficient systems.

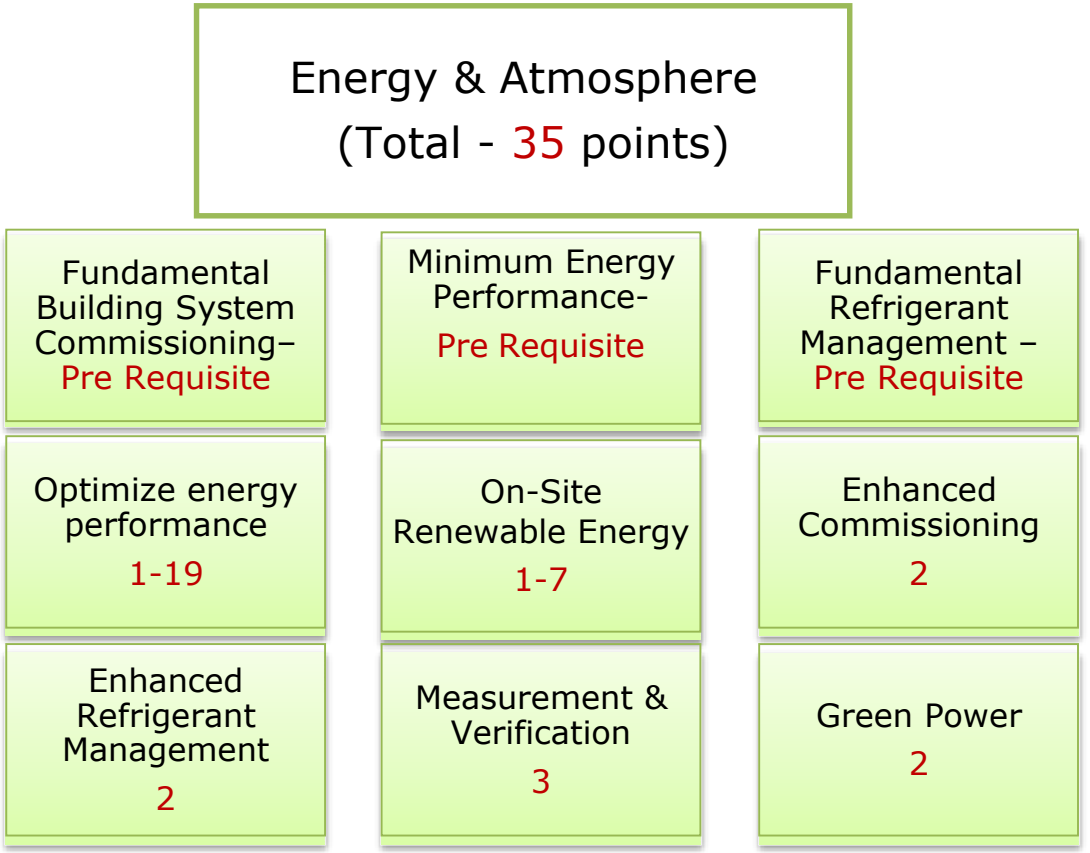
ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
- Minimum Energy Performance – Pre Requisite
- Fundamental Refrigerant Management- Pre Requisite.
- Optimize Energy Performance
- On-Site Renewable Energy
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- Green Power.

Source:
IGBC – Indian Green Building Council

Energy & Atmosphere

IGBC allotted points



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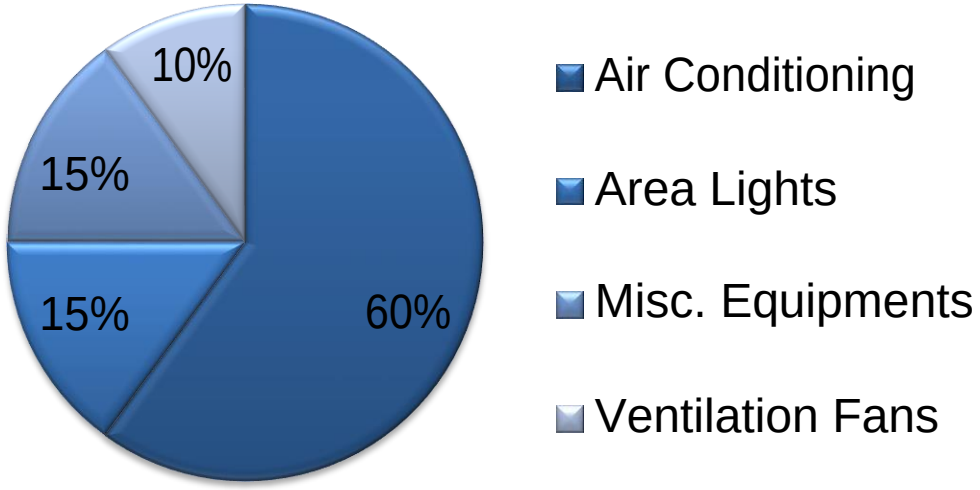
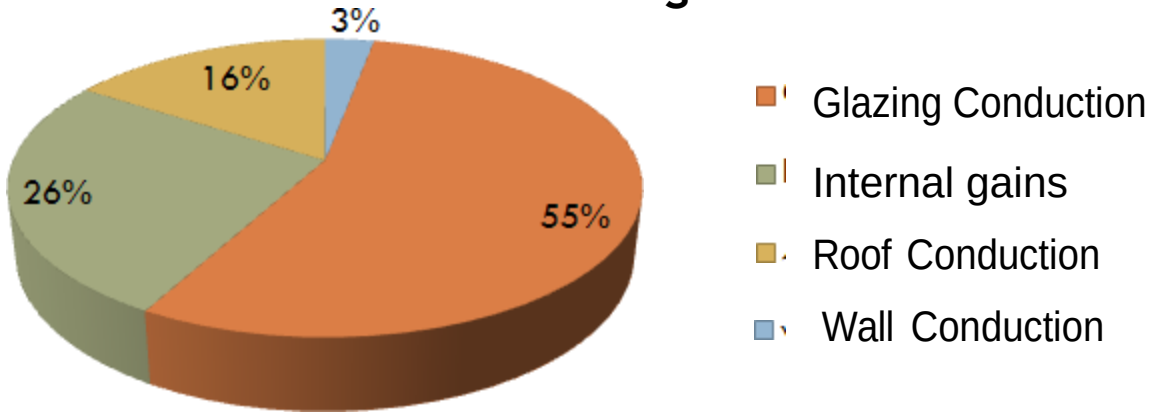
Source:
IGBC – Indian Green Building Council

INTRODUCTION



Break up of Energy consumption in a building



Heat Gain through Various Building parts

ENERGY & ATMOSPHERE

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- Optimize Energy Performance
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- Measurement & Verification
- Green Power.

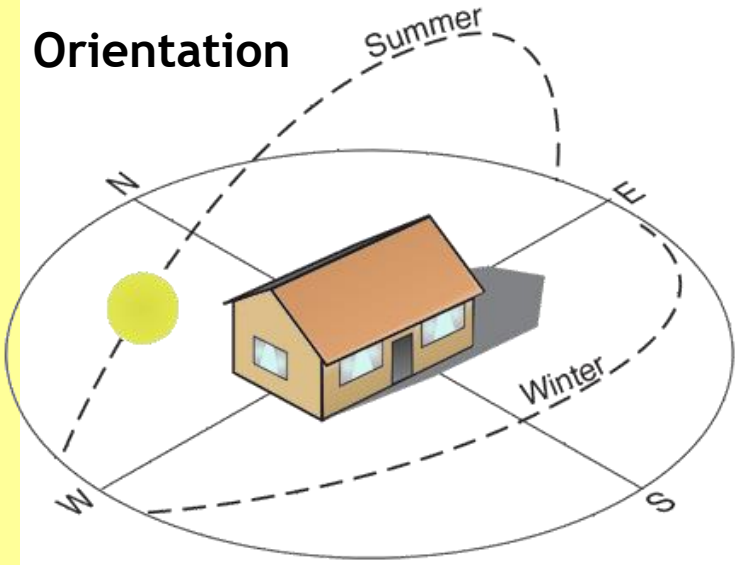
Source:
IGBC – Indian Green Building Council

APPROACH

Orientation
Envelope Measures
- Wall, glazing, fenestration, Shading , Skylight, Roof.

Equipments & Systems
- Chiller , Variable Frequency Drive (VFD), Lighting Controls
- Building Management System (BMS), Humidity Commissioning
-Additional Commissioning, Measurement & Verification(M&V)

Orientation



- Orientation of building is done based on the climatic zone , Sun Path and the requirement of Heat Gain/Heat Loss.
- Buffer South and West exposures by garages, utility rooms , etc. to avoid direct exposure to the main activity zones.

ENERGY & ATMOSPHERE

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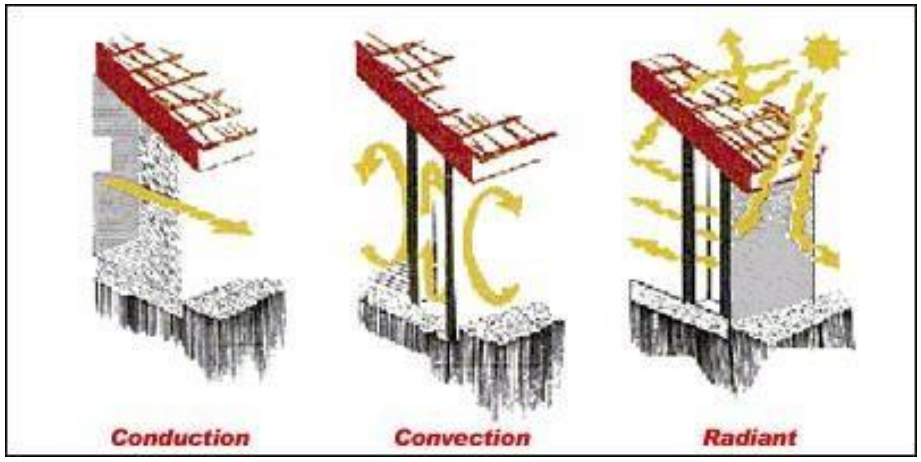
Source:
IGBC – Indian Green Building Council

Envelope Measures

- Wall, glazing, fenestration, Shading , Skylight, Roof.



Use of High performance glass & glazing

- **Low U Value**

  Typical U Value

  Single glazed glass (6mm) :5-6

  High Performance glass :1.7-3.0 (6mm+air gap+6mm)

- Low Shading Coefficient

  Heat gain through a given glazing / heat gain through 3mm clear glass(0.87)

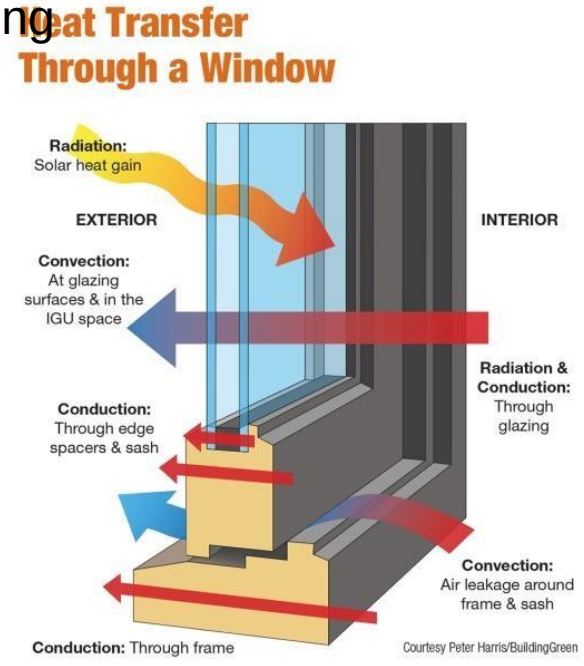
  Solar Heat Gain Coefficient (SHGC)

  Single Glazed 6mm glass : 0.5 -0.8

  High Performance Glass : 0.1-0.4

  Relative Heat gain (RHG) = Direct heat gain + Conductive heat gain

- **High VLT** (Visual Light Transmittance)



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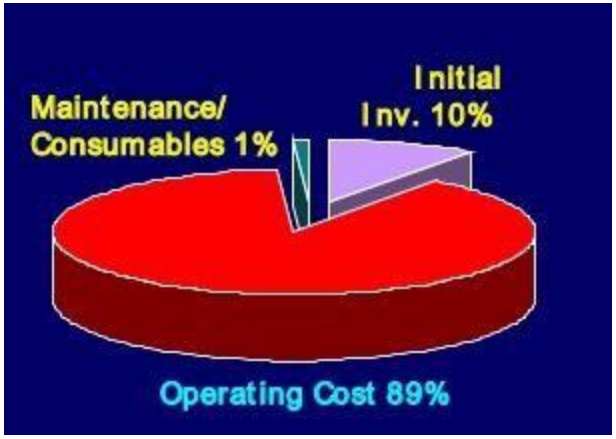
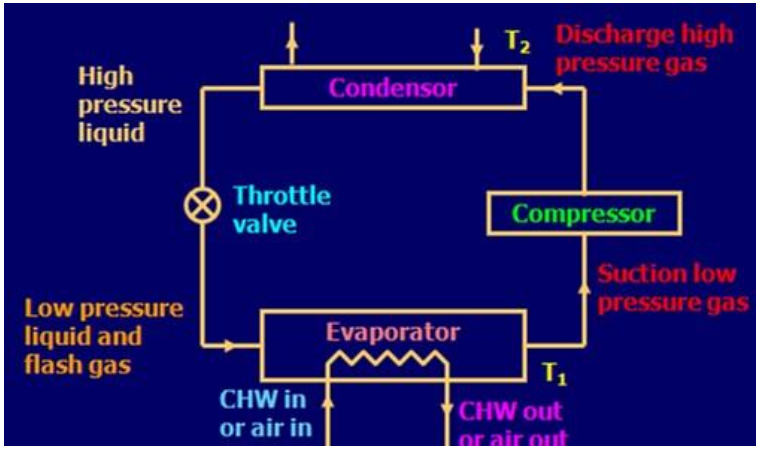
Source:
IGBC – Indian Green Building Council

Equipment & System

Chiller Coefficient Of Performance **(COP) should be higher in Air Conditioning systems**
Variable Frequency drive (VFD) for supply & return fans and pumps
Use of **Heat recovery wheels, Economisers.**
Controls & Building Management Systems





Life Cycle cost for AC systems Conventional Vapour Compression Cycle

COP : Amount of Heat to be taken out / Amount of work required

Carrier Heat Recovery Chillers.mp4

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
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Source:
IGBC – Indian Green Building Council

Equipment & System

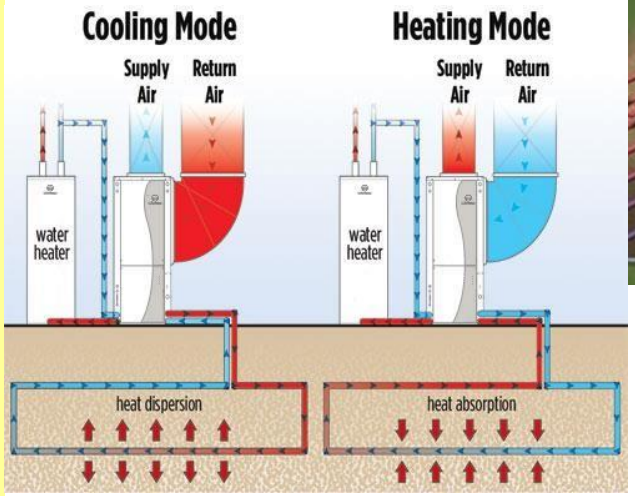
Wind Tower

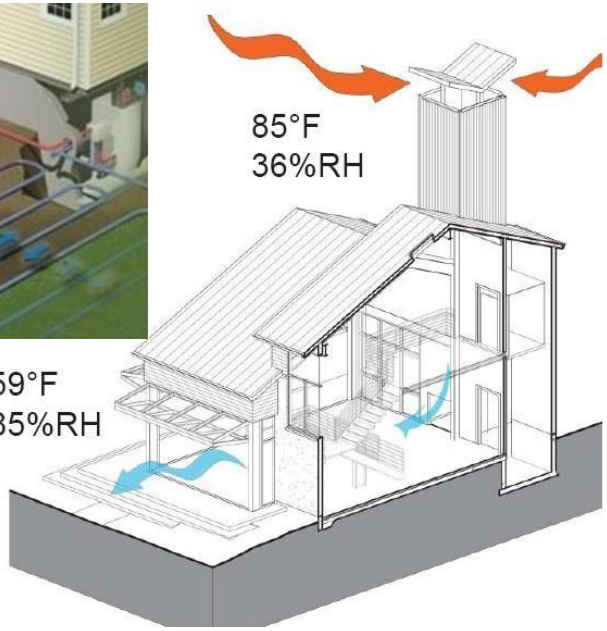
Advantage

Requires little /no energy

Good Indoor Air quality(Fresh air entry) but the performance depends on the Wind availability.

