Shashwat

Let Nature Be

Volume 3 | Issue 3 | March 2017 ₹125

Transforming Habitats

GRIHA
A GRIHA Council Publication

Feature Articles
- Mainstreaming Green Buildings
- Heatwaves and Cool Roofs
- Smart City

In Conversation
with Ken Yeang

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Design Associates Inc. Office

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Message from
President, GRIHA Council

"It is heartening to note that government and private agencies are committing themselves to align with the GRIHA criteria… many agencies who have already pledged their upcoming large constructions towards GRIHA compliance."

Dear Friends,

The past year has been an enriching experience with the GRIHA family. We have together embarked on a journey with a vision for a greener India. Now more than ever, GRIHA is significant in meeting our national goals, especially with regard to the Intended Nationally Determined Contributions submitted to the United Nations Framework Convention on Climate Change, highlighting GRIHA, as the country's own green building rating for combating global warming and climate change.

GRIHA has been designed as a tool to assess the performance of buildings against certain nationally acceptable benchmarks, throughout their lifecycle. In the past, some states and municipal bodies, such as Assam, Punjab, Kerala, Pimpri-Chinchwad Municipal Corporation, and Noida, had provided incentives to GRIHA-rated buildings to ensure resource-efficient construction. Recently, Haryana, West Bengal, and many more states have also introduced incentives for GRIHA-rated projects. It is heartening to note that government and private agencies are committing themselves to align with the GRIHA criteria. The Madhya Pradesh Police Housing & Infrastructure Development Corporation, Madhya Pradesh Housing and Infrastructure Development Board, BESTECH India Pvt Ltd, and IREO Hospitality Company Pvt Ltd, are some of the agencies who have already pledged their upcoming large constructions towards GRIHA compliance.

Going green has manifold benefits of lower costs, healthier lives, safer world, better quality of life, and exploration of new ideas. Sustainability will be a major driver behind innovation in the challenging new world full of opportunities for strategic innovation. It is expected that technology will play a key role in sustainable development covering all aspects: social, environmental, and economic. Additionally, strengthening domestic policy frameworks is required to catalyse and mobilize private finance and investment in support of sustainable development.

The 8th GRIHA Summit shall serve as a platform to showcase latest initiatives at the habitat level, innovative technologies, and strategies for achieving a better performing built environment.

We look forward to your participation at the GRIHA Summit and wish the deliberations a great success.

Dr Ajay Mathur
President, GRIHA Council

GRIHA Timeline

2000
- TERI conducted over 100 building audits
- TERI Retreat constructed as Green building

2005
- TERI GRIHA released as indigenous green building rating of INDIA

2007
- MNRE adopts GRIHA as a National Rating System for Green Buildings
- ECBC released in India

2008
- National Mission on Sustainable Habitat launched

2009
- Committee of secretaries: 3 star GRIHA mandatory for all Government Buildings
- CPWD embraces GRIHA
- Acknowledged as an innovative region-specific green building assessment tool by the UN

2010
- Evaluators' and Trainers' Programme launched

2011
- Pimpri-Chinchwad Municipal Corporation (PCMC) announces discounts on premium charges to developers and property tax rebate for buyers for GRIHA-rated projects
- Environmental clearance linked to GRIHA pre-certification
- MoU signed with CREDAI

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The Energy and Resources Institute

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Ministry of New and Renewable Energy, GoI

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GRIHA recognized as India's own green building rating system in **INDIA's INDC** submitted to **UNFCCC**.

2012

- SVA GRIHA rating launched
- GRIHA Product Catalogue launched
- SIDBI announces concessional rate of interest for GRIHA projects

2013

- GRIHA LD rating launched
- GRIHA app launched
- GRIHA new user-friendly metro design website launched
- FAR for GRIHA projects in Noida
- FAR for GRIHA projects in Greater Noida
- Pimpri-Chinchwad Municipal Corporation(PCMC) announces Premium discounts to developers and property tax rebate for buyers
- FAR for GRIHA projects in Punjab
- Kerala State Housing Board adopts GRIHA

2014

- Launch of GRIHA Prakriti rating
- MoUD, Delhi Division, GoI, announces additional FAR for GRIHA-rated projects
- MoU signed between USGBC and TERI
- Sikkim mandates GRIHA

2015

- GRIHA and GRIHA LD V.2015 launched
- Government of West Bengal, Department of Municipal Affairs, announces additional FAR for GRIHA projects
- FAR for GRIHA projects in Rajasthan
- FAR for GRIHA projects in Pune
- FAR for Ahmedabad Urban Development Authority(AUDA)
- FAR for GRIHA projects in Uttar Pradesh

2016

- Launch of GRIHA Help Centre
- MoU signed with Madhya Pradesh Police Housing & Infrastructure Development Corporation
- Launch of Institute membership programme ACE
- Launch of students, membership programme CATALYST
- FAR for GRIHA projects in Haryana
- Pune Municipal Corporation(PMC) announces discount in premium charges for GRIHA/SVA GRIHA projects
- MoU signed with Indo-Italian Chamber of Commerce and Industry (IICCI)

2017

- GRIHA EB launched
- MoU signed with Bestech Group
- MoU with Ireo Developers
- MoU signed with Madhya Pradesh Housing & Infrastructure Development Board


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Minister of State (Independent Charge)
for Power, Coal, New & Renewable Energy and Mines
Government of India

सत्यमेव जयते

Message

With the looming threat of global warming and climate change all stakeholders including businesses, investors and policymakers are under immense pressure to balance their growth aspirations with the need to reduce carbon emissions. India, being a developing country, also has the responsibility of providing its citizens affordable 24x7 power.

To achieve these goals, Government of India has set the world's most ambitious expansion plans for renewable energy with a target of achieving 175 GW by the year 2022. Government has also launched various Demand Side Management (DSM) projects focusing on reducing carbon footprint through providing access to various energy efficient equipments including LED lighting, agricultural pump sets, fans etc, at affordable prices.

I am delighted to learn that *'GRIHA Council'* is organizing *'The 8th GRIHA Summit, 2017'* on 2nd and 3rd March, 2017, to discuss and deliberate on furthering Green Habitat Development in India. I am confident that the conference will serve as a platform for sharing and stimulating innovative ideas to encourage people to move towards energy efficient and greener products, and thereby, complement Government's efforts to reduce carbon footprint.

My best wishes for the successful event.

Piyush Goyal

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MINISTER
SCIENCE & TECHNOLOGY AND EARTH SCIENCES
GOVERNMENT OF INDIA
NEW DELHI - 110001

MESSAGE

Indian science is regarded as one of the most powerful instruments of growth and development, especially in the emerging scenario and competitive economy. We, at the Ministry of Science and Technology, establish strategically important systems and mechanisms to stimulate and foster excellence and leadership in scientific research and development. These are aligned with India's developmental aspirations and will further help consolidate the niche it has established in several frontiers at the national, regional and global levels.

Today, technology plays an immense role in sustainable development in all of its aspects: social, environmental and economic. However, technology is also largely dependent on fossil fuels, and thus smart, innovative and sustainable solutions are important for the overall progress of our country.

It is heartening to learn that GRIHA Council is organizing the 8th flagship event "The GRIHA Summit 2017". The Summit is central platform for all stakeholders in the industry to exchange ideas, strategize and provide sustainable solution.

My best wishes to the GRIHA Council for the success of the event.

Harsh

(Dr. Harsh Vardhan)

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राजीव कपूर
Rajeev Kapoor

सचिव
भारत सरकार
नवीन और नवीकरणीय ऊर्जा मंत्रालय
SECRETARY
GOVERNMENT OF INDIA
MINISTRY OF NEW AND RENEWABLE ENERGY

Message

It has almost been a decade since GRIHA rating was jointly established by MNRE and TERI. I am pleased to note that India in its "Intended Nationally Determined Contributions (INDCs): Working Towards Climate Justice" document submitted to the United Nations Framework Convention on Climate Change (UNFCCC), has highlighted GRIHA, as the country's own green building rating tool to evaluate reduction in emission intensity through habitats. Thus, GRIHA has been recognized as part of the mitigation strategy of our country for combating global warming and climate change. Several private and government agencies such as Central Public Works Division (CPWD), National Buildings Construction Corporation Ltd. (NBCC), etc. have adopted GRIHA for evaluating their buildings compliant to green concepts. This has been conceivable, as GRIHA encompasses codes and standards of various government agencies such as Energy Conservation Building Code (ECBC), Central Ground Water Board (CGWB), Central Pollution Control Board (CPCB), making it a robust yet adaptable guideline.

It is heartening to learn that the 8th GRIHA Summit with the theme of 'Transforming Habitats' is being organised on 2nd and 3rd March 2017. The Summit shall serve as a platform for showcasing latest initiatives at the city and building level, innovative technologies and strategies for achieving a better performing built environment. Thus, I am sure that it would play a vital role in transforming the habitats sustainably in India. I would also like to acknowledge GRIHA's role in integration of renewables in the building sector to compliment the efforts of Government of India. Further, GRIHA is the only green building rating system which has mandated renewable installation in all GRIHA buildings.

My best wishes to GRIHA Council for the success of the 8th GRIHA Summit, 2017

[Rajeev Kapoor]

ऊर्जा से देश विकास
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February 20, 2017

Message

The primary energy demand of India has grown from about 450 million tons of oil equivalent (toe) in 2000 to about 770 million toe in 2012. This increase is driven by a range of factors, the most important of which are increasing income and economic growth which lead to greater demand for energy services such as lighting, cooking, space cooling, mobility, industrial production, office automation, etc. To cater to the rising energy demands of India and at the same time ensuring reduction in greenhouse gas emissions, the government has adopted several measures, both on the supply and demand side.

Super critical technologies together with cleaner alternative energy sources are being promoted in the generation of electricity, while energy efficiency and demand side measures are being increasingly adopted to regulate demand, both through regulatory and market instruments.

Bureau of Energy Efficiency (BEE), Ministry of Power is implementing the Energy Conservation Building Code (ECBC) to promote energy efficient design of commercial buildings. I am informed that the provisions of the ECBC have been largely integrated in the GRIHA rating system developed by Ministry of New and Renewable Energy (MNRE) and The Energy and Resources Institute (TERI). This will further the adoption and implementation of code in design of new commercial buildings.

I am pleased to learn that GRIHA Council is organizing the 8th flagship event "The GRIHA Summit 2017" on 2nd and 3rd March, 2017.

I wish GRIHA Council success for the GRIHA Summit and in all their future endeavours.

(P.K. Pujari)

RIGHT TO INFORMATION

स्वच्छ भारत
एक कदम स्वच्छता की ओर

राजीव गौबा
सचिव
Rajiv Gauba
Secretary

भारत सरकार
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निर्माण भवन, नई दिल्ली-110011
Government of India
Ministry of Urban Development
Nirman Bhawan, New Delhi-110011

February 13, 2017

MESSAGE

India has a rapidly growing population with rural to urban migration rate of 31.8% during the last decade. A large part of India's infrastructure is yet to be built, which is why we need to understand, critically examine and execute efficient solutions for sustainable development in an integrated manner. To meet these goals, the Ministry of Urban Development (MoUD) have adopted a policy initiative which mandates that all public buildings constructed by Central Public Works Department (CPWD) buildings shall follow green norms.

Sustainable and resilient buildings are the need of the hour with the looming climate change situation. Development of Smart Cities is a step in that direction. GRIHA will play an important part in the sustainable urban development of India.

I am pleased to learn that the GRIHA Council is organising "The 8th GRIHA Summit 2017". I sincerely hope that the Summit will provide a platform for exchange of ideas to move towards a greener and cleaner habitat.

I wish the GRIHA Council a great success.

(Rajiv Gauba)

B.P. Pandey
Special Secretary,
Government of India &
Director General,
Bureau of Energy Efficiency

सत्यमेव जयते

भारत सरकार
GOVERNMENT OF INDIA
विद्युत मंत्रालय
MINISTRY OF POWER

MESSAGE

India's primary energy demand is expected to escalate 3 times by 2030 due to accelerated industrialization, urbanization and emerging consumer society. With rising annual energy consumption in the residential and commercial building sectors, the building industry has seen a consistent rise in the energy consumption from 1970s to 2016. To address the energy security, environmental and economic challenges we face, increasing energy efficiency is a crucial strategy.

Recognizing the fact that efficient use of energy and its conservation is the least expensive option to meet the increasing energy demand, Government of India has undertaken several initiatives under the regulatory provisions of the Energy Conservation (EC) act 2001. I am informed that the GRIHA Council has mandated most of the provisions of the Energy Conservation Building Code (ECBC) into their rating systems.

Among the various strategies adopted for transforming markets towards energy efficient practices, the Energy Conservation Building Code (ECBC) has been developed and is being implemented in a streamlined manner across states and municipalities to design upcoming buildings as energy efficient.

I am sure that the collaboration efforts of both BEE and the GRIHA Council would help on transforming the urban sprawl towards sustainability.

The forthcoming GRIHA summit, with the theme "Transforming Habitats" would provide a platform to address the challenges of promoting sustainable habitats for all. I wish the deliberations a great success.

(B.P. Pandey)

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Message from
CEO, GRIHA Council

> Now is the time to work whole-heartedly to provide a brand that is rapidly emerging as a symbol of excellence. Simplifying, strengthening and standardizing the GRIHA tool are critical for accelerating its penetration in all segments of infrastructure.

Dear Friends & Colleagues,

At the outset, let me thank the entire GRIHA family for welcoming me into their fold and reposing their confidence in me to lead the vision of sustainable habitats for all.

Our economy is at a unique juncture in its development. This is the moment of opportunity of realizing the potential for significant transformation across all sectors of the economy. Several policies have been introduced by the government that support the creation of an enabling ecosystem & encourage the adoption of sustainable lifestyles. With this in mind, we pitched "Transforming Habitats", as the theme for the 8th GRIHA Summit.

Several important developments have preceded the GRIHA Summit. Both government and private developers have expressed their solidarity with the brand "GRIHA" to embark on this transformative journey towards green habitats. Now is the time to work whole-heartedly to provide a brand that is rapidly emerging as a symbol of excellence. Simplifying, strengthening and standardizing the GRIHA tool are critical for accelerating its penetration in all segments of infrastructure. On the other hand, it is equally important to develop an outreach strategy which showcases GRIHA as a transparent, robust, and dependable tool for its large-scale adoption.

The first meeting of the reconstituted Management Committee of the GRIHA Council laid emphasis on developing required processes to achieve our objective. In the year ahead, we would be engaging with several state and central government agencies for mainstreaming GRIHA into the existing and upcoming policy frameworks. Simultaneously, we would endeavour to develop GRIHA as a sustainable corporate entity to provide our talented team of professionals to be challenged and hone their expertise.

Friends, I am delighted to share that this year's GRIHA Summit has received an overwhelming response from all our partners across government, bilateral/multi-lateral agencies, private developers, manufacturers, academia, and professionals. This is all due to the untiring efforts, dedication, and passion of the GRIHA team. The Summit will be an enriching and valuable experience for all the participants and stimulate & foster further partnerships in the years ahead. I express my gratitude to all the partner organizations for their unstinted support.

I acknowledge the enriching work of my predecessors and look forward to their continued support in our future endeavours. On behalf of the President & Members of the GRIHA Council and the GRIHA team, I welcome you all to the 8th GRIHA Summit with the theme "Transforming Habitats".

Sanjay Seth
Chief Executive Officer
GRIHA Council

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IN CONVERSATION 35

FEATURE ARTICLES

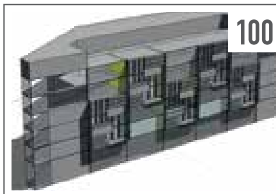
45

We cannot realize our claims of a sustainable or liveable city unless the citizens and the authorities realize that a city is a living, breathing complex ecosystem and has to be given same protection needed by living beings.

65

In India, an increasing reliance on electricity for cooling purposes has overshadowed more traditional methods to deal with hot weather.

100



Even among commercial buildings, the energy consumption patterns, occupancy, and project requirements shall be drastically different and so will the energy consumption trends and hence the energy saving measures.

ONE GOAL, MANY ROUTES

Sunanda Satwah is an environmental architect with a 15-year experience in the field of architecture, and over a decade's experience in healthcare design. She has worked on a wide range of projects. She is currently a visiting faculty at CTESCOA, Chembur, and has her own consultancy.

Ever observed how animals build? Animal architects build by instinct, applying the same methods and materials as their ancestors did. They build to avoid enemies, trap food, for protection from extreme weather conditions, and to raise their young. On the other hand, *Homo sapiens* have been rapidly improvising skills and materials required to build their habitat. It is easy to discard the humble habitats built by animals as insignificant in lieu of what man can build; however, it may be noted that the 850m-long dam in North Alberta, Canada, which can be seen from outer space, is the largest animal-built infrastructure on the planet which has been built entirely by beavers! Prairie dog towns are known to run parallel for several square kilometres underground; the largest covering about 65,000 sq miles in Texas. These burrows are complete with sleeping areas, nurseries, and toilets to boot! The termite mounds of Australia, rising to a height of 20 ft, are a prime example of air-conditioned arcologies! No mean feat for white ants, these earth structures could challenge any man-made skyscraper in structural integrity and thermal comfort. Animal architecture—may it be a spider's web, a baya weaver bird's nest, a weaver ant's nest, or a rabbit's warren—are exemplary examples of engineering and sustainably built forms. These natural habitats have been a source of great inspiration for many architects. Mick Pearce's *Eastgate Building* and *CH2* were inspired by termite hills and how! The history of architecture is rife with structures inspired from nature. Take for instance the numerous bridges inspired from the catenary form found in a spider's web.

Biomimicry in Architecture

In recent years, a new branch of science has evolved that emphasizes upon the wisdom in

learning from nature. Biomimicry (deriving from the Greek word '*bios*' meaning life and '*mimesis*' meaning imitation) is a methodology that is increasingly applied by designers to improve the sustainability of built environments. Biomimicry urges us to look at nature as a model, measure, and mentor. It focuses upon what we can 'learn' from nature, instead of what we can 'extract' from it. After 3.8 billion years of evolution, nature has learnt what lasts and what does not. Biomimicry can be integrated in a design at three levels: the organism (form), the behaviour (process), and the ecosystem. As the names suggest, a design adaptation mimics a natural process at one of the three levels. While Pearce's *Eastgate* and *CH2* mimic termite mounds at a behaviour level, Pawlyn's *Mobius Project* and the *Sahara Forest Project* replicate an ecosystem. Inspired from nature, each approach serves to solve a habitat issue in the least obtrusive way.

Pier-Luigi Nervi's *Palazzetto dello Sport* was inspired by the Amazon water lily leaf, and is a prime example of how efficiently and beautifully nature translates into structures. Julien Vincent once stated that, 'in nature, materials are expensive and shape is cheap'. One observes this in the branching pattern of trees and blood vessels. In nature, nothing is ever wasted as is evident from its ingenuity of form. One has to merely study a single leaf to realize this. Nature's economical use of material and resources has been extensively explored by Murray's Law, the Lindenmayer system, and the Fibonnacci sequence. Nature-made structures have an inherent ability to do maximum work by expending minimum energy or material. Man-made structures, on the other hand, tend to be energy intensive and wasteful.

Biologist E O Wilson has interestingly remarked that ants, across the world, exceed humans in their numbers and mass and yet they have always known to nourish the earth and never harm it. On the contrary, man has depleted natural resources with excessive mining; dumped toxic waste in lands and oceans; polluted air, water, and land; affected climate change; and has unleashed a range of ailments and brought about ruin in almost every aspect of the environment. Conventional development, as we know today, threatens a large number of species and micro-biomes with extinction.

Nature Inspired Buildings

Considering that the building sector consumes about 33 per cent of electricity generated, we are faced with the moral dilemma of reducing our energy demands. Almost 68 per cent of India's energy is generated from coal-based thermal power plants, which is one of the biggest sources of pollution. Based on computer simulation models, the possibility of reducing the energy demand in ECBC compliant buildings by 40 to 60 per cent has been estimated. This reduction in energy consumption, or use of alternative renewable energy, is a step towards a cleaner and greener nation.

Spiders constantly recycle silk to spin their webs, while swiftlets build nests entirely out of saliva. Many animal architects use body juices, mud, and vegetation to build their abodes. Human beings, however, need to procure building material from the land. This should be achieved by applying sustainable building practices and harvesting materials, especially for construction purposes. Harvesting bamboos or growing trees under the Forest Stewardship Council, is gradually gaining prominence. Combined with indigenous practices and vernacular styles, such buildings tend to be climate responsive, thermally comfortable, and energy efficient. Buildings constructed with compressed earth blocks (CEB) excavated from the site, is a vernacular style of construction that is often rooted in the culture and climate of the land. However, considering the burgeoning urban population, by 2040, 75 per cent of the world's population is expected to live in cities, resulting in rapid vertical development. If we could take cues from termite hills, these skyscrapers need not be unsustainable structures.

Most high-rise, artificially-conditioned buildings tend to be huge energy guzzlers. Now, a hornet's several-storied nest is thermally designed to provide controlled temperature for the larvae to pupate. The nest is insulated by walls of paper, several layers thick, that protect the young from cold and heat to ensure thermal comfort. The termites' termitary, too, is designed to seal in moisture and keep out heat via a system of channels and ducts incorporated to circulate air through the mound. Would it not be wonderful if our buildings were designed to mimic nature? The photovoltaic cell is a remarkable adaptation of a photosynthetic leaf that converts sunlight to energy. The responsive facade of Abu Dhabi's *Al Bahar Towers* boasts of a *mashrabiya*-like external automated shading device that responds to sunlight and mimics the opening and closing pattern of a flower. Biomimicry-inspired devices borrow from an endless list of shells, skeletons, soap bubbles, radiolaria, trees, webs, or woven structures. These naturally-occurring inspirations can in turn be developed into a gamut of retractable, inflatable, deployable, pneumatic, reciprocating, or tension structures.

Material, Technology, and Innovation

The advancement in technology has resulted in many ambitious buildings that employ computational morphogenesis and advanced simulation to algorithmically generate and build prototypes of structures based on leaf voronoi, fractals, L system, soap bubbles, and almost any existing physiology. The *Metropol Parasol* in Spain, *Water Cube* at Beijing, and the *Eden Project* in Cornwall, are examples of parametric architecture. However, it is important to remember that buildings which only mimic shapes for the dramatic forms they generate are examples of biomorphism rather than biomimicry, and do not necessarily contribute to the improved functioning of the building.

David Benjamin's *Hy-Fi tower* took behavioural mimicry to a different level when he built the 12 m-high tower with mushroom mycelium bricks. The evocative bricks used in the tower were made from mushroom mycelium and agricultural waste, thus putting to use waste products, harvesting clean building blocks, and simultaneously reducing the carbon footprint.