Geo Thermal System



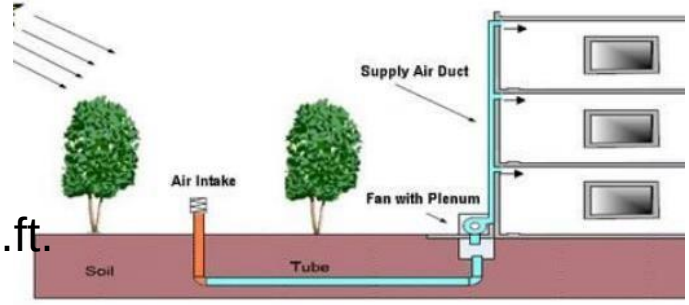


Earth Tunnel Air Conditioning

Earth below 4m

Cooler – During Summer

Warmer – During Winter



Lighting

Overall lighting density:<1.0w/sq.ft.

ENERGY & ATMOSPHERE

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- Optimize Energy Performance
- On-Site Renewable Energy
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- Green Power.

Source:
IGBC – Indian Green Building Council

Controls

Building Management System

Capabilities of Building Management System

- **Centralized Control**
- **Monitor**
- **On Line interaction**
  - Chillers
  - Pumps
  - Fans
  - Lighting
- **Measurement & Verification**
- **Data generation & Updating**

Commissioning

Best of equipment , systems , controls may be in place
- No savings if not commissioned

Can result in 5 – 10 % savings
- Especially if carried out by III party

ENERGY & ATMOSPHERE

- **Fundamental Building System Commissioning – Pre Requisite.**
- **Minimum Energy Performance – Pre Requisite**
- Fundamental Refrigerant Management- Pre Requisite.
- Optimize Energy Performance
- On-Site Renewable Energy
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- Green Power.

Source:
IGBC – Indian Green Building Council

Fundamental Building System Commissioning - Pre Requisite

INTENT
To verify that the project's energy – related systems are installed , and calibrated to perform according to the owner's project requirement , basis of design and construction document.

Minimum Energy performance - Pre requisite

INTENT
To establish the maximum level of energy efficiency for the proposed building and systems to reduce environmental & economic impacts associated with the excessive energy use.

Energy Modeling
Process loads
-Office and general miscellaneous equipment
-Computers
-Elevators and escalators
-Kitchen cooking and refrigeration
-Laundry washing and drying
-Lighting
Process loads to be at least 25% of total energy cost of building.

ENERGY & ATMOSPHERE

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- Minimum Energy Performance – Pre Requisite
- **Fundamental Refrigerant Management- Pre Requisite.**
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Source:
IGBC – Indian Green Building Council

Non Process Loads

HVAC

-Chillers , Fans, pumps , Toilet exhaust, parking garage ventilation , kitchen hood exhaust ,etc.

-Service water heating

LIGHTING

-Interior

-Exterior

COMFORT TEMPRATURE

26±2°C.

Fundamental Refrigerant Management- Pre Requisite

INTENT

To reduce atmospheric ozone depletion

REQUREMENT

No use of CFC based refrigerants for HVAC systems

SUBSTITUTES

HCFC 123, HFC134a, HFC143a

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
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- **Optimize Energy Performance**
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Source:
IGBC – Indian Green Building Council

Optimize Energy Performance

INTENT

To achieve increasing levels of energy performance beyond the pre requisite standard to reduce environmental and economic impacts associated with the excessive energy use.

REQUIREMENT

-Percentage improvement in the proposed building performance Baseline building as per **ASHRAE/IESNA standard 90.1-2007**

New Building Reduction in design energy cost (%)	Renovated Building (%)	Points
12	8	1
14	10	2
16	12	3
18	14	4
20	16	5

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
- Minimum Energy Performance – Pre Requisite
- Fundamental Refrigerant Management- Pre Requisite.
- **Optimize Energy Performance**
- On-Site Renewable Energy
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- Green Power.

Source:
IGBC – Indian Green Building Council

Optimize Energy Performance

New Building Reduction in design energy cost (%)	Renovated Building (%)	Points
22	18	6
24	20	7
26	22	8
28	24	9
30	26	10
32	28	11
34	30	12
36	32	13
38	34	14
40	36	15
42	38	16
44	40	17
46	42	18
48	44	19

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
- Minimum Energy Performance – Pre Requisite
- Fundamental Refrigerant Management- Pre Requisite.
- Optimize Energy Performance
- **On-Site Renewable Energy**
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- Green Power.

Source:
IGBC – Indian Green Building Council

On- Site Renewable Energy

INTENT

To encourage and recognize the increasing levels of On – Site Renewable energy. Self supply to reduce environmental and economical impacts associated with fossil fuel energy use.

Use of Renewable Energy (%)*	Points
1	1
3	2
5	3
7	4
9	5
11	6
13	7

* % of Total energy Consumption

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
- Minimum Energy Performance – Pre Requisite
- Fundamental Refrigerant Management- Pre Requisite.
- Optimize Energy Performance
- On-Site Renewable Energy
- **Enhanced Commissioning**
- **Enhanced Refrigerant Management**
- **Measurement & Verification**
- Green Power.

Source:
IGBC – Indian Green Building Council

Enhanced Commissioning

INTENT
To begin the **commissioning process early in the design process** and **execute additional activities** after system's performance verification is completed.
To ensure that the Owner reaps the Operational benefits.

Enhanced Refrigerant Management

REQUIREMENTS
Avoid use of Refrigerants
Use HFC based Refrigerant

Measurement & Verification

INTENT
- Provide for the **ongoing accountability of building energy consumption over time**
- Ensure that the owner gets the savings
  - Energy & Water

ENERGY & ATMOSPHERE

- Fundamental Building System Commissioning – Pre Requisite.
- Minimum Energy Performance – Pre Requisite
- Fundamental Refrigerant Management- Pre Requisite.
- Optimize Energy Performance
- On-Site Renewable Energy
- Enhanced Commissioning
- Enhanced Refrigerant Management
- Measurement & Verification
- **Green Power.**

Source:
IGBC – Indian Green Building Council

Green Power

INTENT

To encourage the development and use of grid-source Renewable energy technologies on a net zero pollution basis.

REQUIREMENT

- **Invest in off - site Green Power**
- To meet **35% of annual energy requirement**
- Green power generated to be **counted only once**.

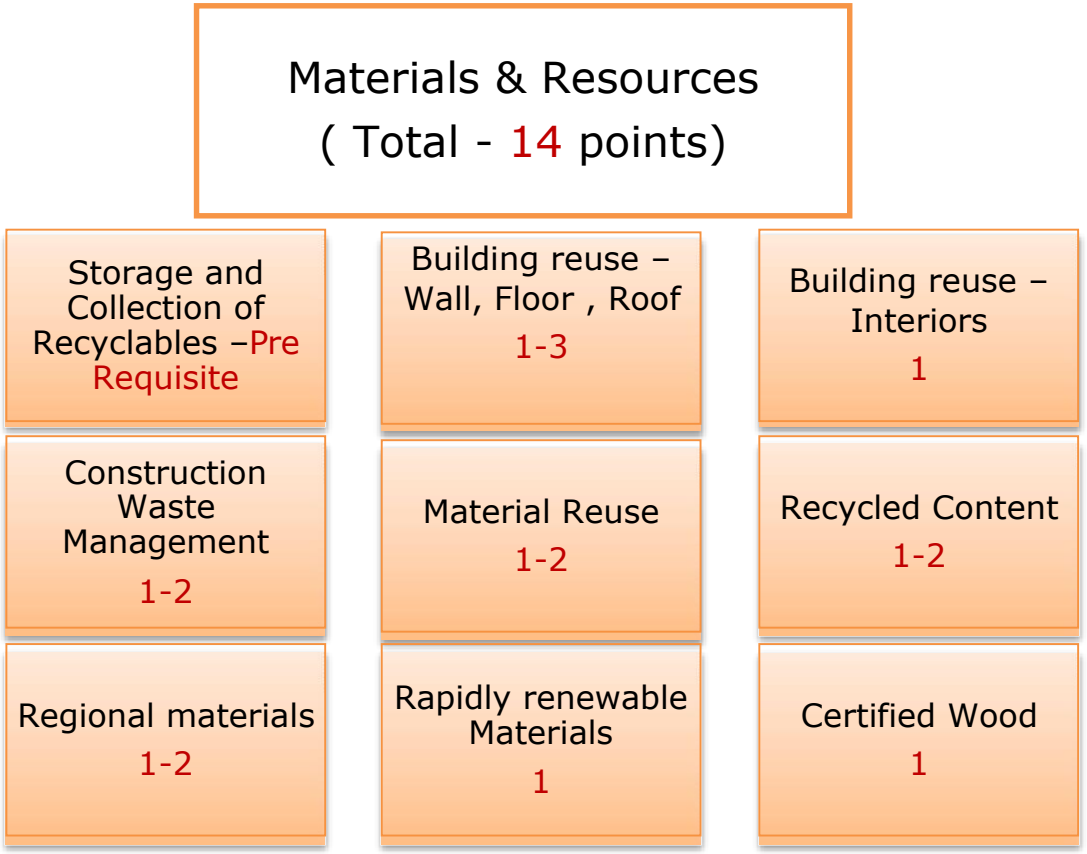
MATERIALS & RESOURCES

Focuses on usage of Recycled Materials , Green materials & Materials Having Low Embodied energy

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- Construction Waste Management
- Material Reuse
- Recycled content
- Regional materials
- Rapidly renewable materials
- Certified Wood

Materials & Resources



Source:
IGBC – Indian Green Building Council

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Storage and Collection of Recyclables

INTENT

To facilitate the waste reduction by building occupants that is hauled to disposed of in landfills.

REQUIREMENT

Dedicated space for segregation & collection of recyclable wastes(post- occupancy)

(Paper, Cardboards, glass, metals & plastics)

Segregation of waste

Source:
IGBC – Indian Green Building Council

MATERIALS & RESOURCES

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- **Building reuse – Walls, Floors, roof.**
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Source:
IGBC – Indian Green Building Council

Building reuse

INTENT

To extend the life cycle of existing Building Stock , conserve Resources , retain cultural resources , reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

REQUIREMENT

Maintain the existing:

Building Structure (including structural floor and roof deck)

Envelope (Exterior skin and framing)

Building Reuse (by area)	Points
55%	1
75%	2
95%	3

Building Reuse(Interior Non - Structural Elements)

Use at least **50 % of existing interior non - structural elements** (by area)

-Interior walls

-Doors

-Floor Coverings

-Ceiling Systems

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- **Construction Waste Management**
- Material Reuse
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- Regional materials
- Rapidly renewable materials
- Certified Wood

Construction Waste Management

INTENT

To **divert construction** and **demolition debris** from disposal in **landfills and infiltration facilities.**

Redirect **recyclable recovered resources** back to the **manufacturing process and reusable materials to appropriate sites**.

REQUIREMENT

Recycle and / or salvage construction & demolition debris.

Waste diverted (by Wt/Vol)	Points
50%	1
75%	2

Typical examples

- Waste concrete for Roadlaying
- Broken Bricks
- Scrap steel
- Packing Wooden material
- Broken Glass
- Cement bags
- Paint container for reuse
- Aluminum

Source:
IGBC – Indian Green Building Council

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- Construction Waste Management
- **Material Reuse**
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- Regional materials
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Material Re Use

INTENT
To reuse building materials and products to reduce demand for virgin materials and reduce waste, thereby lessening impacts associated with the extraction and processing of virgin resources.

REQUIREMENT
Use **Salvaged ,refurbished or reused building materials.**

Reused Materials (by value)	Points
5%	1
10%	2

Typical examples
•Aircraft wings as partition
•Air craft tyres
-Camel carts
-Beams & Posts
-Doors & frames
-Cabinetry & furniture
Loose furniture - not to be considered

Source:
IGBC – Indian Green Building Council

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- Construction Waste Management
- Material Reuse
- **Recycled content**
- Regional materials
- Rapidly renewable materials
- Certified Wood

Recycled Content

INTENT

To increase demand for building products that incorporate recycled content materials , thereby reducing impacts resulting from extraction and processing of virgin materials.

POST - CONSUMER/POST - INDUSTRIAL

Post consumer - Waste material available after consumer use .

Examples: Tetra pack, Used Bulbs ,Plastic Covers

Post industrial - Waste material generated during manufacturing

Examples : Fly Ash, Particle Board

Recycled Content

REQUIREMENT

∑Post Consumer recycled value + ½∑ Post Industrial Recycle value

Recycled Content (by value)	Points
≥10%	1
≥20%	2

Source:
IGBC – Indian Green Building Council

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- Construction Waste Management
- Material Reuse
- Recycled content
- **Regional materials**
- Rapidly renewable materials
- Certified Wood

Regional material

INTENT

To increase demand for building material and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation.

REQUIREMENT

Use building materials or products that have been extracted, harvested or recovered , as well as manufactured, within 400 km of the project site.

Regional materials (by value)	Points
10%	1
20%	2

Source:
IGBC – Indian Green Building Council

MATERIALS & RESOURCES

- Storage and Collection of Recyclables
- Building reuse – Walls, Floors, roof.
- Building reuse - Interiors
- Construction Waste Management
- Material Reuse
- Recycled content
- Regional materials
- **Rapidly renewable materials**
- **Certified Wood**

Source:
IGBC – Indian Green Building Council

Rapidly Renewable Materials

INTENT

To reduce the use and depletion of finite raw materials and long cycle renewable materials by replacing them with rapidly renewable materials

REQUIREMENT

Usage of **Rapidly renewable building materials for 2.5 % of the total building materials** (by value)

-Bamboo
-Eucalyptus
-Linoleum
-Cotton
-Woolen based products

Certified Wood

INTENT

To encourage environmentally responsible forest management

REQUIREMENT

Use a minimum 50% of FSC (Forest Stewardship Council) certified wood based materials (by value)