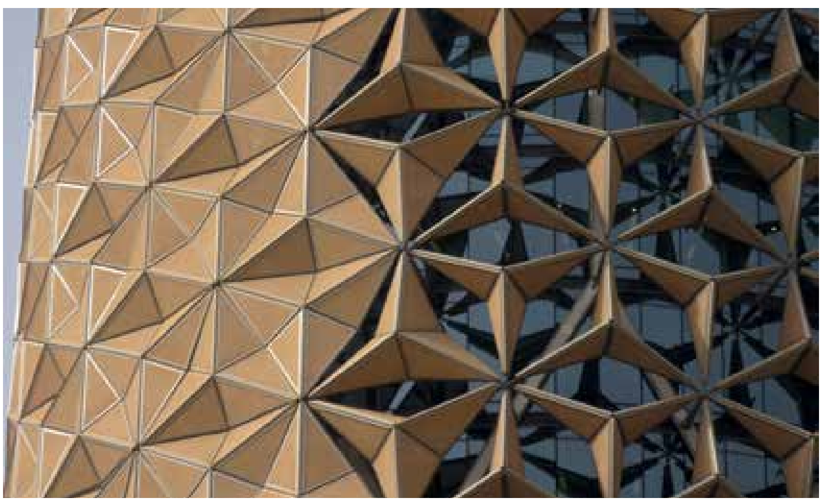
Prof. Doris Kim Sung has installed a breathing, shape-changing facade in Los Angeles that responds to thermal stimulus, much like a mimosa plant which responds to touch, using thermobimetals.

Lightness of form inspired by radiolaria and soap bubbles has been mimicked in Grimshaw's *Eden Project* at Cornwall and Herzog & de Meuron's *Water Cube* at Beijing, thanks to materials like ETFE.

We live in a world where we are constantly challenging our boundaries.

Alternate Energy

We are at a junction in architectural history where we are reawakening to the wisdom of mother earth, and have the technological know-how to affect a positive change and transform habitats in a manner that is sustainable, symbiotic, and solar driven. Janine Benyus emphasizes the need to move from a fossil-fuel economy to a solar-powered economy. Many thinkers have deliberated over the point that one cannot run a linear system of production on a planet with finite resources. It is time we closed the



loop with our choice of materials and procedures for construction, starting from the way we view waste.

As a global village, more and more of us are gradually turning towards a solar-powered society. There have been advancements and government incentives for installing solar-hot water heaters and photovoltaic (PV) panels. A solar-power generation is actively being pursued across the globe. Simultaneously, many parallel developments in the field of solar power harnessing are also being experimented with; one such example is harvesting algae biomass in sun-basking facades. Hamburg's *BIQ House* is the first algae-powered building in the world. It derives the energy required to generate electricity from the solar-heated algae biomass installed within the building's one-of-a-kind facade. Newer ways of generating much-required electricity to run our energy-intensive cities are evolving. One such endeavour is to convert footsteps into electricity. A revolutionary Pavegen tile, which has been developed by Laurence Kemball-Cook, converts every pedestrian step into seven watt of energy using a flywheel generator. Researchers at the University of Wisconsin Madison too are currently exploring this system using cellulose nanofibres in wood pulp floorings. Wood pulp is a cheap, abundantly available, and renewable waste product churned out by several industries. The electricity that is produced can be harnessed to power lights or charge batteries.

It may not seem much, but it is a start. Another avenue explored robustly for the electricity generation is WtE or Waste to Energy. Britain's bio-bus made headlines in 2015 when it ran its first 'poo bus' between Bristol and Bath powered by biomethane gas generated from human and household waste. The steady growth of offshore and onshore wind farms across the globe—and the use of 'sea snakes' to harness tidal energy—are gradually gaining popularity as investors realize the 24-hour potential of these renewable resources. Biogas digesters and bio-fuels that convert biomass and agro wastes to fuels, ensure that waste is now actively being explored as a resource.

Conclusion

We are surrounded by buildings, some of which are consciously striving to reduce their carbon footprints, while some others attempt to mitigate their high-energy demands by tapping into renewable energy sources. Most man-made buildings still continue to be energy guzzlers, wasteful, and display environmental apathy at large; however, there is hope. The way we interact with our buildings is changing. People are no longer willing to live in dead buildings, thus the introduction of terrariums in space-tight accommodations. Everyone wants a patch of green, even if it is a garden in a glass bottle, and a square piece of sky. Our architectural philosophy is metamorphosing to embrace the possibility of net zero energy buildings (NZEB) and a human habitat in symbiosis with the planet. It is imperative to know that we can still live in harmony with the environment, provided we make conscious choices. It is time we learn from nature and mend our ways because this Earth is all we have; and even though it is ours, it is not ours alone.

AN APP FOR ENERGY CONSERVATION BUILDING CODE (ECBC)

Abdullah Nisar Siddiqui is a registered architect with Council of Architecture (India), with interest in scientific computing and built environment simulation. Presently, he is working as Project Manager for UNDP-GEF project on 'Energy Efficiency in Commercial Buildings'.

The "Digital India" initiative has been launched by the Honorable Prime Minister for creating awareness and marking India as a forefront user of digital technology to simplify and make the processes more effective across various government domains.[1] As a part of the initiative, Bureau of Energy Efficiency (BEE) developed Energy Conservation Building Code (ECBC) application under the UNDP-GEF project on 'Energy Efficiency Improvements in Commercial Buildings' to accelerate ECBC implementation and standardize outreach and operationalization throughout the nation. This initiative is the first step, and there is a long way to go.

Energy consumption in Indian buildings is expected to increase substantially due to economic growth, construction demand, and other aspects of human development. BEE introduced the ECBC in the year 2007. This is the nation's first building energy code and aims to have a major impact on energy efficiency in buildings. It covers minimum requirements for building envelope performance as well as for mechanical systems and equipment, including heating, ventilation, and air conditioning system; interior and exterior lighting system; service hot water; electrical power; and motors to achieve energy efficiency in different climatic zones of India. The code is a set of instructions to be interpreted and followed as per the needs of the user, which requires a certain set of background knowledge.

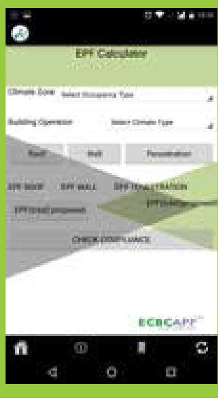
In the context of our country, the primary users of ECBC would be the stakeholders in construction industry. Most of them would be civil/mechanical engineers, contractors, green building consultants, and architects. Through experience during implementation, we realized few intriguing aspects where the challenge exists.

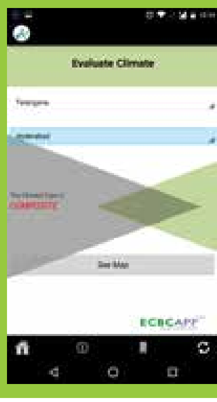
- Why life cycle cost is still a dream for us over initial capital?
- Why energy efficiency does not pay in India as much as it pays off in Sweden, Germany, and US?

Post development of the code, number of technical reference material have been developed for ease of understanding the requirements. The focus has been on developing capacities of engineers and design professionals through training workshops and development of technical reference tools for effective implementation of the code.

The ECBC App has been developed covering the various aspects of the code, which aims at enhancing awareness levels of stakeholders as well as providing technical guidance towards its conformance. Additionally, with a view to assist compliance to the code, an 'Expert System' has been developed with the objective of supporting architects and design professionals to assess

1 http://digitalindia.gov.in/content/e-governance-%E2%80%93-reforming-government-through-technology





the impact of their designs and its conformance with the code requirements. This in our opinion, will change the way people think of energy efficiency in the buildings sector in times to come.

The 'Expert System' will not replace the individual expert but help disseminate first-hand knowledge of an intermediate-level building physicist to take quick cost-effective decisions during design meetings and charrettes. This ambitious 'Expert System' is now functional and has been peer reviewed by experts in the field. List of the ECBC App features is as follows:

- A full access to the ECBC code database or values for all the climate zone type of building and operation hours in a smooth intuitive tree view structure. (In the run up to this decision of making this App, we conducted a small test wherein we found that the time of accessing code information from the book, either hardcover or pdf, requires 30 second to 5 minutes whereas the ECBC App will lead to the same info in 5 to 10 seconds.)
- A calculator for the envelop trade-off method for quick onsite calculations for future compliance verifiers and commissioning agents. This has been implemented but is under testing phase.
- Quick tool for *U*-value calculation for multi-layer assemblies
- The climate zone evaluator based on GPS coordinates (GPS integration is under development)
- The Building Physics Expert System for five climatic zones of India

The ECBC APP[2] is currently available only for Android OS, but we plan to make it cross platform, for Window and iOS too, based on the market share and usage of these mobile-operating systems. The ECBC App has been developed in a manner that it has provision for making it specific to states. Therefore, upon request from the state, we can adapt it to state-specific ECBC. This will assist in increasing the penetration of ECBC among the energy professionals of all states. Currently, there are 500+ professionals using it as a reference tool for accessing ECBC code values.

The expected outcome is to sensitize and enable the stakeholders to make an informed decision in the field.

Acknowledgement

Our appreciation goes to Mr S M H Adil, ECBC Master Trainer, for his assistance in the development of ECBC App.

2 https://play.google.com/store/apps/details?id=ecbcapp.ecbc

WATER EFFICIENT FIXTURES AND WATER SAVING POTENTIAL

Sonia Rani, is Fellow and Area Convenor at Centre for Research on Sustainable Building Science (CRSBS) Group under Sustainable Habitat Division, TERI. She is involved in the field of research and development, policy formulation through project implementation and resource efficiency measures.

Potable water is a precious and limited resource and its efficient utilization and conservation calls for urgent measures which can be immediately implemented. Population outburst, rapid growth in urbanization, and associated changes in lifestyles, etc.—all have contributed towards an exponential increase in water demand. Water scarcity/shortage is a hot topic which comes into the limelight, typically, during the summer months year in and year out through different sources (be it through newspapers or news channels). This scarce resource could be addressed through two sustainable approaches, namely, demand side management and supply side management. While the demand side management includes measures that may reduce water demand simply by changing plumbing fittings for efficient utilization, supply side management addresses alternate sources of water supply (such as rainwater and treated water from sewage treatment plants). In this article, the focus will be on demand side management, especially by using only water-efficient fixtures. Reducing water consumption by optimizing water flow in a fixture is a simple and convenient way to decrease water as well as energy bills.

Rating System for Plumbing Fixtures

The development and promotion of water-efficient technology for plumbing fixtures would lead to reduction in water use across all building typologies. Consumption of water in domestic- and commercial-building applications constitutes a sizeable proportion of the total water demand. Therefore, there is a need to look for opportunities for the conservation of water within this user group, wherein the plumbing network/ fraternity has a significant role to perform. In order to make professional practice responsible, benchmarking has been adopted as an accepted strategy towards water conservation. A water-efficient labelling system for plumbing fixtures and fittings is one such universally recognized

approach to achieve the objective of water conservation both in urban domestic and commercial use.

In India, we have the Water Efficient Products-India (WEP-I), which is a rating system for sustainable plumbing. The use of WEP-I is intended to encourage use of water-efficient products, to incorporate and implement the latest technology and systems, and provide uniformity in the performance of products. WEP-I includes plumbing fixtures, such as water closets, urinals, faucets, and showers, as part of water-efficient products.

Rating Systems in Other Countries

A few countries across the world have already established standards for labelling and rating of water-efficient plumbing fixtures, fittings, and appliances with supportive legislations, such as Water Efficiency Labeling System (WELS) in Australia, Water Sense in the USA, Water Efficiency Labeling Scheme (WELS) in Singapore, ANQIPS labelling system in Portugal, and Water Wise in UK.

The labelling and rating of water-efficient fixtures helps consumers to identify products that are most efficient and economical without compromising on personal hygiene. Furthermore, manufactures can benefit in the marketplace by promoting and offering rated, water-efficient fixtures that perform equally or better than the available models that tend to lead to wastage of water.

Predicting Water Savings

In this regard, the pressing concern that arises is how much water do these water-efficient products really save? One needs to calculate it against baseline water demand, which in turn is calculated by considering the flow rate of conventional/inefficient water fixtures. The water use for each product is calculated as given below:

Total Water Use = (litres per use*number of uses*duration of use*number of users)

Some government organizations and non-government certification systems have standards for calculating baseline water consumption. For a better understanding of predicting water savings, let us consider the case of an office building which is operational for 275 days annually, has occupancy of 100 people, and a male–female ratio of 60:40. The plumbing fixtures in lavatory areas include toilets, urinals, and wash basin faucets. To calculate the water saving potential in the lavatory area, the following assumptions have been made:

Both genders are assumed to use the wash basin faucets equally. In the calculation, the number of uses is restricted to five times a day.

In case of water closets (solid application), it is assumed that 10% of the total population would use the WC. Males use the urinal for liquid applications; as a result, they do not use the WCs for liquid application. Females use WCs for liquid applications and the frequency of use for both genders is assumed to be equal, that is, three times a day.

Table 1 demonstrates the base case water consumption for each fixture in an office building.

Table 1: Base Case Calculation

Type of Fixtures	Flow Rate[1] (LPF/LPM)	Duration of Use[2] (minutes)	Number of Uses[2]	No. of Persons	Water Consumption
Water closet (solid)	9		1	10	90
Water closet (liquid)	9		3	40	1080
Wash Basin Faucets	10	0.5	5	100	2500
Urinals	4		3	60	720
Daily requirement					4390
Annual requirement (KL)					**1207.25**

Note: 1. Base Case Flow Rates are taken from GRIHA Manual.
2. Duration and number of uses are user dependent.

To achieve considerable water savings in the office building, plumbing fixtures—which include a dual flush WC with a flow rate of 6 LPF (litres per flush) for solid applications and 3 LPF for liquid applications, sensor-based urinals with a flow rate of 1.5 LPF, and faucets with a flow rate of 5 LPM (litres per minute)—have been selected and installed. Here, the given table demonstrates water consumption which is achieved due to the installation of water-efficient fixtures in the lavatory areas of office building:

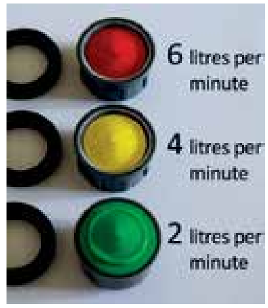


Table 2: Proposed Case Calculation

Type of Fixtures	Flow Rate (LPF/LPM)	Duration of Use (minutes)	Number of Uses	No. of Persons	Water Consumption
Water closet (solid)	6		1	10	60
Water closet (liquid)	3		3	40	360
Wash Basin Faucets	5	0.5	5	100	1250
Urinals	1.5		3	60	270
Daily requirement					1940
Annual requirement (KL)					**533.5**

From the two tables it can be concluded that by using water-efficient fixtures, which have a considerably less flow rate in comparison to conventional fixtures, approximately 56% water can be saved in a lavatory area.

As specified in the National Building Code (NBC 2005) and CPHEEO Manual for Water Supply and Treatment (1999), of the Ministry of Urban Development (MoUD), Government of India, the total water requirement for office buildings in India is 45 LPCD (litres per capita per day), of which the majority (50%–60%) is utilized in lavatory area. By providing water-efficient products in this area, a significant quantity of potable water may be saved that would be sufficient to meet at least 120–50 days of the building's water requirement.

In India, the residential- and commercial-construction sectors are growing at an alarming rate and plumbing fittings have become necessary components/ requirement of the projects; hence, the government needs to mandate the use of water-efficient products for the sake of sustainable development. Special attention must, therefore, be given to the development, promotion, and installation of water-efficient products and consumers must be able to identify these efficient products, leading to the need for an easily understandable rating/ labelling system in India.

Every citizen of India should be sensitized to the need of water conservation and should collectively rise to the occasion for its preservation. The various uses of water-efficient products benefit consumers directly and, indirectly and lead them to contribute/ participate in achieving the common goal of sustaining the planet by minimizing water chaos in the advancing future.

'ECO' TOURISM PROTECTING NATURE

Khushal Matai is an architect with eight years of expertise in various building simulation software, designing in vulnerable areas, and renewable energy. His research area is the environmental impact of solar photovoltaic installations on urban heat island effect.

To travel is man's natural instinct and it is no wonder that the tourism industry is growing exponentially. According to UN's World Tourism Organization, it creates 6%–7% of the world's employment directly and millions more indirectly through the multiplier effect. India being a melting pot of different cultures, festivals, and traditions, attracts a huge tourist footfall. The diversity of our country is best exemplified by the tourist destinations, such as forts and palaces, mangrove forests and rivers, and the Himalayan and Nilgiri ranges are some of the most well known. In this regard, tourism has become one of the major revenue-generating sectors of the economy, contributing significantly to the national income and engendering vast opportunities for work and occupation. However, not all can be deemed idyllic and the threats that are posed cannot be ignored. Though being economically fruitful, the remote forests, hills, and rivers run the risk of being in grave peril if measures are not taken to ensure their protection and preservation. The most spectacular tourism places are often the most vulnerable in terms of earthquakes, landslides, soil erosion and degradation, ecological disturbances, etc. It is for this reason that the idea of 'ecotourism' has come to the fore. The International Tourism

Figure 1: Principles of Ecotourism (TIES 2015)

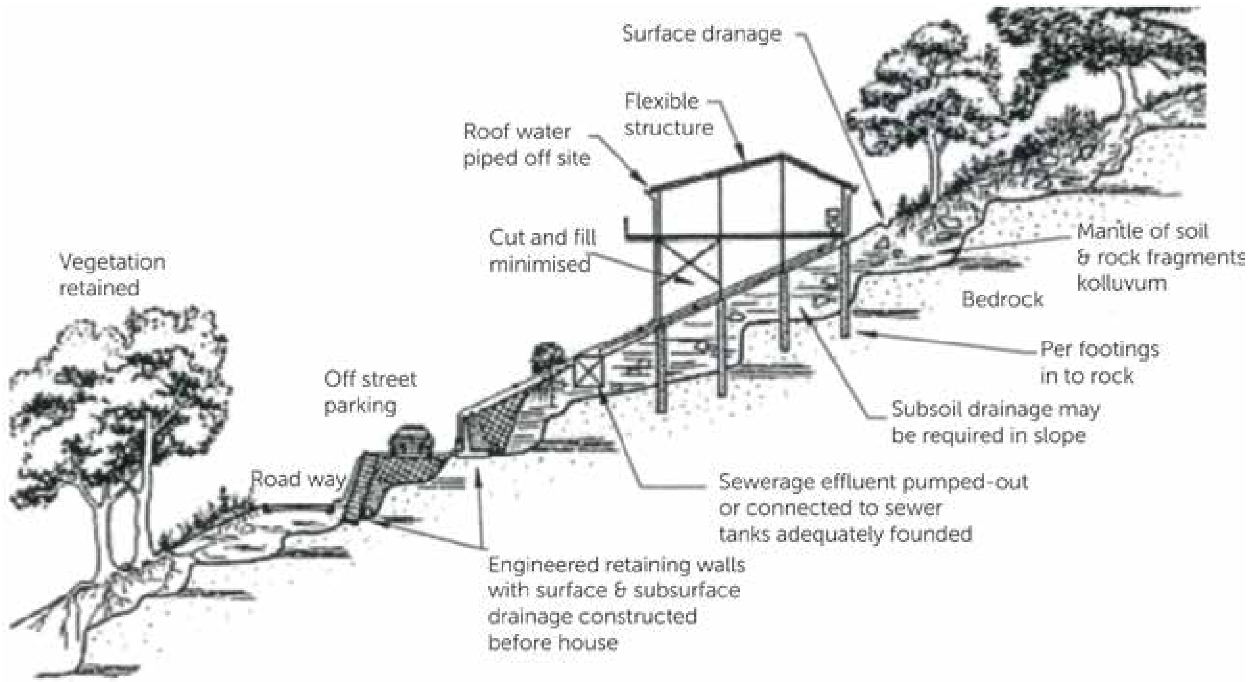


Figure 2: Example of Good Hill Side Practice[1]

Society defines ecotourism as 'responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education'. Education is meant to be inclusive for both staff and guests.

Ecotourism is a holistic term which integrates conceptualization, designing, building, and operations to minimize sustainable damage to the region. The sustainable aspect of tourism has to be conceived from the design stage of the project, which involves managing ecology, environment, energy, waste, and water. The need for sustainable/responsible planning and management is imperative for the industry to survive as a whole and this article focuses on each such step.

Land is a precious resource hence land management ought to be the first and foremost step in initiating a project which uses the site optimally and with minimal damage to its surroundings. The natural land form of the site must be conserved and altered to the least-possible extent. This is especially important in hilly areas where cutting must be avoided and the construction should be terraced and contained to a smaller footprint. A deformed net-like material can be also be used for soil binding which allows plants to grow and acts as reinforcement for the soil.

Top soil, the most precious resource for any site, must be removed and stored in a separate location with the necessary layers of natural grass cover, mulching, etc., to preserve its nutritive value. After the construction is complete, it should be used for

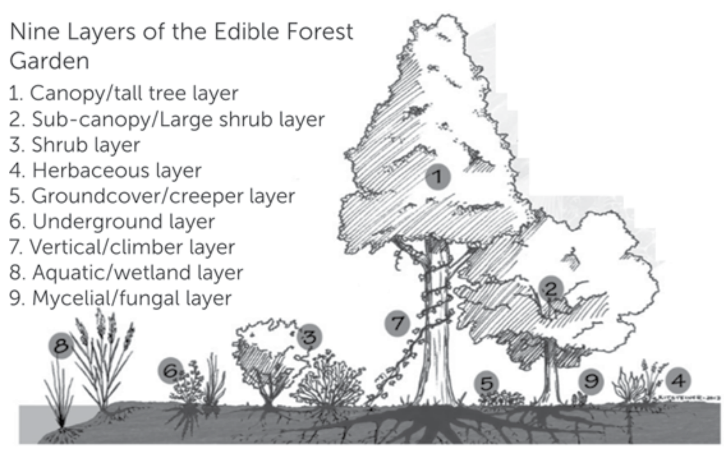


Figure 3: Layered Development[2]

1 'http://civilconsult.com.au/tweed-richmond-sloping-block/

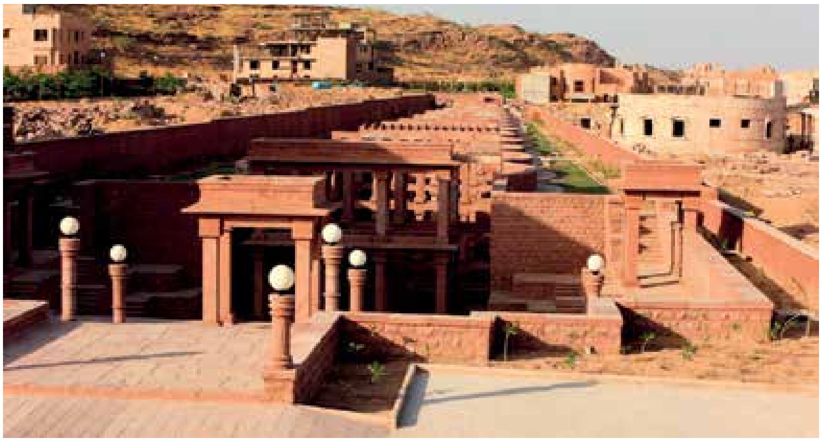


Figure 4: Birkha Bawri, Jodhpur, a Step-well in a Residential Colony[3]

landscaping. Soil depletion is a problem in semi-arid areas. The local species of nutrient-rich trees and plants should be used for landscaping since they are easy to maintain and compatible with the local fauna. Additionally, a mix of various trees must be planted as it provides a healthy ecosystem for nature to thrive and safeguard against any plant diseases.