INDOOR ENVIRONMENTAL QUALITY

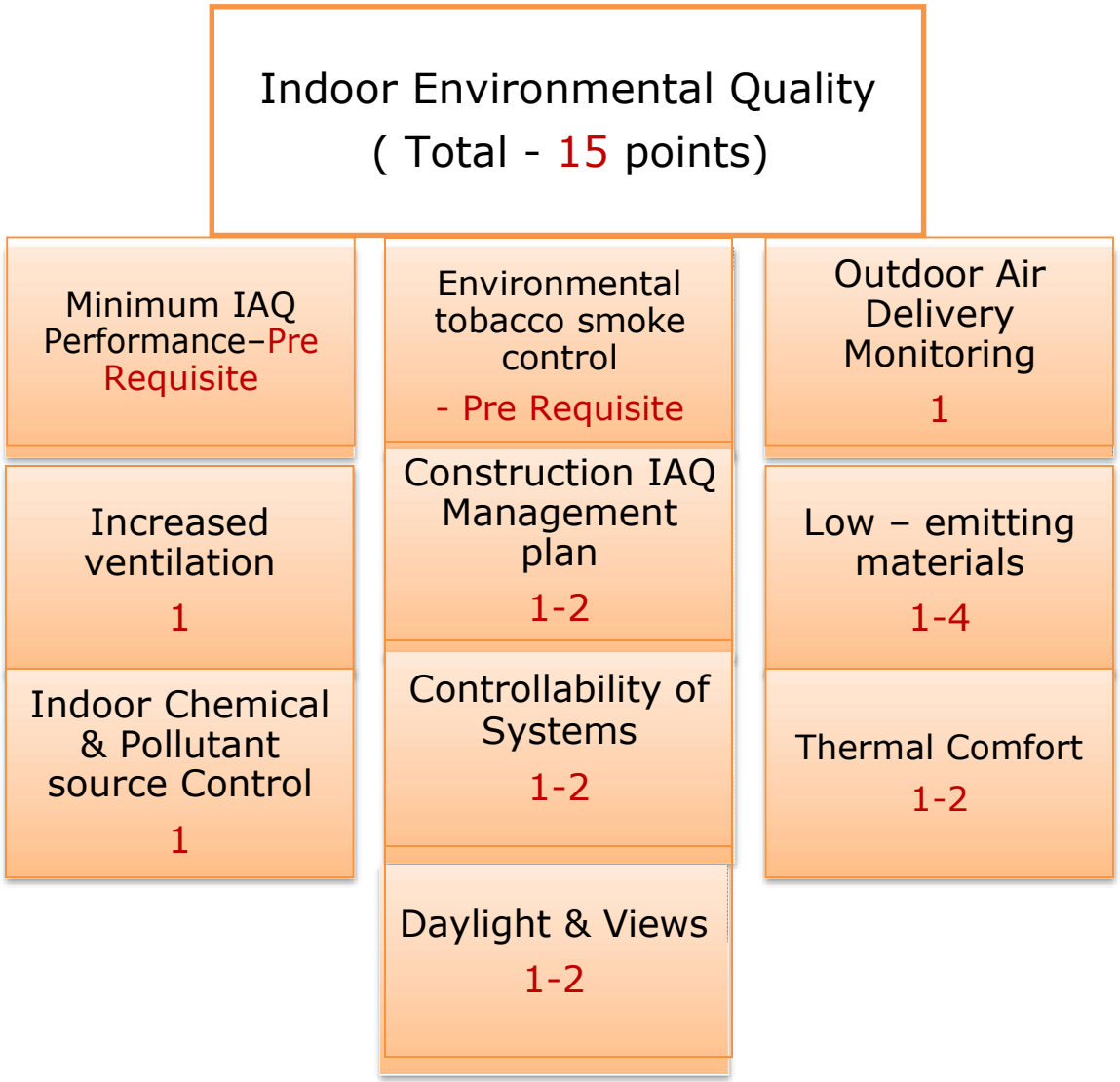
Increase in Fresh air movement inside the building .
Emphasizing on efficient Day lighting & Views

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
- Environmental tobacco smoke control
- Outdoor Air Delivery Monitoring
- Increased ventilation
- Construction IAQ Management plan
- Low – emitting materials
- Indoor chemical & pollutant source control
- Controllability of systems
- Thermal Comfort
- Daylight & Views

Source:
IGBC – Indian Green Building Council

Indoor Environmental Quality



INDOOR ENVIRONMENTALLY QUALITY

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Source:
IGBC – Indian Green Building Council

Minimum IAQ Performance - Pre Requisite

INTENT

- To establish minimum indoor air quality (IAQ) performance to enhance indoor air quality in buildings, thus contributing to the comfort and well being of the occupants.
- **Enhance Indoor Air Quality for**
  - **Comfort**
  - **Performance**
  - **Well-being of the occupants.**

To design based on ASHRAE 62.1 – 2007

- Locate fresh air intakes – **25 ft away from**
  - Entries
  - Outdoor Air Intake
  - Operable Windows

INDOOR ENVIRONMENTALLY QUALITY

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- Daylight & Views

Source:
IGBC – Indian Green Building Council

Typical Fresh air Requirement

Area	Cubic feet /minute (cfm) per person	cfm per sq.ft
Office	5+	0.06
Pharmacy (Preparation areas)	5+	0.18
Warehouses	-	0.06
Retail Sales	7.5+	0.12
Mall Common Areas	7.5+	0.06
Beauty Salons	20	0.12
Sports-Aerobics/Dance	20	0.06

Location of Fresh Air Intakes

Should be located away from contaminated Sources

- Cooling Towers
- Building Exhaust fans
- Sanitary Vents
- Standing water
- Outside Smoking Rooms
- Vehicular exhaust
  - Parking Garages, Loading Docks, Street traffic, etc.,

INDOOR ENVIRONMENTALLY QUALITY

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Source:
IGBC – Indian Green Building Council

Sample summary calculations used to determine Outdoor Air Ventilation rates - Naturally ventilated

Zone Identification		ASHRAE Std. 62.1-2007 Section 5.1 Natural Ventilation				
Zone	Net Occupable Area (sft)	Description of operable openings	Operable Area (sft)	Operable area/ occupiable area (%)	Ratio >4 %	Operable openings within 25' ?
Zone 1	150	(1)5'X5' Slider window	12.5	8.3%	Y	Y
Zone 2	180	(1)5'X5' Slider window	12.5	6.9%	Y	Y
Zone 3	275	(1)6'X5' Slider window	21	7.6%	Y	Y

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
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Source:
IGBC – Indian Green Building Council

Environmental Tobacco Smoke Control(ETS) - Pre Requisite

INTENT

To prevent or minimize exposure of building occupants ,indoor surfaces and ventilation air distribution systems to environmental tobacco smoke (ETS)

REQUIREMENT

- **Prohibit Smoking** in the building except in **designated smoking areas**
- **Prohibit on-property smoking within 25 feet**
  - Entries
  - Outdoor air intakes
  - Operable Windows
- Provide signages
- Provide designated smoking areas
  - Deck to deck partition
  - To operate at a negative pressure
  - Average of 5 pa (0.02” WG)
  - To prove leakage is zero

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
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- Controllability of systems
- Thermal Comfort
- Daylight & Views

Source:
IGBC – Indian Green Building Council

Outdoor Air Delivery Monitoring

INTENT

To provide capacity for ventilation system monitoring to help promote occupant comfort and well – being

REQUIREMENT

Permanent monitoring systems

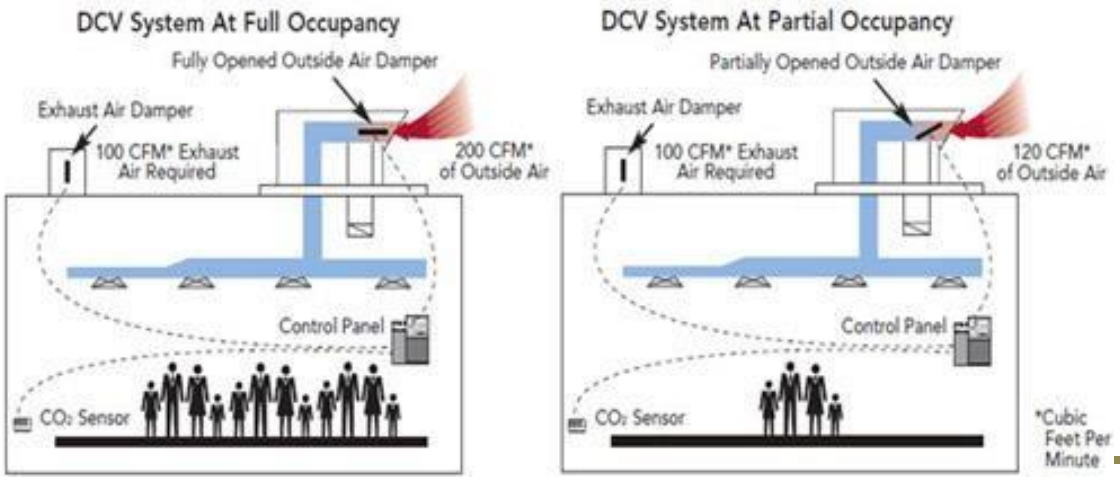
- Air Flows
- CO2

Non Densely Populated area

- One CO2 sensors – return air system

Densely occupied area- 25 people or more per 1,000 sq. ft

- **CO2 sensors : 3-6 feet above floor**
- **Exclusive CO2 sensors** for spaces with collapsible systems **seminars/conferences/meetings**



INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
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- **Increased ventilation**
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Source:
IGBC – Indian Green Building Council

Increased Ventilation

INTENT

- To provide additional outdoor air ventilation to improve indoor air quality (IAQ) and promote occupant comfort ,well- being and productivity.

- **Increased air ventilation** rates to all occupied spaces by at least **30% above the minimum rate required by ASHRAE 62.1 2007**
  - **For 90% spaces**

- **Naturally ventilated spaces**
  - **Effectiveness of naturally ventilated systems to be verified**
    Air flow path & analysis.

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
- Environmental tobacco smoke control
- Outdoor Air Delivery Monitoring
- **Increased ventilation**
- Construction IAQ Management plan
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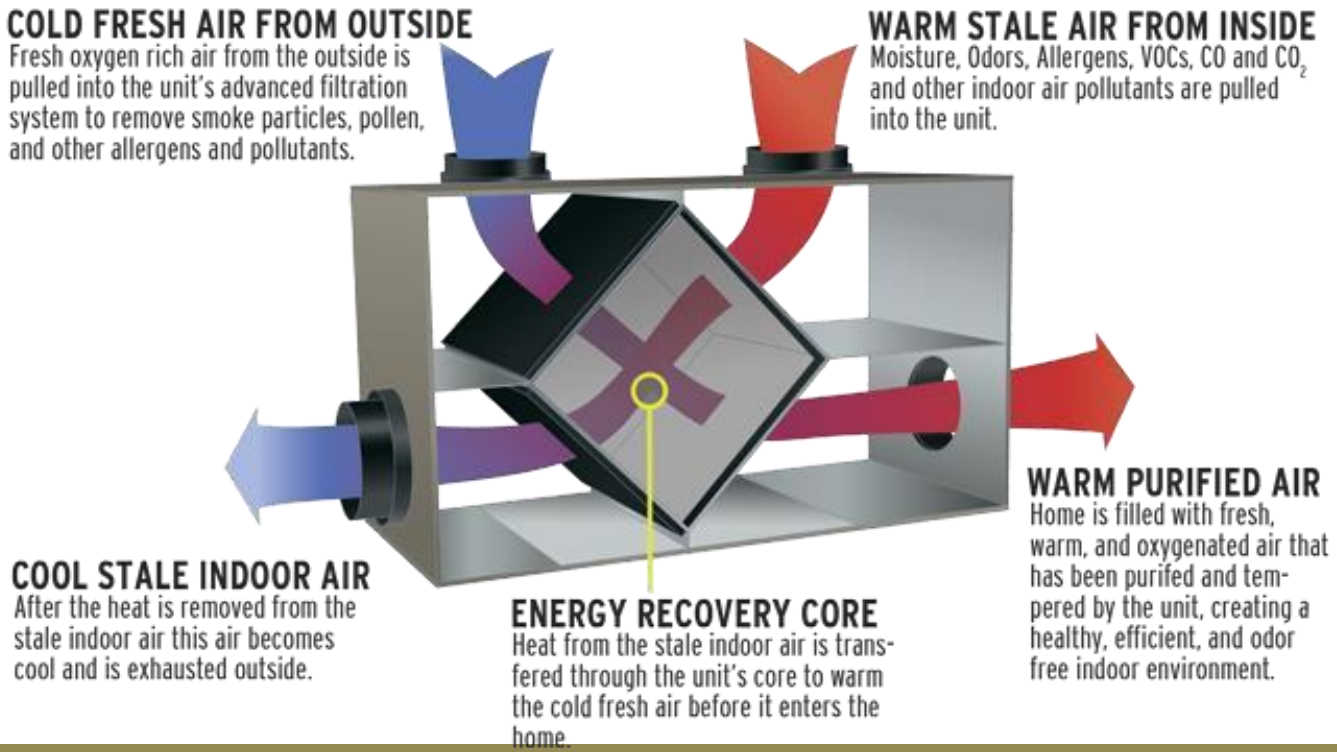
- Daylight & Views.

Source:
IGBC – Indian Green Building Council

Energy Recovery Ventilators

Energy recovery ventilation (ERV) is the **energy recovery process** of **exchanging the energy contained** in **normally exhausted building** or space **air** and using it to **treat (precondition) the incoming outdoor ventilation air** in residential and commercial HVAC systems. During the **warmer seasons**, the system **pre-cools and dehumidifies** while **humidifying and pre-heating** in the **cooler seasons**. The benefit of using energy recovery is the ability to meet the ASHRAE ventilation & energy standards, while **improving indoor air quality and reducing total HVAC equipment capacity.**



INDOOR ENVIRONMENTALLY QUALITY

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Source:
IGBC – Indian Green Building Council

Construction IAQ Management Plan

INTENT

To reduce indoor air quality (IAQ) problems resulting from construction or renovation and promote the comfort & well being of construction workers and building occupants

REQUIREMENT

Minimum IAQ to meet control measures of the **Sheet Metal & Air conditioning Contractors National Association (SMACNA)** IAQ guidelines for Occupied Buildings under construction, 2007

- **Protect materials from moisture damage**
  Stored & installed materials
- If **AHU** used during **construction,** then use **filtration media with a minimum MERV 8 (Minimum Efficiency Reporting Value)**
- **Flush out after finishes installed**
  Paints , Carpets ,etc.

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
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Source:
IGBC – Indian Green Building Council

Low - Emitting materials

INTENT

To reduce the quality of indoor air contaminants that are odorous, irritating and/or harmful to the comfort and well being of installers and occupants

REQUIREMENT

Adhesives, Sealants and sealant primers comply with VOC limits

Architectural Application	Current VOC limit (gram/litre less water)
Indoor Carpet Adhesives	50
Carpet Pad Adhesives	50
Wood Flooring Adhesives	100
Rubber Floor Adhesives	60
Ceramic Tile Adhesives	65
VCT and Asphalt Tile Adhesives	50

INDOOR ENVIRONMENTALLY QUALITY

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Source:
IGBC – Indian Green Building Council

Sealants	Current VOC limit (gram/litre less water)
Architectural	250
Non Membrane Roof	300
Road way	250
Single ply roof membrane	450
other	420
Sealant Primer	Current VOC limit (gram/litre less water)
Architectural	
Non Porous Porous	250 775
Other	750

INDOOR ENVIRONMENTALLY QUALITY

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- **Indoor chemical & pollutant source control**
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- Thermal Comfort
- Daylight & Views.

Source:
IGBC – Indian Green Building Council

Indoor Chemical & Pollutant Source Control

INTENT

To minimize building occupant exposure to potentially hazardous particulates and chemical pollutants.

REQUIREMENT

- **Permanent entryway systems of 10 ft long**
  - Permanently installed **grates , grill ,slotted systems**
- **Deck to deck partitions & independent ventilation** for **chemical rooms/copy rooms with ventilation rate of 0.50 CFM/sq.ft.**
- For **mechanically ventilated spaces provide MERV 13 (Minimum Efficiency Reporting Value) or better filtration media prior to occupancy.**

INDOOR ENVIRONMENTALLY QUALITY

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- **Controllability of systems**
- Thermal Comfort
- Daylight & Views.

Source:
IGBC – Indian Green Building Council

Controllability of Systems

INTENT

•To provide high level of lighting system control ,thermal system by individual occupants or groups in multi – occupant spaces (eg – classrooms and conference areas) and promote their productivity , comfort and well – being.

•REQUIREMENT

Individual lighting control for 90 % of building occupants.

•Provide High level of thermal comfort system control for individual occupants or specific groups in multi occupant spaces.

-**Individual thermal controls for atleast 50% occupants**

-Comfort system controls in multi occupant spaces to meet the group needs & preferences

INDOOR ENVIRONMENTALLY QUALITY

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- **Thermal Comfort**
- Daylight & Views.

Source:
IGBC – Indian Green Building Council

Thermal Comfort Design

INTENT
To provide a comfortable thermal environment that promotes occupant productivity and well being

REQUIREMENT
Design **HVAC systems** & the **building envelope** to meet requirements of **ASHRAE 55-2004**
- Thermal comfort conditions for Human Occupancy

PERMANENT TEMPERATURE & HUMIDITY MONITORING SYSTEM
- **Temperature 26±2°c (for India)**
- **Relative Humidity (RH) should be maintained within the thermal comfort range**
- HVAC systems
  Dehumidification & Humidification system to maintain RH

INDOOR ENVIRONMENTALLY QUALITY

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- Controllability of systems
- **Thermal Comfort**
- Daylight & Views.

Source:
IGBC – Indian Green Building Council

Thermal Comfort Verification

INTENT

To provide for the assessment of building occupant thermal comfort over time.

REQUIREMENT

- **Achieve IEQ c 7.1 - Thermal Comfort Design**
- Survey
  - **Monitor** the **thermal performance** of the building within a period of **6 to 18 months after occupancy**.
  - Install **a permanent temperature & humidity monitoring system**
- **Corrective plan**, if more than **20 % of occupants dissatisfied**

INDOOR ENVIRONMENTALLY QUALITY

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- Controllability of systems
- Thermal Comfort
- **Daylight & Views**.

Source:
IGBC – Indian Green Building Council

Daylight & Views

INTENT

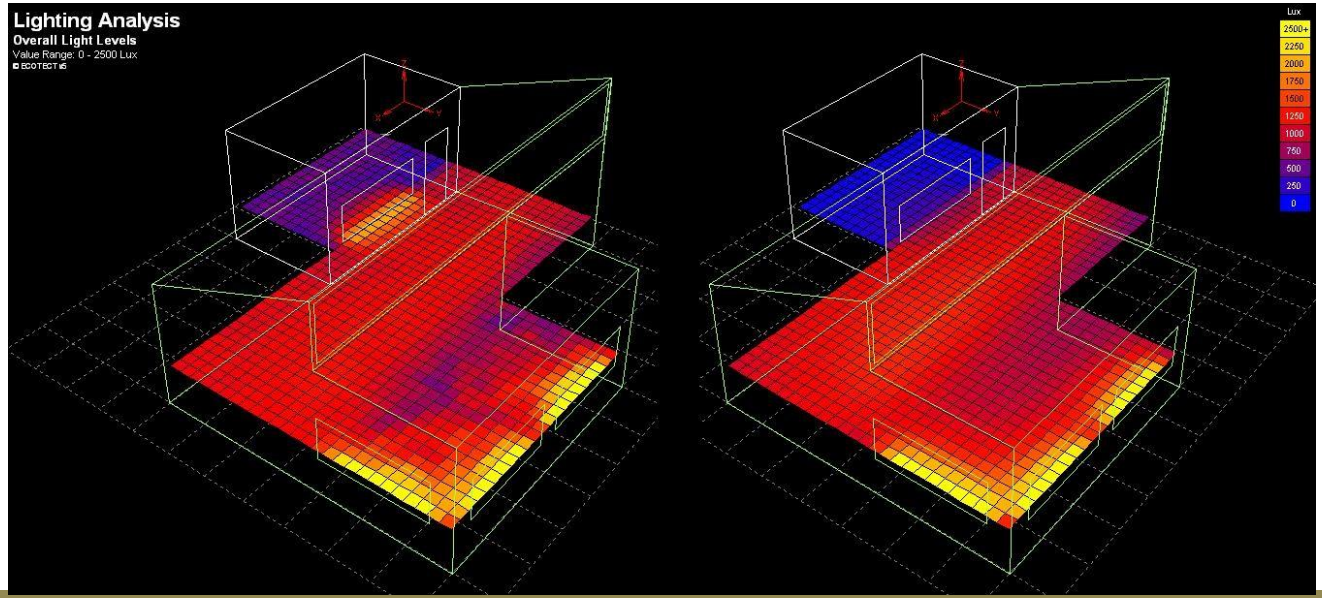
To provide building occupants with a connection between indoor spaces and outdoor through the introduction of daylight and views into the regularly occupied areas of the building.

REQUIREMENT

OPTION 1

Daylight for 75% of the spaces

- Demonstrate through Computer Simulation – daylight illuminance levels **between 270 lux to 5400 lux in clear sky condition on 21 sep from 9 am to 3 pm.**



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- **Daylight & Views**.

Source:
IGBC – Indian Green Building Council

Daylight & Views

OPTION 2

Perspective

-Side-lighting daylight zone

-Value between 0.150 - 0.180

0.15<VLT X WFR<0.18

VLT - Visual light Transmittance , WFR - Window to Floor Area

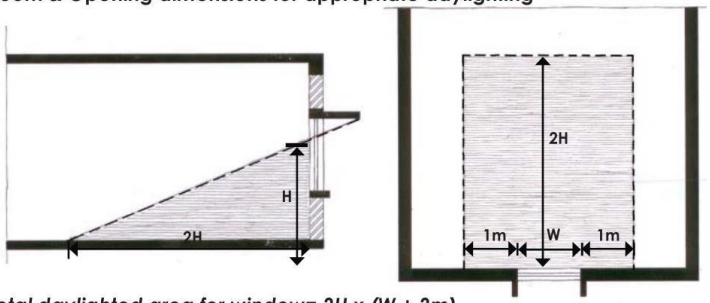
OPTION 3

Measurement

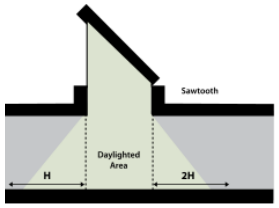
Demonstrate through records – indoor light measurements

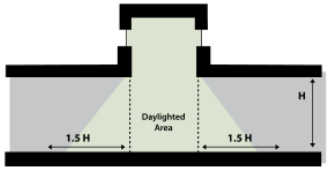
- **Minimum 270 lux**
- **Measurement on 10 feet grid**

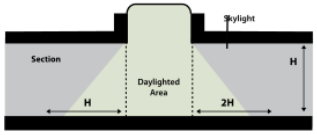
Room & Opening dimensions for appropriate daylighting

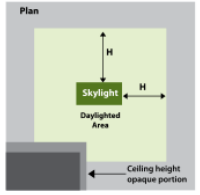


Total daylighted area for window= 2H x (W + 2m)
NBC also recommends that the window area should be atleast 15% of the floor area of the room.









ECBC Lighting Calculation

INDOOR ENVIRONMENTALLY QUALITY

- Minimum IAQ Performance
- Environmental tobacco smoke control
- Outdoor Air Delivery Monitoring
- Increased ventilation
- Construction IAQ Management plan
- Low – emitting materials
- Indoor chemical & pollutant source control
- Controllability of systems
- Thermal Comfort
- **Daylight & Views**.

Source:
IGBC – Indian Green Building Council

Daylight & Views

VIEWS FOR 90% SPACES

INTENT

To provide building occupants a connection to the outdoors through the introduction of daylight & views into the regularly occupied areas of the building.

REQUIREMENT

Views for 90% of regularly occupied areas

Direct line of sight to outdoor environment

- **vision glazing between 30” and 90” above finish floor**

INNOVATION & DESIGN PROCESS

Adapting innovative green techniques in reducing energy consumption & creating comfortable indoor environment

INNOVATION & DESIGN PROCESS

- **Innovation in Design.**
- Accredited Professional

Innovation & Design Process

Innovation in Design

INTENT

To provide design teams and projects the opportunity to **achieve exceptional performance above the requirements set by LEED Green Building Rating System** and/or innovative performance in Green Building categories **not specifically addressed by the LEED Green Building System**

Source:
IGBC – Indian Green Building Council

INNOVATION & DESIGN PROCESS

- **Innovation in Design.**
- **Accredited Professional**

REQUIREMENT

Path 1 Innovation in Design (1-5)

•Achieve **significant ,measurable environmental performance using a strategy , not specifically addressed by rating system**.

- Green Education

- Material Life Cycle Assessment

•Exemplary Performance (1-3)

- Achieve exemplary performance in any of the credit addressed by rating system that allows exemplary performance.

- EA : green power -70 %

- MR : Certified Wood - 100 %

Accredited Professional

INTENT

To support & encourage the design integration required by LEED to streamline the application and certification process

REQUIREMENT

Atleast one LEED Accredited Professional (AP) in the project team

Source:
IGBC – Indian Green Building Council

REGIONAL PRIORITY

Region Based Sustainable techniques according to the Environmental requirement

REGIONAL PRIORITY

- **Regional Priority 1-4 points**

Regional Priority

INTENT

To provide an **incentive** for project teams to address **environmental issues** that **are identified as local/regional priorities by IGBC**. IGBC identified following **six Regional Priority (RP)** credits as having **environmental importance** for projects in the **Indian region**

REQUIREMENT

One bonus point for each Regional Priority credit achieved
Between 4 to 6 Regional Priority credits:

WE cr1: Water Efficiency landscape
WE cr 2 :Innovative Waste Water Treatment & Reuse
WE cr3 :Water Use Reduction
EA cr 1:Optimize Energy Performance
EA cr 3:Enhanced Commissioning
EA cr5:Measurement & Verification.

Source:
IGBC – Indian Green Building Council

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – III – APPLICATION OF RATING SYSTEMS REQUIREMENTS – SARA5333

APPLICATION OF RATING SYSTEM REQUIREMENTS

ROLE OF A GREEN BUILDING CONSULTANT
WHO IS A GREEN BUILDING CONSULTANT?
The green building consultant is the leader of the sustainable design efforts in the project, and major role in the project includes:

•Integrating the efforts of various consultants on the project to create an integrated design solution for the project

•Suggest the various green building strategies for the project based on building type, usage, climate of site and available materials

•Conduct various simulations for solar, energy and daylight to ensure the project meets and exceeds the standards prescribed by ASHRAE, NBC, ECBC etc.

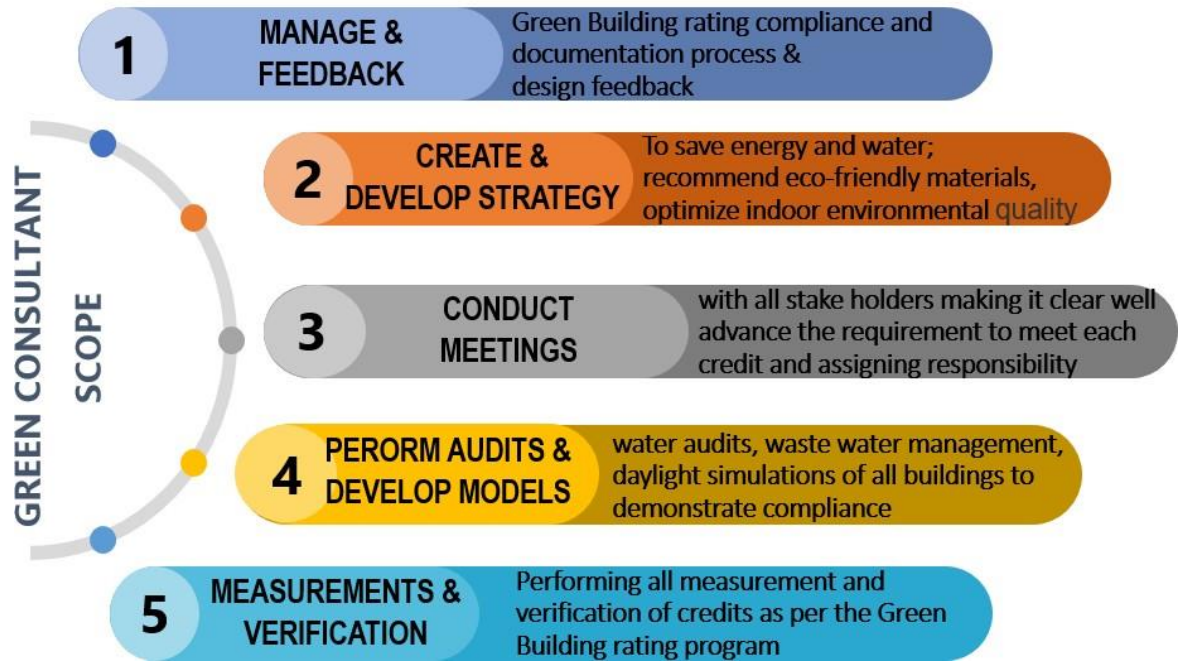
•Payback calculations to ensure the economic viability of strategies

•Feasibility for achievable Green Building rating credits and to prepare the required documentation for certification.

The basic role of a green building consultant is to help the project team make a better building with features that benefit the final occupants and owners of the building. Most of this has to be achieved with minimum cost escalation.

A green building consultant needs to be technically sound in almost all areas of construction and operations of the building. Apart from the technical knowledge about buildings and their environmental performance, the green building consultant needs to have excellent project management skills and marketing skills.

Scope of work:



The good green building consultant should be able to provide the following deliverables and benefits to his/her clients:

- Introduce best practices in energy & water management.
- Provide accurate energy efficiency and water efficiency data.
- Help minimize waste during construction and introduce best practices in waste management post occupancy.
- Improving indoor environmental quality to meet minimum day-lighting and ventilation requirements.
- Introduce best practices in improving quality of life and maximizing productivity.
- Compiling a Green Building Owner's Manual complete with green building features, how to lead a green lifestyle, maintenance tasks and other operational information.
- Staff training and awareness on project green features.
- Providing any guidance to a stake holder if necessary.
- Provide assistance in creating a clear marketing campaign and help generate awareness of the GREEN credentials of the project. This includes creating an online presence for the project, writing a case study, blog articles etc.
- Provide any other sustainability related advice, service and assistance within scope.

The general impression is that a green building consultant simply compiles all documentation required to demonstrate compliance with the various green building rating systems. But the truth is that a good green building consultant should ideally bring a lot more to the table.

Due to the nature of their job, green building consultants are naturally focused on efficiency in every aspect, even their day to day living. This makes them ideal candidates for handling projects where more needs to be done with less. The project owner should be in a position put his faith in this individual and ideally use him as his right-hand man when it comes to making project decisions.

<u>Green Building Professional Credentials in India</u>

The most relevant and recognized credentials in the Indian green building sector are listed below.

IGBC AP
GRIHA Trainer
GRIHA Evaluator
LEED AP
LEED Green Associate
BEMP (Building Energy Modeling Professional Certification)

- **IGBC AP:**

  The 'Indian Green Building Council Accredited Professional Examination' (IGBC AP) offered by IGBC is a credential for professionals to participate in green building projects.

The examination is not based on any specific rating system. It is designed to test the knowledge of a candidate on green building design and construction. Qualified individuals can be involved in projects registered under the 'IGBC rating programmes like IGBC Green Homes, IGBC Factory buildings, IGBC Existing Buildings etc.,

The Indian Green Building Council (IGBC) Accredited Professional exam is administered by IGBC and can be given at any of the Merit Trac on-line test centers around the country.

Website: https://igbc.in/igbc/redirectHtml.htm?redVal=showIgbcApnosign

- **GRIHA Trainer and Evaluator: Green Ratings for Integrated Habitat Assessment**

  GRIHA (Green Ratings for Integrated Habitat Assessment) Trainer & Evaluator is administered by an organization called ADARSH which is a subsidiary of TERI (The Energy Resources Institute).

  GRIHA is the preferred rating system among government projects and is increasingly becoming popular in the private sector due to the government sponsored incentives on GRIHA certified projects.

  The GRIHA Trainer credential allows you to provide training services to people interested in learning the rating system and will also give you basic knowledge of the GRIHA rating system and its requirements. As a GRIHA Evaluator, one can be invited by ADARSH to evaluate GRIHA project submissions.

  The GRIHA Trainer exam is very similar to the IGBC AP exam, whereas the GRIHA Evaluator exam requires you to have thorough knowledge of one specific field. It could be energy, water, site, materials or indoor environment. You can only pick one area of expertise at a time.

  You will have to attend one of the GRIHA Evaluators' and Trainers' program if you wish to appear for these exams. The schedule for these GRIHA training programs is available at their website: http://www.grihaindia.org/?t=events&#&events

  Exam details on website: https://www.grihaindia.org/griha-evaluators-44

- **LEED Green Associate and LEED AP**

  The LEED Green Associate and LEED Accredited Professional (AP) are part of USGBC suite of credentials administered by the Green Building Certifications Institute (GBCI). These are by far the most popular green building professional credentials in the world, but they are not an absolute necessity if you only plan to work on projects within India.

  LEED AP is the best way to demonstrate a thorough understanding of the LEED rating system. One cannot become a LEED AP without first passing the LEED Green Associate (GA) exam and having some proven green building experience. The LEED GA exam is not very different from the IGBC AP exam and can be given at any of the Prometric online test centers in the metro cities.

  Once you have passed your LEED GA exam and gained sufficient experience by working on at least one LEED project, you can then apply for the LEED AP exam.