Layered development mimics the forest ecosystem and acts as a wind barrier in arid areas. This type of plantation also has higher survival chances, provided the habitat resulting from a diverse range of fauna ensures a flourishing, robust ecosystem.

Water is another precious resource that is used not only in construction but throughout the lifecycle of the project. The natural slope and depressions must be utilized to the best possible extent. Rainwater harvesting measures must be adopted as per the local practices. Since the water table in the hilly areas is generally high, the focus should, therefore, be on decreasing the speed of water flow to control soil erosion and landslides. A systematic system of water channelization and percolation can control such problems.

The Talwadi System of Uttarakhand is a method of providing small ponds of approximately 1 m diameter, which allows water retention at regular distances and slow percolation. Similarly, in the desert state of Rajasthan, the traditional step-wells can be incorporated in site planning. Step-wells or '*bawris*' have been part of the cultural fabric of the arid areas and can enrich the design by their aesthetical value.

Land cover changes can modify the natural hydrological cycle; hence, the water resources are very sensitive towards unplanned land conversions. To capture the excess surface runoff, decrease the runoff rate, and aid water purification, sustainable urban drainage systems can be integrated into the design. To achieve this, detention drains can be constructed across the slope, retention ponds can be constructed in a suitable location, and bio swales can be made along the roads and parking lots. Doing so can minimize downstream erosion and flooding. Vegetated paths and soft pavers inhibit the flow of water thus, decreasing soil erosion. After the site, the design of the built structures must be climate responsive. This will include an in-depth study of the climate conditions, critical points, thermal properties of the material used, shading devices design, etc. The GRIHA Manual and the ECBC code can be used as guidelines to decide window-wall ratio, SHGC, day lighting, and material selection. For a small resort, a concise and complete SVA GRIHA manual can be followed.

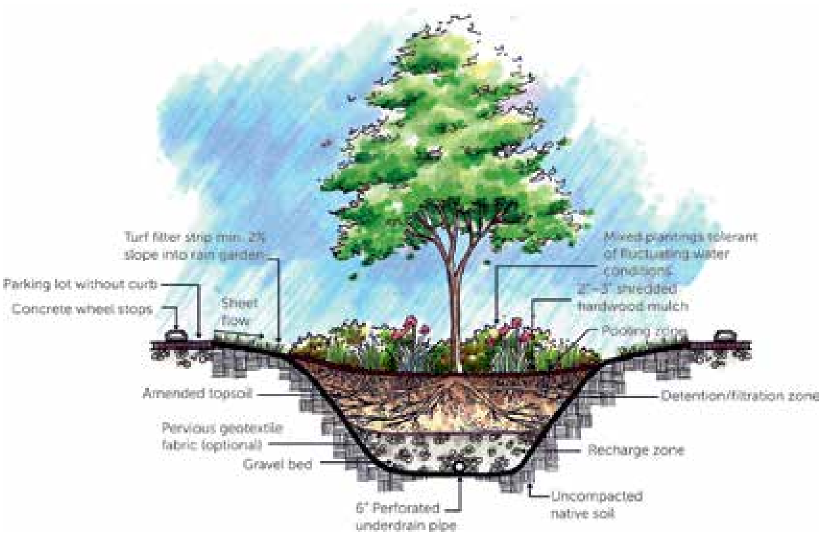


Figure 5: Bio-Retention Cell[4]

[3] 'Birkha Bawri: A Rainwater Harvesting Structure'
[4] http://www.clemson.edu/extension/hgic/water/resources_stormwater/bioretention_cells.html

Figure 6: Soil Bio Technology Plant[5]

The use of local materials and techniques should be encouraged for construction and must first be thoroughly researched. An example of such techniques could be the mud construction in Kuchch or the use of local stones in Uttarakhand, which not only preserve local techniques but also provide employment to people. Using advanced materials such as TRIC wall can make construction lighter and cheaper. Mud from the site could be used to make compressed earth blocks, which could significantly reduce the embodied energy of the materials while reducing the damage through excessive transportation to vulnerable sites. Goverdhan Eco Village is an exemplary sustainable community which manages its water, waste, and food on site.

As compared to everyday life, people tend to create more waste when on vacation. As per the United Nations Environment Programme (UNEP), the Manual of Waste and Water Management records that the annual solid waste generation per capita is 25% higher than the national average of any region. The improper management of this waste can lead to substantial and irreversible direct and indirect environmental, economic, and social impacts. Kitchens of a resort or hotels generate huge quantities of organic waste which must be used for vermicomposting or biogas, depending on the site conditions and space constraints. Colour-coded dustbins must be provided at every 400 metres or so as people tend to litter when they do not see a dustbin. Sewage treatment should be a well-thought and designed process. It could even be a packaged plant as they are the most convenient; however, when a bigger space is available, a constructed wetland or root-zone treatment can be done. Energy is the driver behind development and each site is unique in terms of the renewable energy available for harnessing. Before starting a project, a study about the energy potential of the site ought to be carried out so that the best possible hybrid system can be worked out. A single type of renewable energy is erratic in nature and, therefore, expensive and unreliable. In western India, solar and wind energy have good potential whereas, in coastal zones, tidal and wind energy are considered as lucrative.

Instead of adding the renewable energy-generation measures after the completion of a project, people involved should be introduced to the design from the initiation of a project thereby making not just the technology but also the idea an integral part of the project.

Any construction project disturbs the social, cultural, and environmental fabric of the people living in nearby areas. 'Design, construct and operate low-impact facilities' is one of principles of ecotourism, as defined by the International Ecotourism Society. Ecotourism must aim to be non-consumptive, must create ecological conscience, and must uphold eco-centric values and ethics. The projects which imbibe the essence of their surroundings are known to have greater success and it is for this reason that the ideas of ecotourism should be initiated from the very beginning. The main focus should be on covering all aspects and taking a holistic approach so that the beauty and sanctity of nature can be preserved.

[5] Biome Solutions

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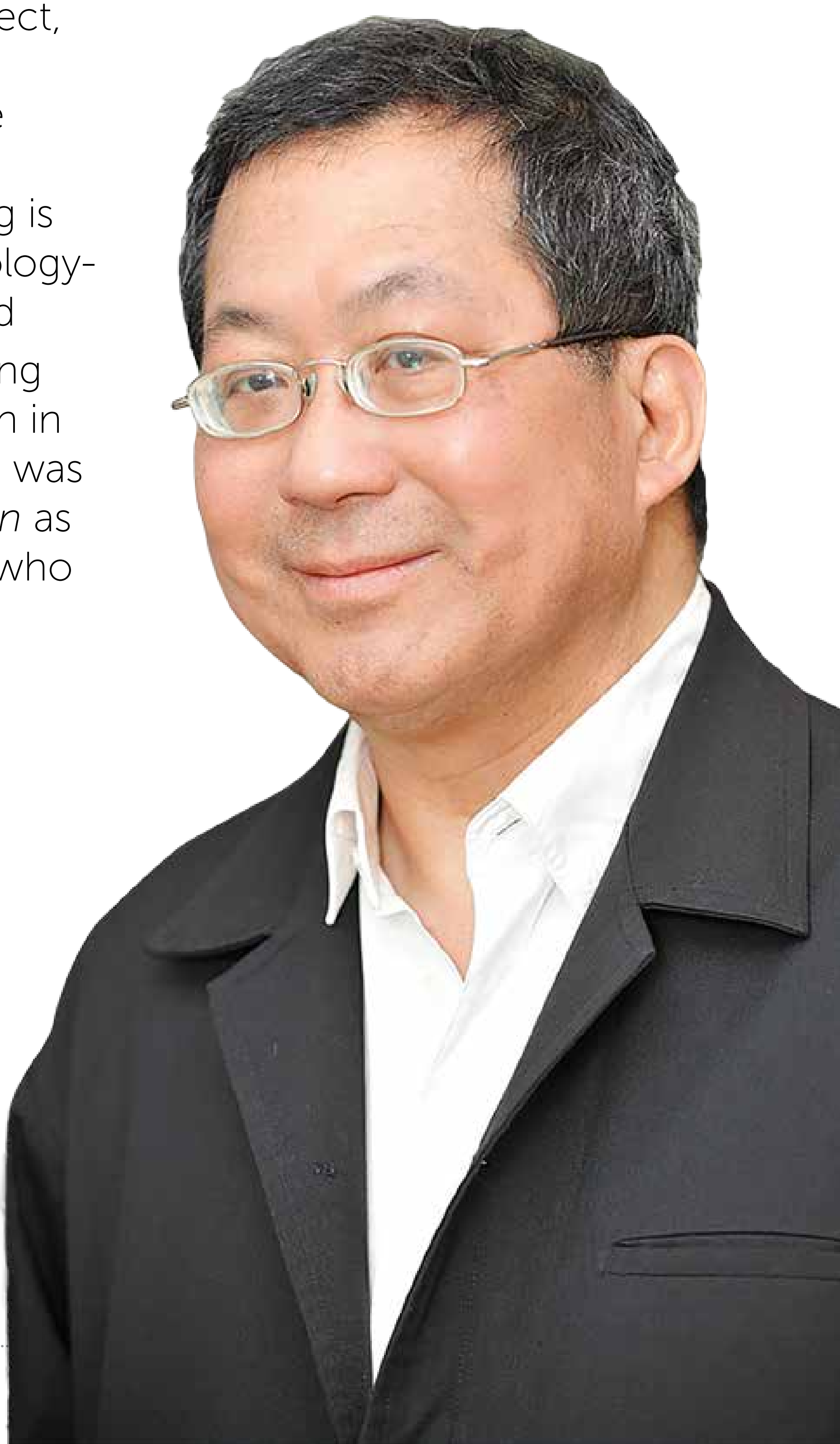
IN CONVERSATION
with Ken Yeang

Ken Yeang, is an architect, ecologist and author, known for his signature eco-architecture and eco-masterplans. Yeang is an early pioneer of ecology-based green design and master planning, carrying out design and research in this field since 1971. He was named by *The Guardian* as "one of the 50 people who could save the planet".



What is Eco-design?

Eco-design is essentially the same as conventional design except that it takes the ecology of the environment into consideration in designing as a routine and mundane part of the design process. Its objective is to achieve a seamless and benign bio-integration of our designed system with the natural environment so as to not harm nature.

Can it be also applied to improve the existing buildings?

Yes, it should be applied to all our existing built environment to retrofit these to make them ecologically effective and sustainable.

What is your take on contemporary architecture in India?

Much of contemporary architecture anywhere in the world is simply not ecological. This applies similarly to the contemporary architecture of India.

Which architect's work do you admire? Are you also inspired by them?

I like different architects for different reasons. I like the work of Victor and Alldar Olgyay for their research and built work on designing with climate as bioclimatic architecture. I like the work of Ian McHarg (who is a landscape architect) for his work on ecological land use planning. I like the work of Buckminster Fuller (who is an engineer) for his work and inventions on designing to conserve energy and material resources. All of them are inspirational.

You have been named by *The Guardian* as "one of the 50 people who could save the planet". How do you plan to contribute to the same?

My contribution to a sustainable and ecologically effective future for humanity is through my research and theoretical work in ecological design which I have been doing for over 40 years; through my books, which seek to proselytise ecological designate a wider audience; through my design interpretation; my built work; my ideas through my development of design systems and devices; and through the development of an ecological aesthetic.

How big and wide spread is the demand for environmentally conscious designs?

Ecological design is crucial and vital for the survival of humanity and must be implemented worldwide.

What are some of the great opportunities within the design world today, as our cities are becoming larger and denser?

The great opportunity for our design world is to reinvent our future to make it sustainable and ecologically effective. As our cities and our human world become larger and denser, we, as the human species (one out of millions of species in nature), must change. We need to change our lifestyles, our economies, our social and political systems, and our built environment and its production systems in the production of energy and artefacts to bio-integrate benignly and seamlessly with the ecological systems and the biogeochemical cycles in nature. This is easier said than done.