A bit like GRIHA Evaluator exam, you will have to choose your area of expertise from building design & construction, interior design & construction, homes, operation & maintenance and neighborhood development.
https://www.green-buildings.com/articles/leed-india-how-do-i-become-a-green-associate-and-leed-ap-in-india/
https://new.usgbc.org/credentials#ga

- **ASHRAE Certification: Building Energy Modeling Professional**
  Building Energy Modeling Professional (BEMP) certification program is administered by American Society of Heating Ventilation & Air Conditioning Engineers (ASHRAE). The purpose of this program is to certify the individual's ability to evaluate, choose, use, calibrate, and interpret the results of energy modeling software when applied to buildings' and systems' energy performance and economics. It also certifies the individual's ability to model new and existing buildings and systems with their full range of physics.
  Energy analysis is an integral part of green building and if energy modeling is something you are interested in you can aim to become a BEMP at some point in your career.
  Achieving the above credentials will require at least two to three years of continuous work and study in the field of sustainable high-performance buildings.
  https://www.ashrae.org/education--certification/certification/bemp-building-energy-modeling-professional-certification
  Reference: http://www.ytenterprises.com/the-blog/indiangreenbuildingthetop7greenbuildingprofessionalcredentialsinindia-1

  https://www.usgbc.org/education/sessions/leed-green-associate-core-concepts-12281709

Green Building Materials

What does “green” really mean?

“Going Green” seems to be the new and popular thing to do. It is an easy statement to make, but gives very little detail of how one will address such a global issue. There are currently over fifty regional and national green labeling programs throughout the United States. Each of these have similar yet quite different versions of rating systems and qualifying characteristics that they look for in a green building. Some focus on only the end results and completely overlook what happens during the gathering and manufacturing of materials. Others look more heavily at issues of economics and energy savings while deeming other issues like the distance a material travels or the toxins it could emit into the air as much less important.

Atleast one positive impact on the environment, it could be defined as green. However when analysed more carefully, this same material could actually be harming the environment more than it is helping.

Therefore it is extremely important to know who is labeling a material as green. Many labeling organizations are sponsored by material industries and will consequently be lenient

in granting those materials green status. This complicates the process of determining exactly how green specific materials are. The trouble in identifying the truest definition of green may be that there is no absolute definition. The lack of public unity in a definition has caused the meaning to become convoluted and impossible to distinctly pronounce. However,

by examining the problems and corruption of the green labelling industry, one can indeed gain an understanding of the complexity of variables that contribute to the greenness of a material and how to apply these principles in design and building.

Green Labeling Programs

There are over fifty green labelling programs across the country. This is an overly abundant number of organizations who are all in theory supporting and dealing with the same things. Some common issues that they all take into consideration are:

• Construction techniques

• Waste reduction/recycling through construction phase

• The indoor environment and its use of environmental products

• Water-efficient processes

• Renewable energy options

• Smart growth and sustainable land development practices

However all of the programs weigh the importance of these issues differently and consequently establish their own unique checklists. The decision of which matters are more important to a specific label often stems from the desires of sponsors and investors. If a labeling program receives funding from another organization, they will unfairly rate that organization's products as greener than the really are.

Corruption in the green labelling industry makes it difficult to discern which are the most credible and trustworthy programs. Knowing who is behind the labeling is the first step in uncovering truly green materials. Although there are many green labeling programs in America, there are really only a handful that are well-known. Builders are more likely to choose materials with these ratings. This is because they want their efforts to be widely recognized, and they automatically trust these companies since everyone else seems to think they are superior.

Four of the largest and most recognized green labeling programs are:

• LEED

• Energy Star

• Green Globe

• Green Seal

Each are administered by different organizations, have their own rating criteria and focus most heavily on different issues. By looking at all four of these, one can begin to see overlaps

and shortcomings. One can begin to develop a more holistic approach to defining a true green material.

Energy Star

Definition

• A government backed organization focusing on improving energy efficiency

• Administered by the US Environmental Protection Agency and the US Department

of Energy Standards for Energy Star rated buildings are set by the EPA

Their motto is “Energy-efficiency comes first”. Founded in 1992, Energy Star began as a labeling

program that only rated consumer products. Products like household appliances and air conditioning units with the Energy Star label now save between twenty and thirty percent of energy.

Buildings can receive an Energy Star Label too. To qualify they must reduce the amount of energy needed to operate and cause less carbon dioxide emissions than other buildings of the same type.

Rating System and Criteria

• Buildings rated on a 1-100 scale in comparison to other buildings of the same type

• A score of 75 or above can earn an Energy Star label

To be rated, you submit data about your building. This information includes total square footage,

Number of occupants, number of computers, location, etc. A computer than takes this data and formulates a figure that would be the optimal energy spending. This is derived from data gathered by the Department of Energy’s Energy Information Administration.

Then your building is evaluated in comparison to this data and ranked among its peers. The top twenty five percent in each building type category receive the Energy Star label.

Currently Energy Star has ratings for the following building types:

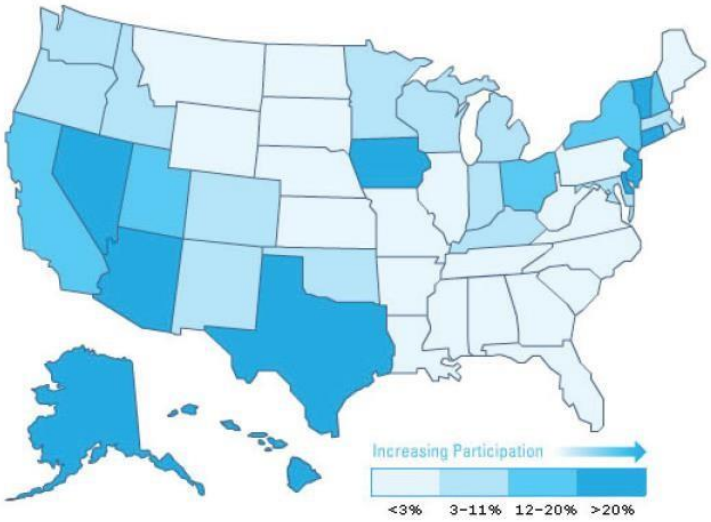
• Bank/financial institutions, courthouses, hospitals (acute care and children’s), hotels and motels, K-12 schools, medical offices, offices, residence halls/dormitories, retail stores, supermarkets, and warehouses (refrigerated and non-refrigerated)

• Industrial Facilities: automobile assembly plants, cement plants, and corn refineries

• Municipal Water Treatment Plants

To determine if a building qualifies to be Energy Star rated, fifty percent of the gross square footage (excluding garages/parking) must belong to one of the above categories.

Problems with Energy Star Although Energy Star takes a strict approach to cutting down on energy use therefore reducing greenhouse gas emissions and saving money, it fails to look at materials in depth. They are really only focused on the way that the end product performs in relation to energy savings. Whatever means needed to be taken to get a product a certain way, even if extremely harmful to the environment, would be dismissed by Energy Star. Plus there have been reports that the organization sometimes uses loose and outdated standards and lets companies rate their own products



Statewide participation rates in the Energy Star program.

Source UTSoA - Seminar in Sustainable

• A guidance and assessment program that offers realistic and achievable ways to increase the sustainability of commercial buildings

• Administered by the Green Building Initiative in the U.S.The most important components of the Green Globe program are:

• Comprehensive environmental assessment protocol

• Software tools that speed and ease online assessment

• Best practices guidance for green construction and operations

• Experienced green building assessors

Green Seal uses the International Organization for Standardization (ISO) standards for environmental labeling programs, ISO 14020 and 14024.

Rating System and Criteria

• 1000 point scale in multiple categories: energy, indoor environment, site, water, resources, emissions, project/ environmental management

• Can earn 1-4 globes for achieving at least 350 points

After a building has earned at least 350 points, third party independent assessors review building documentation and walk through the site. The site walk through is very intensive and includes a review of all construction documentation as well as the physical walk-through.

Buildings that earn green globes should:

• use less energy

• conserve natural resources

• emit fewer pollutants

Green Globe does look at the total life cycle assessment of the materials in the building. This is different from many other labelling programs that do not look into the source of the materials and products. They also separate buildings into “new construction” and “continual improvement of existing buildings”.

Fig. 09 Green Globe logo

Green Globes™ Ratings		
85-100%		Reserved for select buildings that serve as national or world leaders in reducing environmental impacts and efficiency of buildings.
70-84%		Demonstrates leadership in energy and environmentally efficient buildings and a commitment to continual improvement.
55-69%		Demonstrates excellent progress in reducing environmental impacts by applying best practices in energy and environmental efficiency.
35-54%		Demonstrates movement beyond awareness and a commitment to good energy and environmental efficiency practices.

Fig. 10 Green Globe's Rating System.

Green Seal

Definition

• a non-profit, third party certifier and standards development party

• the largest U.S.-based ecolabelling organization

• the U.S. member of GEN (Global Ecolabelling Network), which consists of 26 of the world’s leading ecolabelling programs

• develops standards from green cleaning products to lodging

Green Seal uses life cycle assessment, evaluating products from raw materials extraction to manufacturing and use to disposal or recycling. If a product meets Green Seal standards, it will be awarded the Green Seal. This organization works with the marketplace in an effort to create a “more sustainable world”

Green Seal Environmental Standards

• Construction Materials, Equipment and Systems

• Facility Operations, Maintenance and Services

• Hospitality, Lodging and Food Service

• Home Products and Services

• Office Products and communications

• Personal Care and Consumer Packaged Goods

Conditionally Green Materials

The majority of available green products have one or more of the following health and/or environmental attributes:

• Promote good indoor air quality (typically through reduced emissions of VOCs)

• Durable and require little maintenance

• Incorporate recycled content (post-consumer and/or postindustrial)
• Have been recycled from existing or demolished buildings
• Are made using renewable resources
• Have low embodied energy
• Do not contain Chlorofluorocarbons, Hydrochloroflurocarbons or other ozone depleting substances
• Obtained from local resources and manufacturers
• For wood or bio-based products, they employ sustainable harvesting practices
• Recyclable
• Biodegradable

However not many, maybe even none at all, carry all of these characteristics. Even some materials that are claimed to be the "greenest" are missing at least one of these attributes. Here are just a few of such cases:

Bamboo

Usually used as flooring, this is the material that all architects seem to turn to for a quick addition of sustainability to their designs. However, bamboo is not always the greenest choice. Although it is a

rapidly renewable product, the forest that it comes from is sometimes not. In order to ensure this materials green credibility, it needs to come from a FSC source.

In general, a better and greener flooring material would be rammed earth. It is just as strong and durable as concrete and its source can be at the immediate site. It has ninety percent less embodied energy than concrete also.

Insulated Concrete Forms (ICF)

These are stackable blocks of expandable polystyrene which are filled with concrete and re-bar as needed. They are strong and extremely well insulated cutting down on energy costs greatly.

They also get rid of the necessary wood formwork traditionally used in poured concrete forms. However, the polystyrene is a fossil fuel based product and could contain VOCs.

These are extremely harmful to a person's health. There is an ICF made from recycled wood chips

called "Durisol", and this would be the best choice for an ICF wall.

Low VOC Paint

The name says it all. Low VOC is better for the environment and everyone's health. However this label is misleading. In order to be considered "Low VOC", the paint must contain less than 250 grams per liter of the compound. However many companies count the grams

per liter before the pigment is added, which has a large amount of VOC in it as well. So these really aren't what they claim to be. The best option for paint is a Zero VOC paint.10

Recycled Denim Insulation This material is 100% recycled. So what couldn't be green about that? First, the insulation value is extremely poor (about equal to that of fiberglass). Second, it causes vapor barrier issues. Third, mice love to live inside of it. Finally, in most cases the

blue jeans used for the insulation are shipped all over the country, wasting fuel and negating the "greeness" of the product.

Structurally Insulated Panels (SIPS)

These are wall panels comprised of rigid foam insulation sandwiched between two pieces of oriented strand board. They can have insulative values up to R-60. This high value saves energy and money. However, they are usually not made of green materials. Some companies are now using bio-based materials, but others still used expanded polystyrene, which as in ICF can contain VOCs and be a health and environmental hazard.

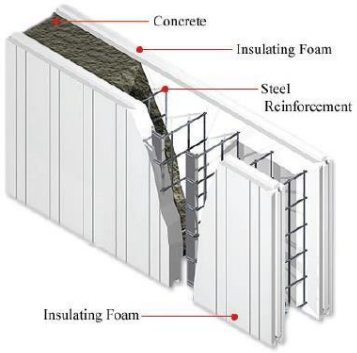


Fig. 12 Insulated Concrete Forms.


Fig. 13 Recycled Denim Insulation.


Fig. 14 Structurally Insulated Panels.

Glossary of Green Terms

When reading about green materials, certain terms appear quite frequently. This is a greatly summarized list of some of those terms.

Carbon Footprint: A measure of an individual's impact on the environment in terms of the amounts of greenhouse gases produced, measured in units of carbon dioxide.

Carbon Sink: A natural or manmade reservoir that accumulates and stores some carbon-containing chemical compound for an indefinite period. Major examples are oceans, forests and landfills.

Chlorofluorocarbon: CFC; an organic compound that contains carbon, chlorine and fluorine. Most widely found in refrigerants and aerosols, when released into the air these compounds lead to ozone depletion.

Embodied Energy: The available energy that was used in the work of making a product. This is an accounting methodology which aims to find the sum total of the energy necessary for an entire life cycle process.

Forest Stewardship Council: FSC;

A non-profit organization which promotes responsible management of the world's forests. It sets standards and independently certifies and labels forest products

Green Products: Products that have been certified through a process of "eco" or "green" labeling, which insures that the product was handled, made or grown under conditions that

meet standards of sustained use, pesticide application and harvesting as well as certain social and economic criteria for workers.

Greenwashing: The practice of companies disingenuously spinning their products and policies as environmentally friendly.

Greenway: Undeveloped linear open space usually set in cities, set aside and used for recreation or conservation. Greenways can be used to created connected networks of open space that include traditional parks and natural areas.

Half-life: The time required for a pollutant to lose half of its effect on the environment.

Post-Consumer Recycled Material: reclaimed waste product that has already served a purpose to a consumer, and has been diverted or separated from waste management collection systems for recycling.

Example: used newspaper that is made into cellulose building insulation.

Pre-Consumer Recycled Material: A material that is removed from production processes (including scrap, breakage, or by-products) and reused in an alternative process before consumer distribution. Example: mineral (slag) wool, a by-product of the steel blast furnace process, used for mineral fiber acoustical ceiling panels.

Rapidly renewable products: any material that regenerates in ten years or less: i.e. Bamboo, cork, wool and straw.

Sustainable Harvesting: Harvesting only what the ecosystem and region naturally produce and no more. This provides future generations with the assurance of these resources.

Volatile Organic Compound: V.O.C.: An organic chemical compounds that have high enough vapor pressures to vaporize and enter the atmosphere. They can come from methane, formaldehyde, office equipment

Recyclable vs Green vs

Sustainable Materials

Recyclable: A material that can be used again.

Green: A material that has at least one positive environmental characteristic.

Sustainable: A material that meets the needs of the present without compromising those of future generations.

OTHER GREEN RATING SYSTEMS

PEARL RATING SYSTEM:

The **Pearl Rating System** is the green building **rating system** developed by the Abu Dhabi Urban Planning Council as part of their sustainable development initiative, Estidama. ... The **pearl rating system** is divided into Buildings, villa, and community. Each with the **scale** of 1 to 3 **pearls**.

The aim of the Pearl Building Rating System (PBRS) is to promote the development of sustainable buildings and improve quality of life. Achievement of a sustainable building requires the integration of the four pillars of Estidama together with a collaborative and inter-disciplinary approach to building development known as the Integrated Development Process.

The PBRS encourages water, energy and waste minimisation, local material use and aims to improve supply chains for sustainable and recycled materials and products.

An Executive Council Order of May 2010 states all new buildings must meet the 1 Pearl requirements starting in September 2010, whilst all government funded buildings must achieve minimum 2 Pearls. Following this mandate, significant effort has been made to align the PBRS with the Abu Dhabi Development and Building Codes.

The PBRS is applicable to all building typologies, their sites and associated facilities, including hospitals, warehouses, industrial buildings, laboratories and hotels. In essence, any building constructed for permanent use and that is air-conditioned must meet the PBRS requirements. Please refer to Information Bulletin #3 V.2.0 for further guidance.

Within each credit, applicability and/or alternative specific requirements may be specified for the following building typologies:

- **Office:** applies to offices and associated spaces such as meeting rooms, reception/waiting areas, staff facilities, server rooms, corridors, toilets, print rooms, store rooms and plant rooms.
- **Retail:** applies to display and sale of goods, food retail (supermarkets, convenience stores), food preparation (restaurants, cafés, takeaways) and service providers (banks, post offices, travel agencies). This category also includes shopping centers, department stores and retail parks. It does not include isolated single use warehouse-type retail developments.
- **Multi-Residential:** applies to multi-family residential developments greater than three stories above grade. All villas must be assessed using the Pearl Villa Rating System (PVRS).
- **School:** applies to primary schools, secondary schools, sixth form colleges and further and higher education/vocational colleges and institutions.
- **Mixed Use:** applies to combinations of two or more of the above usage categories. Where relevant, individual credit calculations should be based on an area-weighted average. All buildings intending to achieve a PBRS rating will be evaluated by the DPM.