Nature cannot be regarded as belonging to humans. It is one thing that can never belong to humans. Nature is self-willed, independent, and indifferent. From nature's viewpoint, it is silent to the extensive devastations inflicted upon it by humans. We can contend that nature has not even noticed that it is in an ecological crisis at all—it is simply reacting to humanity's deleterious acts upon it. If humanity continues with its present destructive acts and does nothing to mediate, rectify, and halt its consequences; then when the planet's entire ecological systems collapse, nature will just do its own thing: nature will just recover and start all over again, in a process of ecological succession, wherein the recovery will be over geological time, estimated to be 10 million years from the mass extinction of life (Nature, March 9, 2000). We must seek to avert this collapse because if we let this happen, it will mean obliteration of just about all life on the planet, including our present day human society, its achievements in culture and civilization, and built environment.

India is one of the fastest growing economies today. How can we strike a balance between sustainability and rapid urbanization?

A society must change its economic systems from an economy of encouraging increasing consumption to a cyclic economy of adequacy.

The existent economy encourages production and consumption of more and more things.

Changing this starts with public education and implemented by governmental intervention.This then is the challenge that confronts society today.

What are some of the inspiring and challenging projects on your plate right now?

All our projects currently under design or implementation are challenging, experimental, and seek to advance ecological design, and we are excited to see their outcomes and realization.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BENEFITS OF ECBC IMPLEMENTATION IN INDIA

A CASE STUDY OF KARNATAKA



Kanagaraj Ganesan, founder of Integrative Design Solutions Pvt. Ltd. (IDSPL); **Raj Kumar Chozhan**, has worked on the Energy Conservation Building Code (ECBC) implementation in the state of Karnataka; **Ashish Sharma**, a Master of Research (MRes) student at Macquarie University in Sydney, Australia.

Overview of Energy Conservation Building Code (ECBC)

With rapid urbanization in India, the country's energy consumption is bound to increase. Real estate is the most tangible manifestation of this urban growth. Currently, the building sector consumes about 31% of the total electricity generation in India.[1] Commercial building sector consumes 11% of the total electricity generated in the country and is growing at a whopping rate of 8.8% per annum. As per the study conducted by the Energy Conservation and Commercialization (ECO) III, the total built-up area of commercial buildings is expected to reach 1.9 billion m^2 by 2030, from the 2016 figure of 892 million m^2—a growth which is twice as much. This offers a great opportunity and responsibility to designers to develop this future building stock as energy efficient and climate resilient. The Bureau of Energy Efficiency (BEE)—a statutory body under the Ministry of Power in India—which comes under the Energy Conservation (EC) Act 2001, has introduced ECBC

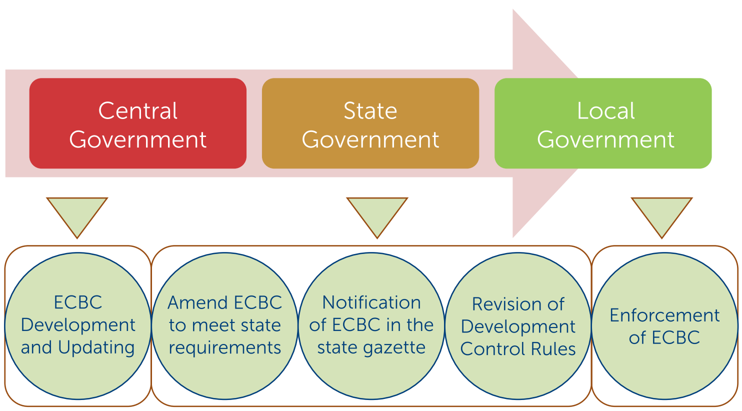


Figure 1 Responsibilities for ECBC Implementation

1 Domestic consumption of 23% and commercial consumption of 8% (Central Statistics Office, 2016)

in 2007. ECBC sets minimum energy standards for commercial buildings that have a connected load of 100kW or a contract demand of 120 kVA and above. The code sets the minimum energy efficiency requirements for five building systems: (i) building envelope (walls, roof, fenestration, etc.); (ii) heating, ventilation, and air conditioning (HVAC); (iii) service water heating, (iv) lighting, and (v) electrical power. Although the code is developed by the central government, the implementation of the code lies in the hands of state and urban local governments.

Benefits of Implementing ECBC

Currently, the total energy consumption of commercial buildings in India is about 172 Tera Watt Hour (TWh).[2] If conventional design and construction practices prevail (business-as-usual basis), then, by 2030, the cumulative energy consumption from new commercial buildings[3] will be 200 TWh. Effective implementation of ECBC will lead to an electricity saving of 53 TWh.[4]

This particular form of energy savings can be considered equivalent to the following:

- Cost savings of INR 368 billion for commercial-building consumers[5]
- Avoiding the installation of 20 power plants of 500 MW capacity each, thereby saving approximately INR 600 billion.
- Meeting the electricity requirements for 13 million urban homes[6]
- Electrification of 2.2 lakh villages by 2025[7]
- CO_2 emission reduction of 43 million tonnes

The developers will get an advantage of showcasing their project as energy efficient in comparison to the existing building stock and may attract better premium on sale/lease or rent of the space. State and local governments can show their contributions towards reducing the energy requirements and carbon emissions.

Under Section 15 (a) of the EC Act 2001, the state government may, by notification, in consultation with BEE amend ECBC to suit regional and local climatic conditions. As per the provision of Section 18 of the EC Act, the state government may issue directions for the efficient use of energy and its conservation through notification of the code in the state gazette. Till January 2017, 10 states had notified ECBC and 10 states are in the advance stages of notification. Karnataka is one of the proactive states, which has showed a positive response towards implementing ECBC effectively.

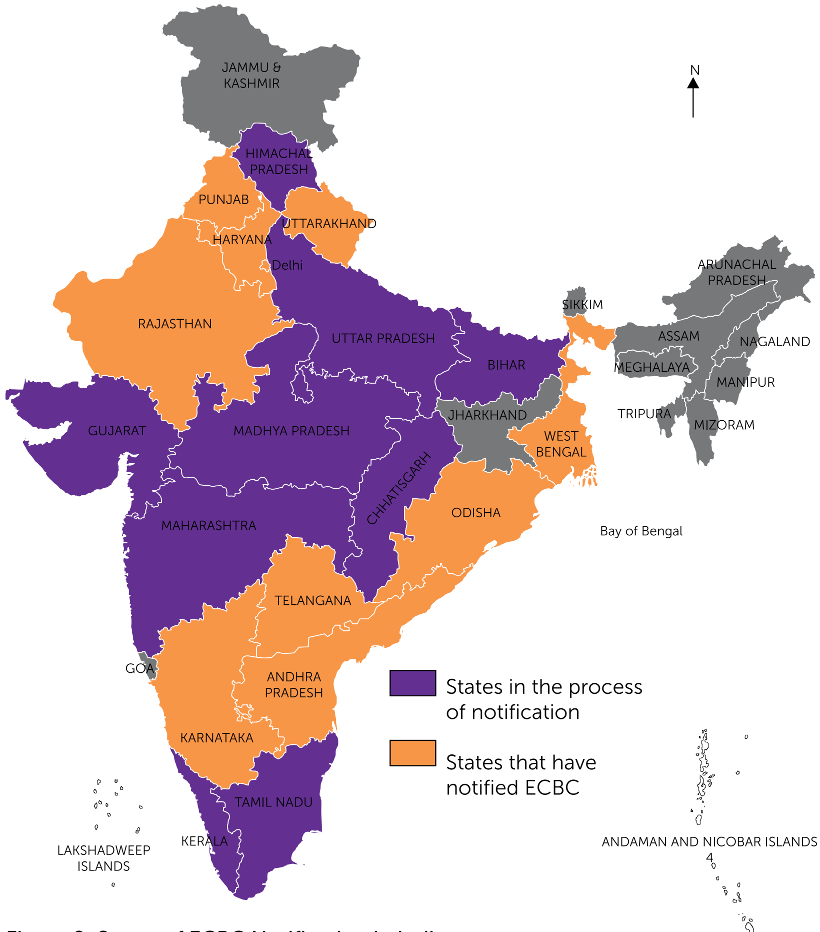


Figure 2: Status of ECBC Notification in India

2 Commercial built-up area of 892 million m2 (ECO III Project, 2010) and an average EPI of commercial building as 193 kWh/m2.year (UNDP GEF BEE Project, 2015)

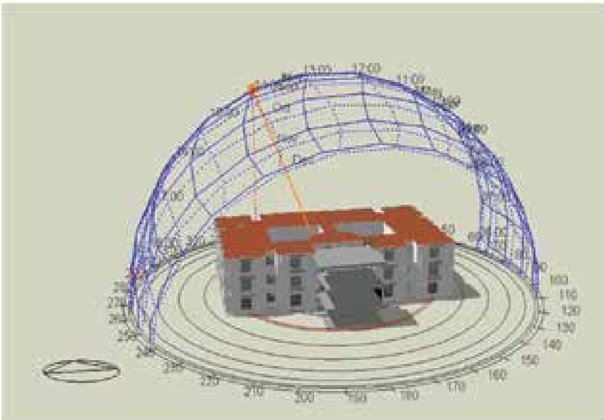
3 New commercial buildings at the projected growth rate of 5–6% per annum

4 Considering 75% of the new commercial built-up area complying with the code and considering 35% energy saving of ECBC compliant-buildings compared to business-as-usual construction

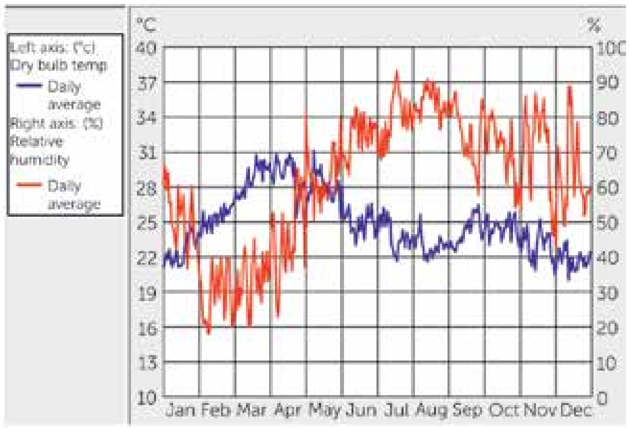
5 Electricity cost of INR 7.00 per kWh (without considering price escalation) for commercial building

6 EPI of the urban residential building as 44 kWh/m2.year

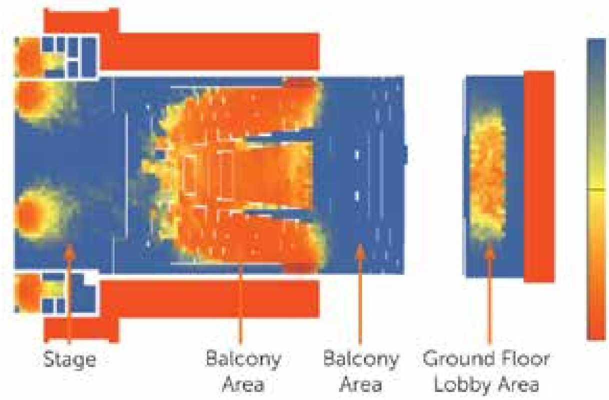
7 This is considering the number of households in the villages to be 200 and the annual electricity usage to be 630 kWh per household



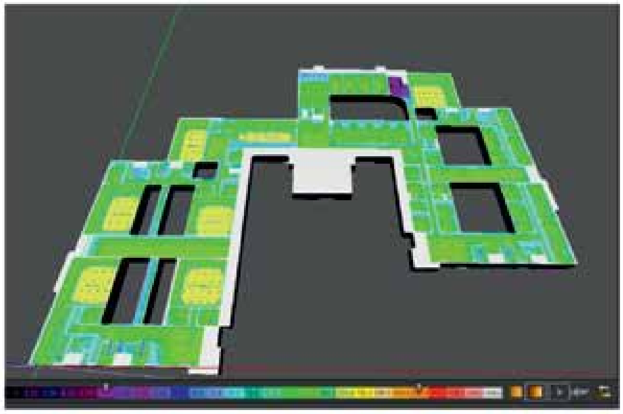
Sun-path Analysis for Shading Design



Climate Data Analysis



Daylight Analysis of Assembly Building



Artificial Lighting Design for Institutional Building

Status of ECBC Implementation in Karnataka

The Government of Karnataka, through a consultative process amended the central government ECBC to suit its regional requirements. Karnataka ECBC (KECBC) is applicable to all buildings or building complexes that have a connected load of 100 kW or greater, or a contract demand of 120 kVA or greater, or have conditioned area of 500 m^2 or more and are used for commercial purposes. It is applicable for both government and private buildings. The following are as per the notification:

- Urban local bodies will be responsible for the enforcement of KECBC with respect to private buildings.
- Public Works Department (PWD) and the architectural department of PWD will be responsible with respect to state government buildings.
- Department of Electrical Inspectorate, Government of Karnataka, will inspect the electrical installation in the buildings for KECBC compliance.