Nonetheless, the building must be registered with the appropriate Municipality and follow the building permit process. Project teams planning to submit an application for Pearl Rating should follow the process and instructions outlined here.

Pearl Building Rating System and Guides

The Pearl Building Rating System

This document contains all credit intents, requirements, relevant calculations and methodological information, design and construction submittal requirements and any relevant reference standards.

PBRS Submittal Guide

- This guide explains how to use the PBRS submittal templates.

PBRS RE-R1 Energy Prescriptive Pathway Guide

- The Energy Prescriptive Pathway is an alternative approach to energy modelling that can be used by design teams to comply with RE-R1. It is applicable to buildings with a gross floor area (GFA) of 5,000m² or less.
- Building projects that exceed 5000m² and wish to undertake the prescriptive compliance option should approach the Estidama team at DPM prior to commencing the design submission. The Prescriptive Pathway Guide document provides a summary of the requirements relating to envelope, systems, lighting, HVAC and renewables to help design teams complete the Energy Prescriptive Pathway Template provided below.

Consultants Guide

- The 1 Pearl Building Guide for Consultants provides detailed recommendations for achieving the required credits of the Pearl Building Rating System throughout the design process.

Pearl Building Rating System Calculators

PBRS Energy Model Template

- The energy model template is an excel file that enables design teams to summarise model details and overall energy performance in order to demonstrate compliance with the mandatory provisions of RE-R1 and optional requirements of RE-1 and RE-6 in the Pearl Building Rating System.

PBRS RE-R1 Energy Prescriptive Pathway Template

- The Energy Prescriptive Pathway Template is an excel file that enables design teams that don't wish to undertake energy modeling to demonstrate compliance with RE-R1. It is only applicable to buildings with a gross floor area (GFA) of 5000m² or less. Building projects that exceed 5000m² and wish to undertake the prescriptive compliance option should approach the Estidama team at the DPM prior to commencing the design submission. For further guidance please refer to the guide provided above.

PBRS Water Calculator

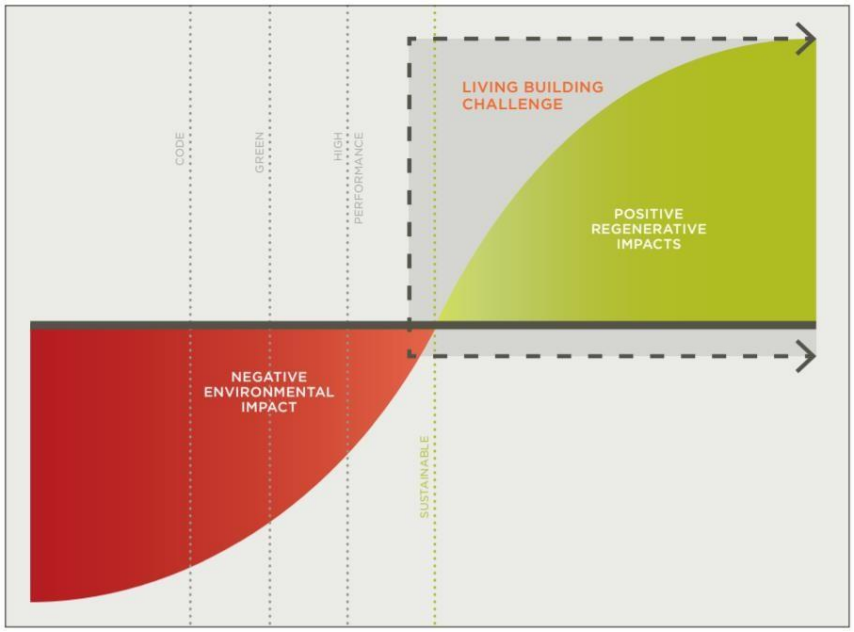
- This spreadsheet based calculation tool is to be used as part of the submission for the required credit, PW-R1. It is also to be used for those projects pursuing PW-1, PW-2.1, PW-2.2 and PW-2.3 optional credits. The tool will automatically determine if the required credit is achieved and the number of credit points obtained for any optional credits the project has pursued.

PBRS Scorecard

This spreadsheet tool lists all the PBRS credits and is to be used by project teams to track project implementation of the Pearl Rating System.

LIVING BUILDING CHALLENGE

THE LIVING BUILDING CHALLENGE IS A PHILOSOPHY, CERTIFICATION AND ADVOCACY TOOL FOR PROJECTS TO MOVE BEYOND MERELY BEING LESS BAD AND TO BECOME TRULY REGENERATIVE



The Living Building Challenge is an attempt to dramatically raise the bar from a paradigm of doing less harm to one in which we view our role as steward and co-creator of a true Living Future. The Challenge defines the most advanced measure of sustainability in the built environment possible today and acts to rapidly diminish the gap between current limits and the end-game positive solutions we seek. The Challenge aims to transform how we think about every single act of design and construction as an opportunity to positively impact the greater community of life and the cultural fabric of our human communities. The program has always been a bit of a Trojan horse—a philosophical worldview cloaked within the frame of a certification program.

The Living Building Challenge was the 2012 winner of the Buckminster Fuller Prize, the world's top award for socially responsible design. successful because it satisfies our left brain craving for order and thresholds and our right brain intuition that the focus needs to be on our relationship and understanding of the whole of life. As such the program is a philosophy first, an advocacy tool second and a certification program third. Within the larger Living Future Challenge framework that covers the creation of all human artifacts and edifices, the Living Building Challenge focuses on humanity's largest creations—its buildings. It is in essence a unified tool for transformative thought, allowing us to envision a future that is Socially Just, Culturally Rich and Ecologically Restorative. Regardless of the size or location of the project, the Living Building Challenge provides a framework for design, construction and the symbiotic relationship between people and all aspects of community. Indeed, "Living Building Challenge" calls for action that describe not only the building of all of humanity's longest-lasting artifacts, but also of the relationships and broader sense of community and connectivity they engender.

https://living-future.org/wp-content/uploads/2016/12/Living-Building-Challenge-3.0-Standard.pdf

WELLS RATING STANDARD

The **WELL** Building **Standard**® is a performance-based system for measuring, certifying, and monitoring features of the built environment that impact human health and wellbeing, through air, water, nourishment, light, fitness, comfort, and mind.

WELL is the leading tool for advancing health and well-being in buildings globally. Register your office, building or other space to leverage WELL's flexible framework for improving health and human experience through design.

The role buildings can play in human health and well-being has never been more evident or more important. Thanks to an evolving evidence base, we understand more about the relationship between the physical environment and human health than ever before. We know how to create spaces that enhance – rather than hinder – health and well-being. We can measure – and then improve – the quality of our air, water and light. We can design environments that fuel our bodies, move us, keep us connected, inspire our best work and facilitate a good night's sleep.

With WELL as our vehicle, IWBI helps to translate what we know into what we practice. We aspire to transform buildings and organizations in ways that advance health and well-being to help people thrive. This has been our mission since we launched WELL in 2014. And today, we know much more about how to achieve our goals. We've channeled all that we have learned into a more accessible, adaptable and equitable rating system, which continues to be anchored by the latest scientific research and industry best practices and serves as the foundation upon which the entire WELL ecosystem is built.

Since the launch of the WELL v2 pilot in 2018, we've worked tirelessly to incorporate feedback from thousands of members of our global community. During the two-year pilot phase, WELL v2 underwent improvement and refinement through a rigorous process, including a six-month public comment period and a final stakeholder review, garnering hundreds of market insights across the two phases. Throughout the pilot, we also published quarterly addenda to clarify and streamline implementation for projects around the world. In addition, the IWBI Task Force on COVID-19, comprised of 16 co-chairs and nearly 600 leaders and experts from 30 countries, collectively crowdsourced hundreds of comments during a 40-day sprint to assess how WELL v2 could be further strengthened to better support prevention and preparedness, resiliency and recovery.

The evolution of WELL v2 was supported by more than 150 WELL concept advisors. Concept advisors have expertise in one or more of the ten WELL concepts and provide input on solutions to health and wellness concerns, best practices for localization, case studies to fill research gaps and innovative topic areas. Their expertise and input supported IWBI's Standard Development team, comprised of experts in each of the ten WELL concepts, at every turn, and helped take WELL to new heights.

In 2020, IWBI formed our Governance Council comprised of key global thought leaders, doctors, public health professionals and business executives. The IWBI Governance Council is tasked with a dual purpose to uphold the integrity of the WELL Building Standard development process and accelerate market transformation at a global scale. The first task of the Governance Council was to vote to confirm that WELL v2 met defined best practices for standard development and that each WELL feature met four tenets:

1. **Evidence-based.** Each WELL feature is underscored by available evidence that links design, policy and built environment strategies to health and well-being outcomes. Features are substantiated by a diverse and rigorous evidence-base, including peer-reviewed literature; academic research; and leading design standards, laws, codes and best practices.
2. **Verifiable.** All WELL features are third-party verified by GBCI through documentation and/or performance testing.
3. **Implementable.** All WELL v2 features haves been tested through WELL v1 and/or WELL v2 pilot demonstrating adoption and uptake by projects across the world.
4. **Presented for outside input.** At every step of the way, IWBI gathered feedback from a diverse community of practitioners, subject matter experts, users and other third parties to inform the development and evolution of WELL.

When put to the vote, in June 2020, the esteemed members of the IWBI Governance Council *unanimously* agreed that every single feature in WELL v2 meets the tenets outlined above. Following this rigorous review process leveraging internationally recognized standard development best practices, WELL v2 has demonstrated it is resilient, verified and dynamic.

PRINCIPLES OF WELL V2

This latest version of WELL has proven itself to be a scalable and globally applicable feature set that's responsive, inclusive and adaptable to fit any environment or organization seeking to elevate human health and promote wellness for all.

WELL v2 is founded on the following principles:

- **Equitable:** Aims to benefit a variety of people, including and especially disadvantaged or vulnerable populations.
- **Global:** Proposes interventions that are feasible, achievable and relevant across many applications throughout the world.
- **Evidence-based:** Draws upon a diverse and rigorous body of research across varying disciplines, validated by a collaborative body of experts, including IWBI advisors.
- **Technically robust:** Defines industry best practice and validates strategies through performance verification and a rigorous third-party verification process.
- **Customer-focused:** Sponsors the success of WELL users through dedicated coaching services, dynamic resources and an intuitive platform for navigating the journey.
- **Resilient:** Keeps pace with advances in research, science, technology and society, continuously improving by integrating new findings.

ARCHITECTURE OF THE RATING SYSTEM

WELL v2 consolidates previous iterations and pilots into a single rating system that is designed to accommodate all project types and sectors. The system is intended to grow in specificity and specialty over time, adapting to accommodate diverse project types and geographies and in response to new evidence and ever-evolving public health imperatives.

Each concept consists of features with distinct health intents. Features are either preconditions or optimizations.

UNIVERSAL PRECONDITIONS

Preconditions define the fundamental components of a WELL Certified space and serve as the foundation of a healthy building. WELL v2 offers a universal set of preconditions for all projects.

All preconditions – including all parts within them – are mandatory for certification.

FLEXIBLE OPTIMIZATIONS WITH MEANINGFUL WEIGHTINGS

Optimizations are optional pathways for projects to meet certification requirements in WELL. Project teams may select which optimizations to pursue and which parts to focus on within each optimization.

WELL v2 operates on a points-based system, with 110 points available in each project scorecard. All optimizations are weighted with varying point values. The maximum point value of a feature is determined by the sum of its parts. A part is weighted by its potential for impact, defined as the extent to which a feature addresses a specific health and wellness concern or opportunity for health promotion, and the potential impact of the intervention.

Note: for some optimizations, achieving points in one part is contingent upon achieving points in another part.

DYNAMIC SCORECARD

The WELL digital platform guides project teams through the development of a unique scorecard. The digital platform recommends a selection of features based on project-specific parameters that can be further defined and refined by the project team.

PERFORMANCE VERIFIED FEATURES

WELL is a performance-based system. Every WELL project is verified through on-site testing of building performance. This practice is fundamental to high-performing buildings and helps project teams better understand the relationship between the physical environment and human health.

The process for on-site assessments and testing is called Performance Verification. On-site measurements are taken for various air and water quality parameters, as well as sound and light levels. It is a distinct process from traditional building commissioning and assures that the building performs as intended, according to WELL requirements.

Performance Verification is completed by an authorized WELL Performance Testing Agent, who usually spend one to three days in the building to validate the project's documentation and complete a series of performance tests, spot-checks and measurements covering all WELL concepts. Testing is completed according to IWBI's sampling protocols available in the WELL Performance Verification Guidebook.

PROJECT TYPES

WELL v2 projects fall into one of two main groups, determined primarily by ownership type:

- **Owner-occupied**: The project is mainly occupied by the project owner (which may be different than the building owner).
- **WELL Core:** The project owner occupies a small portion of the project area and rents/leases most of the space to one or more tenants.

OWNER-OCCUPIED PROJECTS

Owner-occupied projects are owned or leased by the project owner, and regular occupants (e.g., employees) are affiliated with the project owner. Owner-occupied projects are awarded WELL Certification at the Bronze, Silver, Gold or Platinum level (see Scoring and Certification Levels below).

Interiors represent a particular case of owner-occupied projects, where the project owner rents/leases space within a larger building (the "base building") that is less than half the size of the base building. Interiors projects operate like other owner-occupied projects, but in some cases, they can receive credit for amenities within the base building (see Project Boundary below). In other instances, interiors projects may be required to collaborate or work with the building owner or landlord to meet feature requirements that apply to building systems or spaces outside of the project owner's control, such as the HVAC system.

WELL CORE PROJECTS

WELL Core is a distinct pathway for core and shell buildings (also known as base buildings) seeking to implement fundamental features to benefit tenants. In these projects, the majority of regular occupants are not affiliated with the project owner. Any building type can register for WELL Core, provided that at least 75% of the project area is occupied by one or more tenants and/or serves as common space in the building accessible to all tenants. Note that offices affiliated with the project owner but unrelated to the management of the project property may be considered a tenant, as long as additional tenants unaffiliated with the project owner occupy at least 60% of the net leased area. WELL Core projects are awarded WELL Core Certification at the Bronze, Silver, Gold or Platinum level (see Scoring and Certification Levels, below)

Mixed-use buildings where WELL Core is appropriate for at least 60% of the project area may register the entire building for WELL Core. Areas operated/occupied by the project owner are considered "non-leased space" (see Scope and Applicability below). Non-leased spaces include the common areas of the building and private spaces directly under the control of the building management team. Mixed-use buildings where WELL Core is appropriate for less than 60% of the project area should register one or more portions of the building as individual projects for WELL Certification or WELL Core Certification, as appropriate.

FEATURE APPLICABILITY AND SCORING

Features have varying scopes of applicability for WELL Core projects, depending on the relevant population and project area. For example, some features, such as daylighting (L05) or bicycle storage (V04), must be met across the entire building. Other features apply only to spaces or personnel under the purview of the project owner, such as offering healthcare (C06) or childcare (C10) benefits.

Applicability designations are defined as follows:

- **Whole Building**: Includes all areas within the project boundary. Some features indicate that projects can achieve a feature by providing a tenant budget. To use this pathway, project teams need to submit as part of documentation review, design assumptions and sample cut-sheets (as applicable) that justify the budget and can be used by the tenant during their design and construction process.
- **Extent of Developer Buildout:** Includes all non-leased space and all construction within the leased space for which the project team is responsible.
- **Leased Spaces:** All areas within the project boundary that are leased to or owned by tenants, including areas for lease or for sale that are not currently occupied.
- **Non-leased Spaces:** All areas within the project boundary that are not considered leased space.
- **Building Management Staff:** Individuals responsible for maintaining and operating the building, including contractors and sub-contractors. Workers who spend less than 30 hours per month in the building (i.e., who are not regular occupants) are not considered building management staff.
- **Direct Staff:** Building staff under direct employment by the project owner. Note: If a project has no direct staff on-site (i.e., the building is entirely operated by contracted building management staff), the project is allowed to earn points by meeting feature requirements for all or a defined subset of building management staff. Projects must use a single consistent population across all features, including preconditions (e.g., a project with no direct staff may only earn a point for meeting an optimization for its building management staff, if it also meets all preconditions for that same group of people).