Karnataka Renewable Energy Development Limited (KREDL) will function as the nodal agency to monitor the implementation of the code at the state level and also to create the awareness regarding ECBC.

It is expected that these directives for the implementation of KECBC will ensure the construction of energy-efficient buildings with reduced electricity consumption by 30% to 40%.[8]

ECBC Cell in Karnataka

The All India Institute of Local Self Government (AIILSG) in January 2016 has been entrusted by UNDP, GEF, and BEE projects to establish an ECBC cell in the office of the chief architect, Karnataka Public Works Department (KPWD). The ECBC cell is expected to address information, knowledge, and human-resource gap in the state to implement ECBC. The MoU for the establishment of the cell was signed between BEE, KREDL, and AIILSG. The cell includes two young architects/ planners and two engineers,

8 Karnataka ECBC 2014 document

who are technically backstopped by AIILSG's Delhi office. KREDL provides advisory support and coordinates with the ECBC cell to ensure the implementation of KECBC in the state.

The cell assisted the KPWD office in updating the Schedule of Rates[9] (SoRs) to include energy-efficient materials and technologies. Karnataka has two distinct SoR documents, one for civil works and the other for electrical and mechanical works. The ECBC cell had proposed specification and cost information for 146[10] energy-efficient items in both the SoRs. The proposed items of energy-efficient building materials and technologies were extensively reviewed by both architecture and engineering departments of KPWD. The revised SoR for civil work was published in January 2017 and has a separate chapter on KECBC compliant materials and strategies.

Proposal for Civil SoR (35 items)

- Insulated wall
- Insulated roof, cool roof, and green roof
- High-performance glazing and frame
- Solar water heater

Proposal for Electrical SoR (111 items)

- HVAC components and systems
- Light-emitting diode (LED) fixtures and controls
- Solar photovoltaic system

The cell also supported 11 new projects designed by the office of the chief architect of the PWD to make them energy efficient. The typology of the project includes office buildings, institutional buildings, hospitals, parking lot, and assembly buildings. The cell followed an integrated design process by involving team members from PWD architecture and engineering departments in the early design stage to identify possible energy-efficient strategies for each project. State-of-the-art energy simulation tools[11] were used to analyse the performance of existing design, potential of project-specific, energy-efficient strategies. Cost effectiveness of the proposed strategies was also presented to the PWD architecture team to facilitate informed decision making. The software Design Builder was used to show the KECBC compliance of the PWD building through Whole Building Performance method. The ECBC cell also takes into account the following:

- Developed Karnataka geo-referencing maps to place climatic zones, districts, administrative divisions, and green-rated buildings
- Compiled directory of manufacturers and suppliers of energy-efficient products
- A trained team of PWD architecture on building physics, KECBC, use of energy-simulation tools
- A developed draft proposal for KECBC rules and building by-laws

Way Forward for KECBC Implementation

To bring the implementation of KECBC code into a mandatory regime, Karnataka has to take the following steps:

- Build capacity of administrators, municipal officials, government departments, developers, architects, and design engineers
- Update building by-laws of Urban Local Bodies (ULBs) to include KECBC provisions
- Implement transparent KECBC compliance procedures in ULBs
- Implement robust online monitoring and verification tools like Energy Monitoring Information System (EMIS)

In a nutshell, the success of the implementation of KECBC will depend on the acceptance of KECBC by building sector stakeholders, availability of technical skills in the state, robust framework for compliance, and implementation of KECBC monitoring and verification system.

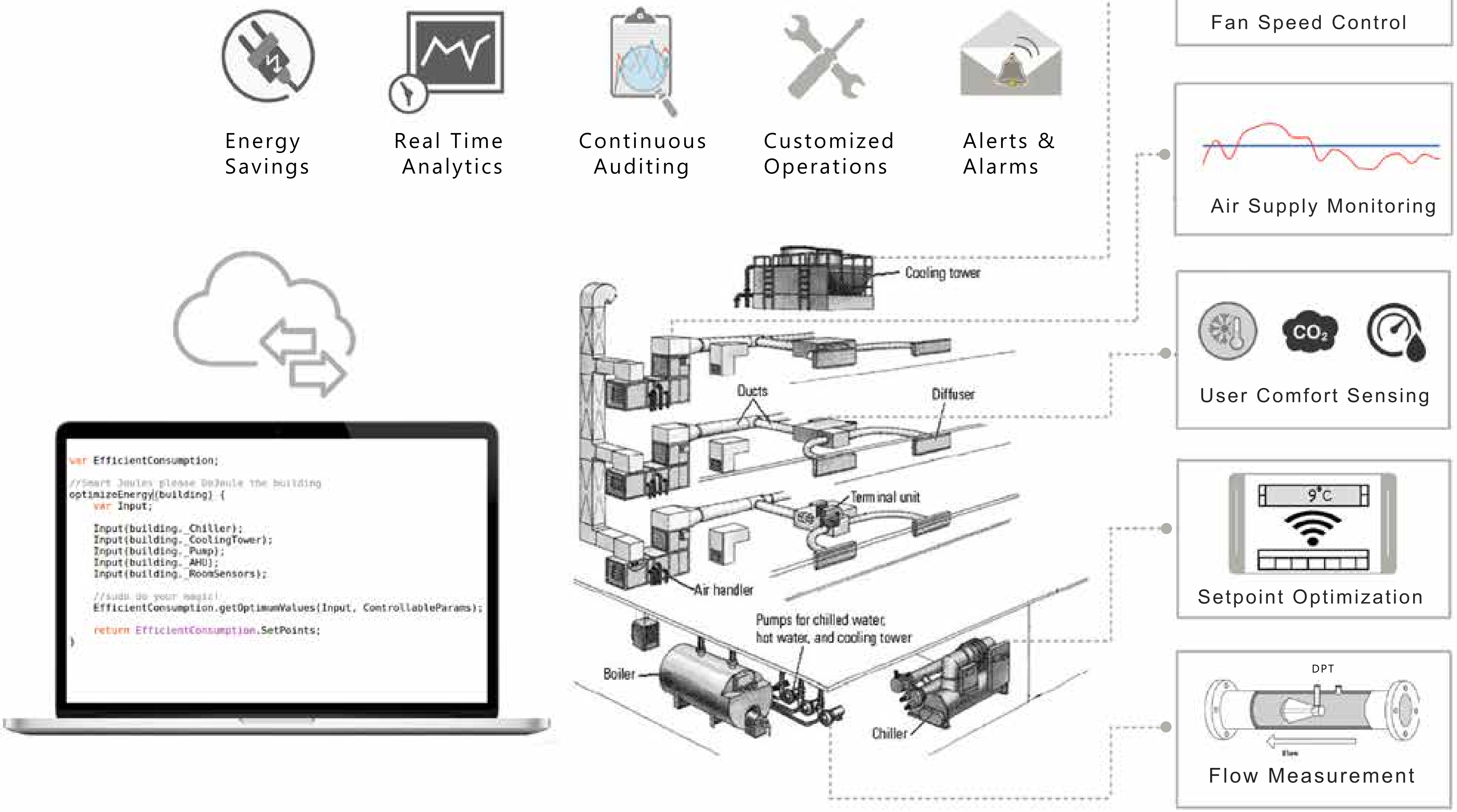
9 SoR is a reference document followed by PWD and some Public Sector Undertakings (PSUs) for providing material and technology-related specifications as well as for cost estimation of new buildings

10 35 items for civil SoR and 111 items for ele ctrical and mechanical SoR

11 Design Builder version 4.0 for thermal analysis, Design Iterate Validate Adapt (DIVA) for day lighting analysis, Dialux for Artificial Lighting analysis

DeJoule

IOT Technologies for Continuous Building Energy Optimization



SMART CITIES

Paritosh Tyagi, former Chairman of Central Pollution Control Board, is a civil engineer with specialisation in public health engineering. He is an individual consultant in environmental management and is currently the Chairman of IDC Foundation.

Green city, eco-city, sustainable city, liveable city, bio-philic city, and smart city are terms evolved by movements associated with improving urban design. All of them have an initial concept and a broad definition but none of the definitions seem to be precise enough to distinguish one term clearly from another. Each also seems to be amenable to include more and more activities within its scope.

My perception is that abundant overlap notwithstanding, 'green' has emphasis on parks, avenue plantation, and community forests; 'eco' covers ecology along with economy; 'sustainable' pays attention to availability, consumption, and renewability of resources; 'liveable' takes into consideration the quality of living standards, 'bio-philic' has liberal provision for open spaces and connection with nature; and 'smart' focuses on improving urban governance and services through innovative use of information and communication technology. The key goal has gradually shifted from standard of living to quality of life in general.

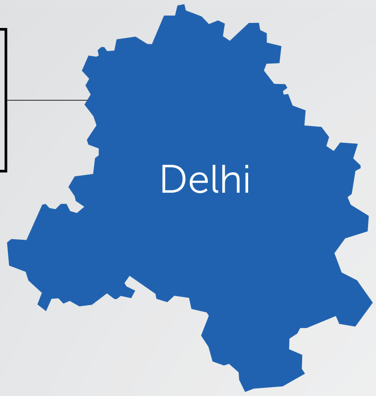
To me, the ambiguous and amalgamated concepts regarding urban design and planning do not make as much sense as the ability of people to walk or ride bicycles or to drive freely without the traffic jams. The safe and convenient access to a playing area for the children is far more important, so is the availability of fresh water in every household. The city could only move towards sustainability when having toilets in households is not a 'luxury', and our rivers are not being used as sewers. Availability of healthcare and education for each and every household is indispensable. A good quality of life can only be ensured when the drains are free of silt, noise and dust generation is minimal, connectivity is free of random breakdowns, and our public spaces are safe.

We cannot realize our claims of a sustainable or liveable city unless the citizens and the authorities realize that a city is a living, breathing complex ecosystem and has to be given same protection needed by living beings.

Recalling Rabindranath Tagore's famous prayer, I would say 'in that heaven, my Prime Minister, let our cities and citizens live'.

GRIHA PROJECTS' UPDA

Ministry of Urban Development (MoUD) gives **1%** to **5%** extra ground coverage and FAR for projects of more than 3,000 m² plot size on the basis of GRIHA evaluation.



5% Additional Floor Area Ratio (FAR)

Upto **25%** extra FAR for all building uses (except plotted residence) for all GRIHA variants.