WELL Core projects have different point-values for parts and features than owner-occupied projects, based on the extent to which the requirements benefit all occupants within the project. Features that must be met for the whole building are generally worth more for WELL Core, while features with no or limited effect on tenants are generally reduced in value.

Some features allow WELL Core projects to earn points for applying the feature outside of the leased space and earn an *additional* point for achieving the requirements for their tenants. Further guidance on applicability and additional point-earning potential for WELL Core is provided in the digital standard. To view this guidance, be sure to select the "WELL Core" view in the digital standard.

PERFORMANCE TESTING SCOPE

For WELL Core projects, at least 2.5% of the total building floor area must be available for performance testing. The available testing area must include all common areas and spaces directly under the control of the building management team. If common areas and spaces under owner control comprise less than 2.5% of the total building floor area, the project must supplement with tenant spaces to reach this threshold. Testing in leased spaces in these cases can take place before or after tenant occupancy.

Some performance-based optimizations explicitly state that they require testing in tenant spaces to be awarded. The project is responsible for identifying and communicating to Green Business Certification, Inc. (GBCI) and the WELL Performance Testing Agent the particular spaces which are available for testing.

MULTIFAMILY RESIDENTIAL PROJECTS

Multifamily residential projects may pursue WELL if they contain at least five dwelling units in a single building with common structural elements. Projects that qualify include apartments, condominiums, townhouses and other residential complexes within all market thresholds – affordable housing, market-rate and luxury.

Multifamily residential projects utilize the WELL Certification pathways (i.e., not WELL Core), even though most of the regular occupants are tenants, and the project owner may not complete the fit-out of the dwelling units.

Performance testing within dwelling units for precondition features is not required for multifamily residential projects seeking certification at the Bronze or Silver level. However, projects cannot achieve Gold or Platinum without testing conditions in a sample of dwelling units. See Features A01, W01, W02, L02 and T01 and the Sampling Rates for Multifamily Residential section of the WELL Performance Verification Guidebook for more details. For optimizations, testing within dwelling units is required, whether or not the project is targeting Gold or Platinum.

At recertification, for all levels of certification, testing is not required within dwelling units -- only in common areas and spaces dedicated to building management.

SCORING AND CERTIFICATION LEVELS

Projects must achieve all preconditions, as well as a certain number of points towards

Total points achieved	WELL Certification		WELL Core Certification	
	Minimum points per concept	Level of certification	Minimum points per concept	Level of certification
40 pts	0	WELL Bronze	0	WELL Core Bronze
50 pts	1	WELL Silver	0	WELL Core Silver
60 pts	2	WELL Gold	0	WELL Core Gold
80 pts	3	WELL Platinum	0	WELL Core Platinum

PROJECT BOUNDARY

Defining the boundary of the project pursuing WELL certification, or the borders of the project brings further specificity to the project's scope. The project boundary must be consistently applied across all features. The project boundary may not unreasonably exclude portions of the building, space or site to give the project an advantage in complying with feature requirements. The project must accurately communicate the scope of the project in all promotional and descriptive materials and distinguish it from any space that falls outside of the project boundary. The project pursuing WELL certification should be defined by a clear boundary, such that the project is physically distinct from any portion of spaces not part of the project pursuing WELL certification.

The project boundary can include both interior and exterior spaces. Note that if the project boundary includes exterior (outdoor) spaces, this area is not counted when determining the project's area at registration (including for pricing purposes). For more guidance on how to calculate project size, download the WELL Certification Guidebook.

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – IV – THE FUTURE OF RATING SYSTEMS – SARA5333

FUTURE OF GREEN RATING SYSTEMS

The World Green Building Council undertook the largest review of studies into the link between green-building ratings and value, and found that having a green rating could decrease a building's sale price by as much as 15% or increase it by up to 30% compared with a conventional building. Similar ranges of -7.5% to 25% for rental values and 0-23% for occupancy rates were also found, although, on average, buildings with green ratings were found to be more valuable and easier to lease. The study also found that, overall, green buildings did not cost more than a 'non-green' building to build and that the price differential was largely based on perception rather than data.

"Many studies have tried to establish if a more sustainable building is a more valuable building, and green building ratings provide a well-understood indicator of a building's sustainability against which its value can be analysed"

INCENTIVES FOR GREEN BUILDINGS IN INDIA

India's growth over the past decade has led to economic progress and dramatic urbanization. India's continued economic development depends on providing more affordable, clean, and reliable energy and lessening the strain on current supplies, presenting an opportunity to real estate developers who can lock in energy and cost savings by building green. Investing in energy efficiency across India's urban areas is key considering that cities contribute about 62 percent of GDP in India, which is likely to increase to 75 percent by 2021.1 Further, India's building stock is expected to triple in the next 17 years as part of the urbanization process.2 Building greener now before floor space triples is necessary to save significant costs and energy and avoid expensive retrofits later on. India has shown leadership in developing efficient buildings, increasing its green floor area from just 20,000 square feet in 2004 to more than 1.35 billion square feet in 2013.3 To move the rest of the market, India has taken an important step by creating an Energy Conservation Building Code (ECBC), which contemplates incorporation of efficient technologies, materials, and construction techniques into new and renovated commercial buildings (potentially also including high-rise residential buildings). Buildings that comply with the ECBC may be up to 60 percent more efficient than standard buildings in India.4 States are at various stages of implementing the ECBC to raise minimum efficiency, and both public and private stakeholders are offering unique incentives to encourage building green and make efficiency pay for developers. As our recent issue brief, Building Efficient Cities: Strengthening the Indian Real Estate Market Through Codes and Incentives, makes clear, most developers encounter common barriers to building green. However, solutions and incentives exist to overcome most barriers, enabling developers to take advantage of energy efficiency's savings and benefits and construct green cities across India. Government officials—from central to state and local levels—can and should work with real estate developers to develop policy and regulatory incentives, and effective compliance mechanisms, to shift India's buildings market toward cost-saving, energy efficient buildings.

INDIAN CITIES' URGENT NEED FOR EFFICIENT BUILDINGS

The country must adopt widespread efficiency measures in buildings in the near term to protect India's economic growth, energy security and climate.

- **Growing energy needs to fuel the country's development in urban and rural areas:** India is currently the fourth-largest consumer of energy in the world.[6] If the country's average annual growth is to meet its target rate of eight percent through 2017, India must increase its production of commercial energy by nearly 41 percent over its 2012 level.[7] India plans to accomplish this by adding more than 88 GW of generating capacity by 2017, 79 percent of which is expected to be from coal- or lignite-fired sources.[8]
- **Energy security is threatened by the widening gap between coal supply and demand:** The country's planned energy expansion cannot and should not be met by limited coal supplies that are now more difficult to extract. Further, without improved reliability of electricity, India will continue to rely in part on diesel back-up generators during power cuts, which are dirty and expensive to run.[9] There are significant opportunities to save energy and therefore increase energy security by scaling energy efficient construction of new and existing buildings across Indian cities.
- **Building energy use causes significant climate impacts and is growing rapidly:** Commercial buildings cause a significant portion of India's rising carbon emissions, while climate change poses significant threats to the population. Commercial buildings consumed nearly 90 terawatt-hours of electricity in 2010, which will increase significantly if floor area triples by 2030 as projected.[10] India's commercial buildings are responsible for emitting nearly 78 million tons of carbon dioxide annually.[11]

Ensuring that India's buildings are energy efficient is a cost-effective option with both economic and environmental benefits. McKinsey & Company values the global building efficiency opportunity at more than Rs. 41 lakh crore ($700 billion) by 2030 and estimates that India could save nearly Rs. 83,000 crore ($14 billion) per year by investing in energy efficiency—an amount equal to current spending on health and education combined.[12]

https://www.nrdc.org/sites/default/files/energy-efficient-construction-incentives-IB.pdf

Shifting the Market: Incentives Available to Indian Real Estate Developers

The following incentive mechanisms and opportunities can help developers overcome barriers to building green to achieve higher levels of energy efficiency, locking in cost and energy savings. Building Rating Systems Building rating systems recognize newly constructed or retrofitted buildings that achieve high levels of energy efficiency. In addition to lower operating costs and other benefits, as highlighted in our case study Saving Money & Energy: Case Study of the Energy Efficiency Retrofit of the Godrej Bhavan Building in Mumbai, building efficiency champions benefit from the brand recognition, leadership, and market competitiveness that come with such ratings. The number of certified green buildings in India has exploded over the past four years, from ten million square feet of green certified buildings to more than 1.35 billion square feet.

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, normalized for its operational use and climatic zone. Looking ahead: Building ratings programs need to undergo continuous improvement to keep rewarding higher caliber buildings. Better verification after the building is completed to measure actual energy savings

and ensure compliance with certification requirements would also strengthen the rating system. Finally, ratings programs should push to increase participation by a broader segment of India's real estate market beyond the current market leaders and champions to increase the proportion of building stock that meets these high standards.

Building Spotlight: Infosys

Infosys, a global consulting and technology firm, was awarded the LEED India 'Platinum' rating by the IGBC for its Software Development Block 1 (SDB 1) building in Hyderabad, Andhra Pradesh. The SDB 1 uses innovative radiant-cooling technology—the first in a commercial building in India—thereby setting higher standards for energy efficiency in Indian building systems design. 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.

© Bhaskar Deol

THE INFOSYS SDB 1 BUILDING IN HYDERABAD, ANDHRA PRADESH, RATED LEED INDIA 'PLATINUM.'

Rebates on Property Premiums and Taxes A number of municipal corporations are beginning to offer tax and premium rebates for buildings that meet certain minimum conditions under existing rating programs. For example, the Pimpri Chinchwad Municipal Corporation (PCMC) in Maharashtra, has made a conscious effort to optimize resources in the built environment through the GRIHA platform. The PCMC offers rebates on premiums paid by developers and also offers property tax discounts based on the number of stars the building achieves through GRIHA certification. Other cities in the state of Maharashtra, including Nashik and Navi Mumbai, are developing property tax-based incentives for green buildings too.

Municipal governments across India can offer similar rebates to lock in energy savings, reducing energy demand as urbanization continues. Participating cities can also consider expanding the program by increasing the types of buildings eligible for these premiums and

property tax rebates to diversify the landscape of efficient buildings. Energy Service Companies Energy Service Companies (ESCOs) help building owners develop and finance energy saving projects, frequently by paying for the energy upgrades upfront. For a fixed long-term time period, the owner then pays the ESCO for their energy, often capped at their pre-retrofit costs, and the ESCO pays the utility for the energy actually used. Because of the energy savings of the project, the ESCO can use the difference to pay for the financing of the project and make a profit while removing the barrier of efficiency's high upfront cost for building owners. Although Indian ESCOs have successfully implemented some energy efficiency improvement projects, the ESCO market has yet to take off in India, due, in part, to the weak legal framework for contracts enforcement. Although involvement by the Bureau of Energy Efficiency (BEE) has helped to support ESCOs, they have not yet been able to significantly penetrate the market.

Looking ahead: Increasing awareness among developers and companies of the benefits of the ESCO model and how it can support a building's construction or retrofit, and even take on some of the payback risk, would expand the network and reach of ESCOs. A well-defined, standardized, transparent EPC contract format would help boost ESCO operations and promote full-service financing models that include lenders, equipment manufacturing and installation, and energy saving monitoring and verification.

Floor Space Index Allowances Many states in India and other municipalities around the world have limits on the Floor Space Index (FSI) or Floor-Area Ratio (FAR), a measure of the built-up floor area of a building relative to the size of the plot it is built on. In some areas, high costs can be paid to exceed this limit. To incentivize developers to build green, a portion of this extra FSI is given to developers of efficient buildings for no cost, increasing the value of their properties. The Noida region outside Delhi allows GRIHA-certified gold or platinum (4 or 5 star) rated buildings that have plots exceeding 3,000 sq. meters to exceed the FSI limit by one to five percent.

Similarly, the city of Bhubaneshwar and states of Punjaband Keralahave announced additional or free FSI allowances for buildings that meet a stipulated minimum green building rating.

In Pune, the Municipal Corporation offered buildings with qualifying solar or wind power equipment two additional FSI or a discount of 50 percent on paid FSI, although this program has since been discontinued.

Building Spotlight: Mahindra Towers

The Mahindra Towers office building in Mumbai successfully worked with an ESCO to complete an energy efficiency retrofit focused on its lighting system. As a result of the retrofit, Mahindra Towers reduced its monthly power consumption by 10 percent, saving 470,403 kilowatt-hours (kWh) per year and Rs. 40,09,965 ($67,952) from March 2009 to March 2010. With an initial investment of Rs. 15,90,000 ($26,944) for the retrofit, Mahindra Towers had an impressive payback period of less than half a year. The Mahindra Towers retrofit demonstrates how working with an ESCO to implement energy efficient measures is practical and profitable in India's rapidly transforming building market and provides replicable practices for cost and energy savings.[19]

MAHINDRA TOWERS POST-RETROFIT.

Photo used with permission from Mahindra & Mahindra

Other Highlighted Incentives The country offers a variety of other incentives as well at the municipal, state and national levels. State-level Incentives and Codes: n Haryana: The Department of Renewable Energy bears 50 percent of energy audit costs and grants monetary awards for excellence in energy conservation.

Punjab: The Punjab Energy Development Agency and the Indian Institute of Architects collaborated on a draft adaptation of the ECBC that would apply to large residential buildings.

Uttarakhand: A draft ECBC has been submitted for notification.

Maharashtra: Expedited environmental approvals are provided for green-certified buildings.32 n Andhra Pradesh: Adopting the ECBC as mandatory in 2014 with innovative compliance mechanisms. City-level Incentives and Codes:

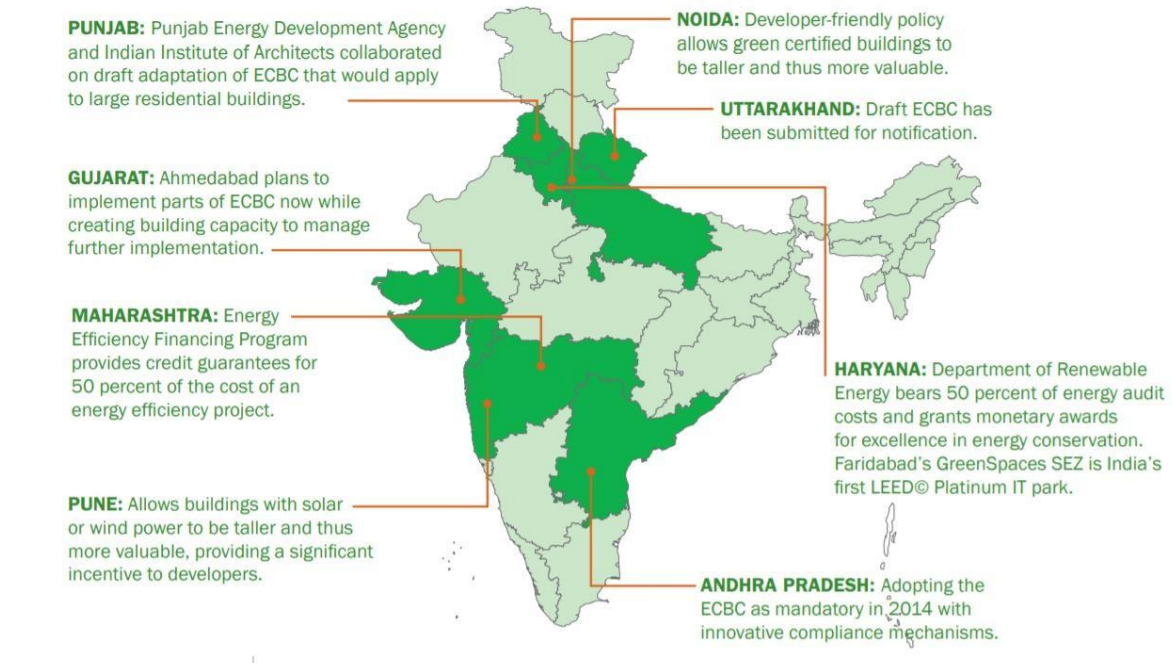
Noida: Developer-friendly policy allows green-certified buildings to be taller and thus more valuable.

Ahmedabad: Developing a scheme that would allow city to implement parts of the ECBC now while building capacity to manage further implementation.

Hyderabad: Architects can receive monetary incentives for designing GRIHA-rated buildings.

Pune: Allows buildings with solar or wind power to be taller and thus more valuable, providing a significant incentive to developers. On the central government level, the Ministry of Environment and Forests (MOEF) gives priority for obtaining environmental clearance to buildings meeting the criteria of rating programs, including GRIHA and LEED India

Figure 1. Energy Efficiency Advances Across India's Cities and States



ENERGY AUDIT FOR BUILDINGS

Purpose of Energy Audit

- The term audit defines evaluation activity of an organisation, process, project or product.

Purpose of auditing

- Use the information collected for achieving an improvement :
  - better performance,
  - cost reduction,
  - improved security or,
  - improvement of the overall quality

- "the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption" - BEE

When the Subject of Audit is " Buildings" and the purpose is - To reduce the consumption of energy it is called Energy Audit

A simplified energy audit process can be structured into four steps :

1. acquisition of documentation;

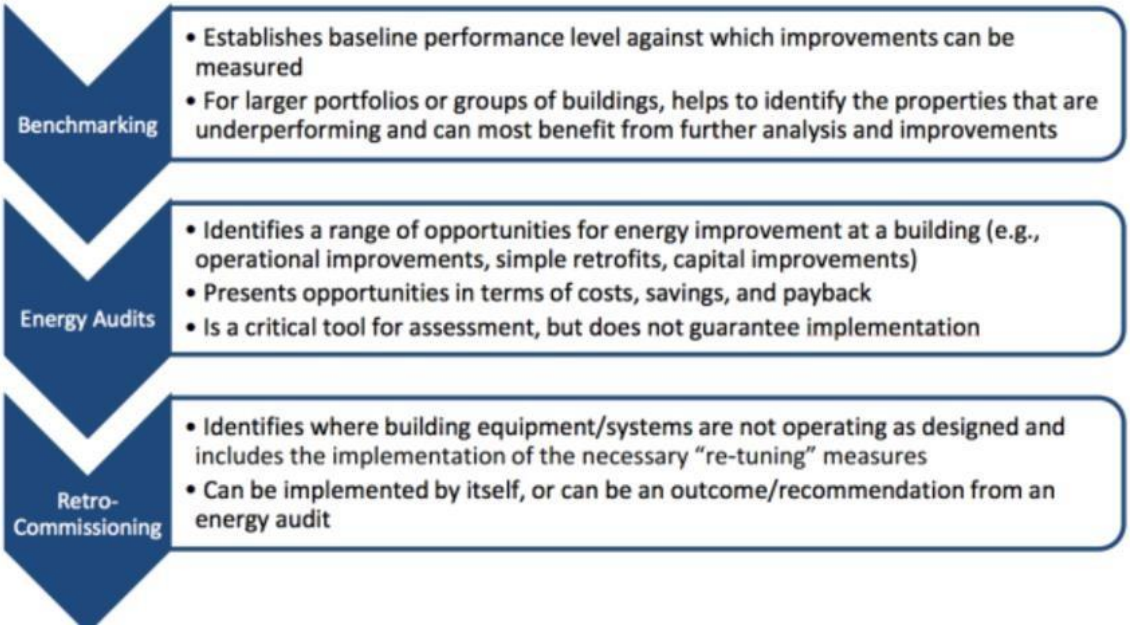
2. field surveys and monitoring;

3. definition of energy retrofit measures and

4. editing of the audit report.

PROCESSS

Layers of policy can help building owners understand their **energy use** (benchmarking), **identify opportunities for savings** (audits), and implement the **low cost improvements for immediate savings** (retro-commissioning).



In the Building Audit, issues are regarding :

- **Thermal comfort**
- **Air quality**
- **Lighting comfort**
- **Acoustic comfort of internal spaces**
- **Building envelope**
- **HVAC systems**
- **Energy consumers like lifts (elevators), safety and security**
- **Domestic hot water (DWH)**

WHO IS AN ENERGY AUDITOR?

- Energy Auditor is a specialized consultant who helps improve the energy efficiency buildings
- Energy auditors are essentially building inspectors who provide consultations on energy efficiency.
- Energy auditors conduct tests in order to determine the source of poor energy efficiency and provide clients with actionable, real-world advice.

For the auditor other skills should be considered:

• the ability to operate in the field;

• a knowledge of current security issues;

• competence in using survey and monitoring instruments;

• the ability to communicate and interact not only with the client but also with his staff;

• the ability to write the audit reports clearly and effectively;

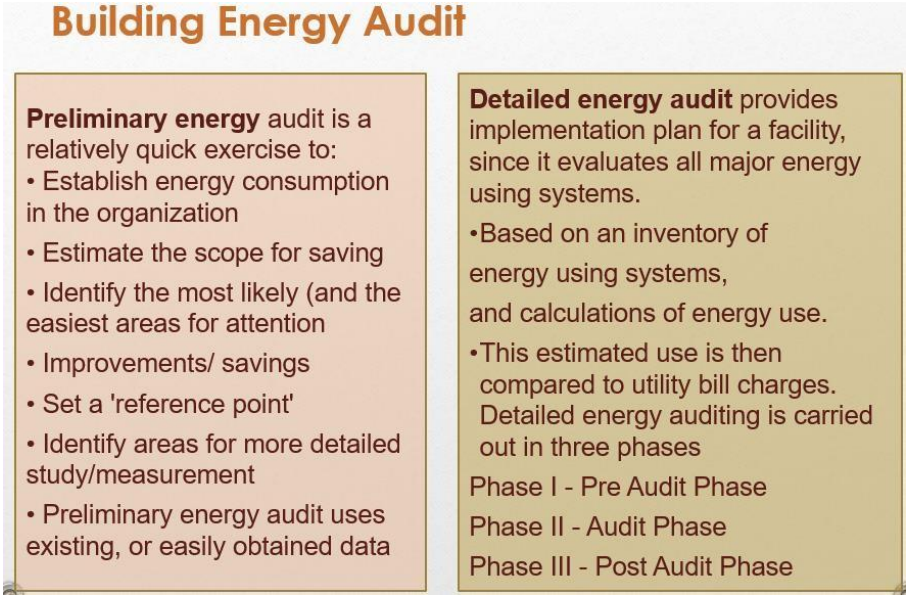
• ensured continuing professional development (CPD), covering all updates in norms and regulations

• the skills & knowledge to continuous updating of the technical and legislative requirements and

• confidentiality in handling information.

Types of Energy Audit

- The type of Energy Audit to be performed depends on:
  - Function and type of buildings
  - Depth to which final audit is needed, and
  - Potential and magnitude of cost reduction desired
- Thus Energy Audit can be classified into the following two types.
  - i) Preliminary Audit
  - ii) Detailed Audit



Procedure of Energy Audit

- **Pre-audit stage**
  1. Defining scope of energy audit
  2. Forming an energy audit team
  3. Estimating time frame and budget
  4. Collecting building information
- **Energy audit stage**
  1. Conducting site inspection and measurement
  2. Analyzing data collected
  3. Preparing energy audit report
- **Post-audit stage**
  1. Implementation of energy management opportunities
  2. Monitoring and review

Questions that the auditor may ask the client

Possible questions	Interpretations of responses
Is reducing the cost of management the only goal of the audit?	If so, few opportunities remain to suggest other motives and one must understand what financial commitment the customer is ready to sustain and for how long. A negative response provides an opening to other possible reasons; it is for the auditor to define a broader framework
Is the heightened value of the building as a result of the retrofit work a factor to consider?	A positive response can lead to prediction of the time of return on investment, which may exceed the period of use of the building, since all that is not recovered from the improved performance can be recovered from the consequent increased value of the building when it is sold
If the client is already planning redevelopment of the opaque building envelope, is it for technological reasons or to improve the image?	The measures applied to improve opaque building envelope performance are those that require larger investments and longer payback times An affirmative answer to this question gives the auditor the opportunity to offer these remedial actions. The economic evaluation of the investment should reasonably take into account only the value added related to improved energy performance

Transition from Energy Audit to 'Green' Energy Audit

Energy Audit aim – reduction of energy consumption approach based on economics, not emphasizing on reduction in environmental impact derived from choices of greater efficiency …but the resultant reduction in operating costs.

Though Energy Audit does represent an important opportunity to contribute , through measures proposed and implemented to reducing the overall environmental impact of the building or structure under investigation.

This consideration has given rise to idea of giving a different interpretation of energy audit.

It emphasizes those aspects in addition to ensuring improved energy performance, lead to reduced consumption of other resources and generates benefits in terms of overall sustainability of building.

Green Energy Audit is thus not limited to providing tools and methods to reduce only energy consumption, but has a much more important goal:

- to contribute to an overall improvement in the sustainability of the building.
- to maximise energy performance and to maximise environmental quality;

• measures that use renewable energy are preferred (e.g., solar thermal, PV solar and biomass);

• when defining measures, the auditor should consider all natural solutions that can help control the climate and illumination in the building, such as green roofs, green facades, natural shading systems, passive solar and day-lighting systems;

• evaluation of sustainability targets according to the LEED Standards.

Green Energy Auditing and LEED Credits

In the case of the Green Energy Audit, any measure, is not uniquely linked to a credit.

The aim of a Green Energy Audit is to evaluate the degree of improvement in sustainability of the building as a whole that can be obtained through the proposed choices; such choices do not necessarily generate an advantage in terms of energy, but they can generate many advantages with respect to sustainability.

EA category is relevant to window replacement measures since, in the case of building renovation, replacing windows with models of superior properties can improve the energy performance of a building

LEED credits for new construction related to the transparent building envelope, and points are used to indicate the relevance of certain transparent building envelope remedial actions to the LEED credits.

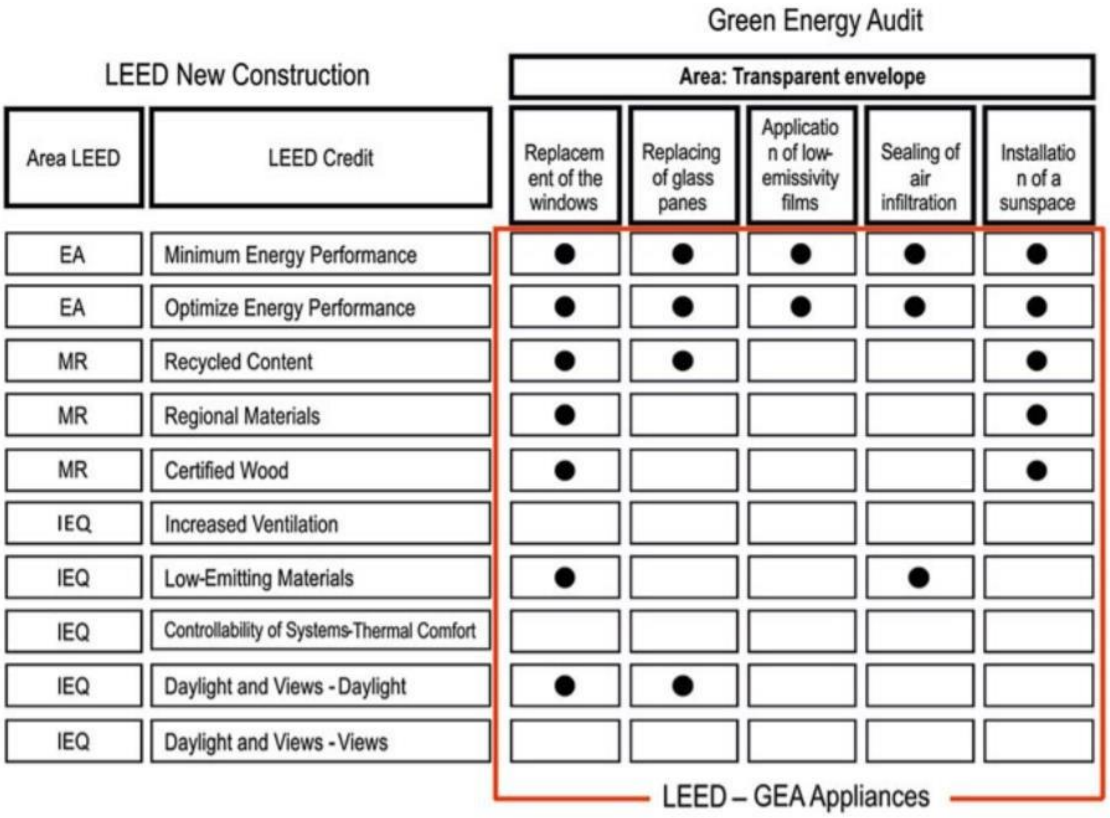


Fig. 9.2 Transparent building envelope intervention with relevance to LEED credit

Operating levels

- Green energy audit's three operational levels

1. Walkthrough
2. Standard
3. Simulation.

Walk through

This gives the idea of just "passing through" during the field visit, conducted in one day

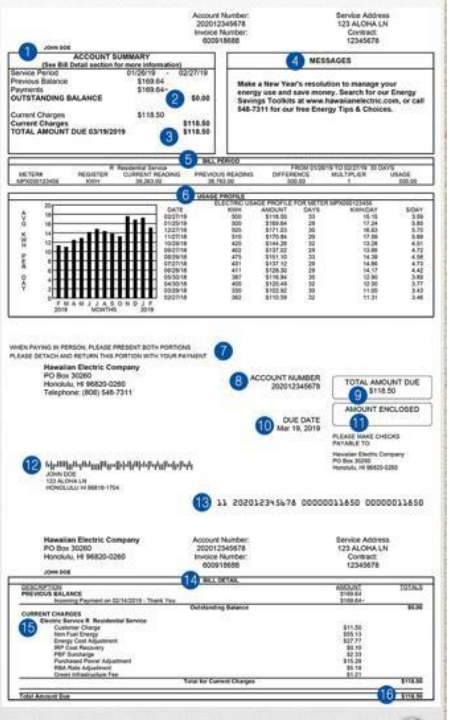
Inspection contains:

Comparison of data with client and asking for additional documents

Check directly features of building and facilities to identify area of inefficiency

Standard Audit

Stringent energy audit than previous. Derives analysis of the energy bills, actual operating conditions. Baseline is created.
Where we check by calculations the effects of different retrofit measures.
Monitoring of environmental conditions like air temp, RH, CO2 concentration
Conducted over period of 1 – 2 weeks



Simulation Audit

A virtual model of the building is created and based on this model, effectiveness of the strategies adopted are verified.
Simulation softwares – Energy Plus, TRNSYS, ESP-r, this helps find the flow of energy between different systems.

- Using computer-based tools to simulate the energy use of a building throughout an entire year of operation.
- Commonly referred to as "annual energy use simulation."

  - Computer based tool
  - Simulates annual energy use of a building
  - Methodical and iterative process to evaluate potential decisions and achieve long-term goals

Energy-Analysis or Energy-modeling is used to:

- Predict the monthly and annual energy consumption
- Predict the annual energy cost
- Annual CO2 emissions
- Compare and contrast different efficiency options
- Determine life cycle payback on various options

1. EnergyPlus
2. eQuest
3. TRNSYS
4. IES - VE
5. Trace 700
6. Apache SIM

GLOSSARY

Commissioning (Cx): a systematic quality assurance process that spans the entire design and construction process, helping to ensure that the new building's performance meets owner expectations. Owner expectations are listed in the owner project requirement (OPR) document.

Retrocommissioning: a systematic method for investigating how and why an existing building's systems are operated and maintained and for identifying ways to improve overall building performance.

Re-commissioning: another type of commissioning that is applied when a building, which has already been the subject of commissioning, is subjected to another commissioning process. Ideally, a re-commissioning plan should be part of the original commissioning plan that is drawn up during the construction of the building.

CxA: an individual hired to lead a retro/commissioning process: the CxA is responsible for managing the process to ensure that the owner will obtain the required performance listed in the OPR document.

Commissioning Team: all persons involved in commissioning activities and that work together to complete the commissioning process. It ideally includes all the persons involved in the design, construction and management of the building, such as the client/user, the design team, the contractor, the construction supervision, the CxA, the operation and maintenance staff and many others.

Commissioning Plan: a document containing all the information required to re/commission the facility. The plan may include specific tasks, their descriptions and their schedules. Other information that may be helpful includes operational requirements for key systems, functional tests and documentation templates.

Commissioning Report: a document that provides an overview of the commissioning process.