5% Additional FAR for projects of plot area > 5,000 m²

AUDA: 5% discount on chargeable FAR payable to approving authority

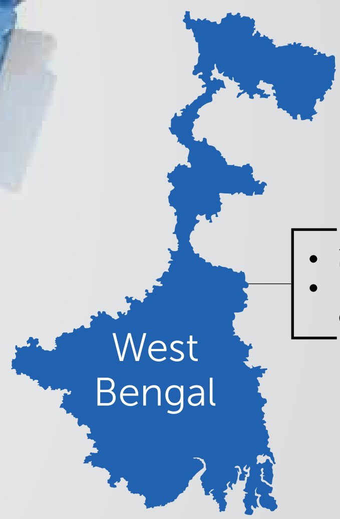
*The numbers indicated in the map represent registered projects for Rating with GRIHA Council.

TE & LINKED INCENTIVES

GRIHA REGISTERED PROJECTS=850
GRIHA FOOTPRINT=35 MN/M² (APP)

- **NOIDA & G.NOIDA: 5%** Additional FAR for projects of plot area > 5,000 m^2
- **UTTAR PRADESH: 5%** Additional FAR for GRIHA Rated projects.

Mandate for all government projects to go for minimum 3 Star GRIHA rating



- **10%** Additional FAR
- Fast track sanction of Plans

- **PMC & PCMC:** Discount in Premium charges (payable to Municipal Corporation) — for both GRIHA & SVA GRIHA
- **PMC & PCMC:** Up to **10%** discount on Property Tax for home-owners for GRIHA projects. Up to 15% discount on Property Tax for home-owners for SVA GRIHA projects

OTHERS

01 **Fast track Environmental Clearance** by Ministry of Environment, Forest and Climate Change (MoEFCC) for GRIHA pre-certified projects.

02 **Financial assistance of ₹5 lakh** by Ministry of New and Renewable Energy (MNRE) for each of the proposed 100 Small Townships/ Campus.

03 **Concession on rate of interest** (presently 50 Basis points) by **Small Industries Development Bank of India, SIDBI**.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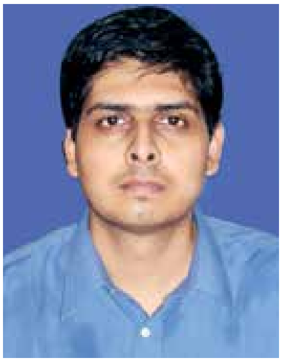
AN APPROACH TOWARDS SUPPLEMENTING CLIMATE RESPONSIVENESS OF VERNACULAR HABITATS IN JHARKHAND



Dr Manjari Chakraborty is a Professor at Dept. of Architecture, Birla Institute of Technology. She is recipient of "Career Award for Young Teachers" of AICTE (2000–03). **Janmejoy Gupta** is an Assistant Professor at Dept. of Architecture, Birla Institute of Technology Mesra, Ranchi.

Building with earth is an age-old practice, and as a building material, earth has been used the world over. The earliest recorded examples of building with earth date back to 8000 BC. Since then, earth architecture has been practiced steadily, and though it became a somewhat neglected aspect of architecture, it gained resurgence over the last few decades with the concept of sustainability. A major cause of renewed interest in earth architecture is the fact that building with earth leaves the least amount of carbon footprint with necessary thermal comfort and is a very sustainable practice. Understanding climate of a region is a pre-requisite for practising sustainable architecture. It provides information to optimize the dwelling design variables to create comfortable living conditions. Though mud architecture as practised in villages near Ranchi is a form of vernacular architecture developed through the years by the local inhabitants responding to the prevailing climate of Ranchi quite satisfactorily, it has developed largely through random methods without an objective and proper scientific study. Since the Iron Age, Jharkhand has been a land of thirty different tribes on the Chota Nagpur Plateau. A few kilometres away from Ranchi passes the imaginary Tropic of Cancer (23.5° North). Huts made of mud walls and thatched roofs were the standard construction. Studies, such as one by Gupta and Chakraborty in 2016,[1] have shown that these mud huts are thermally responsive construction. The houses are often on a raised platform made of compacted earth. The high thermal mass helps to keep the house cool in the evenings in summer, which

1 'The need for vernacular mud huts of Ranchi to adapt to the changing climate of Ranchi'

makes it pleasant for people in the evenings. The huts normally have minimal openings. Often the only opening on the external walls is the main door.

Methodology

This process of creating sustainable rural architecture is addressing issues at three levels: Climatic considerations (climate), the human body's response to the prevailing climatic conditions and desired conditions of thermal comfort (biology), and finally, the passive design-related technological and architectural solutions to achieve the desired comfort levels inside the dwellings, making the rural dwellings climate responsive.

Analysis

Climatology

The climatic elements crucial for building thermal design include site information, temperature data, humidity data, solar radiation data, and wind data.

The study area Ranchi, Jharkhand, falls under the composite climate zone. Ranchi's geographical location is 23.38° North latitude and 85.33° East longitude. Study area is located at an altitude of 900 m above mean sea level, placed on the Ranchi Plateau.

The average maximum temperatures recorded in 2012–13 are considerably more than 1986–87. Temperatures in peak summer (May–July) go up to 40°C and more. Over the last couple of years, the temperatures have gone down to 2°–3°C in peak winters (December and January). High levels of solar radiation are available even in winter, which can be utilized for heating. Wind movement is prevalent at moderately high speeds throughout the year. Prevailing wind direction in Ranchi is from South/Southwest in summer & from North in winter.

Biological evaluation

Biological evaluation consists of human response to the climatic conditions of a place.

Using materials with higher mass, providing night ventilation, and sun shading can expand the thermal comfort zone as shown in Figure 1.

Technological Solutions

The various technological solutions can be summarised as follows:

Site selection and consequent arrangement of dwelling units on site: Based on his studies, Olgyay[2] theorizes that in the cold months, to maximize the sun's radiation, occupants should use the south-eastern part of the site, as during winter maximum radiant gain is from the east of south. Conversely, in summer when heat gain is unwanted, the biggest sun gain is from the south-west direction on a site. Most sites in the studied villages are randomly chosen, without really paying attention to these nuances. The typically followed clustering is that of four dwelling units arranged around a common courtyard.

Orientation: In ordinary circumstances, an east–west alignment of a rectangular house provides maximum solar energy gain in winter and minimum in summer. The optimum orientation for Ranchi is the longer side of the rectangle oriented along east–west axis.

Shading calculations: By provision of proper sun shading devices, 10%–20% savings in energy required for cooling can be brought about. Krishan and colleagues[3] stated that in case of a composite climate, one would need to design shades that cut off the sun in summer but allows the sun in the under-heated period.

Housing forms: Studies in villages near Ranchi have shown that moderately compact huts with adequate ventilation in summer perform best from a thermal comfort point of view throughout the year.[1]

Use of appropriate building materials: In view of the prevailing climate of Ranchi, high thermal capacity of mud walls, though

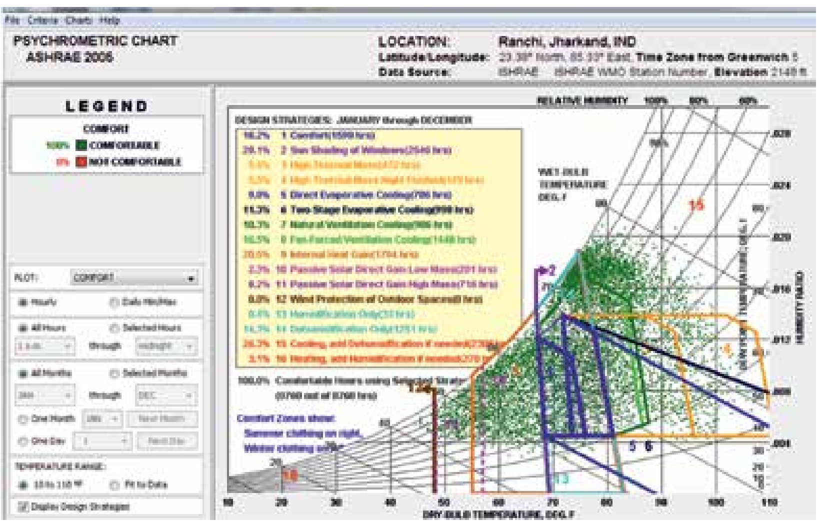


Figure 1 Revised BBCC for Ranchi, Jharkhand

2 Design with Climate: Bioclimatic Approach to Architectural Regionalism
3 Climate Responsive Architecture: A Design Handbook for Energy Efficient Buildings

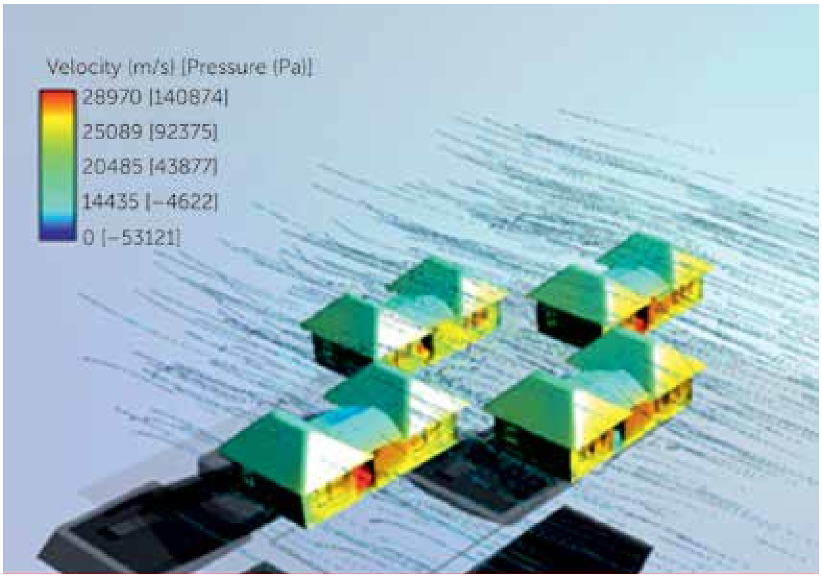


Figure 2 Wind flow simulation analysis in Autodesk Software showing existing typical arrangement of rural dwellings not allowing for all huts to receive adequate ventilation

beneficial in the daytime, creates a problem during the night time when the stored heat in the mud walls is radiated inside, creating hotter thermal conditions inside the hut than cooler outside temperatures. As per Keshtkaran,[3] the best indoor heat balance can be gained by using heavy construction materials in the living areas, which are used during the day, and light construction materials in the bedrooms, where people sleep at night.

Architectural Application

Architectural applications for creating climate-responsive rural dwellings in Jharkhand are as follows:

- *Architectural application of arrangement of dwelling units on site*: The existing arrangement of huts typically followed in studied huts does not result in the individual dwellings getting adequate ventilation, as indicated in Figure 2. A typical cluster in tropical zones with moderate to high humidity should be designed as shown in Figure 3. The intention is to provide clear wind flow access to all blocks by arranging them in a staggered layout.

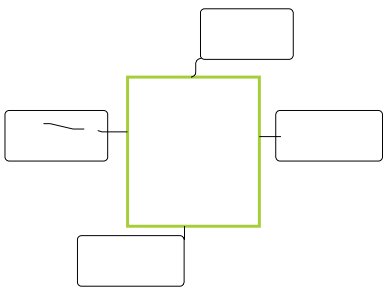


Figure 3 Suggested arrangement of huts in a slight variation of the already existing courtyard type planning to channelize cooling breezes in summer

- *Architectural application of compactness of dwelling units and its effect on climate responsiveness of dwellings*: A study was conducted by Gupta and Chakraborty[1] about the three different types of dwelling units commonly found in the studied villages around Ranchi, all having a courtyard style of planning and varying in their degree of compactness of planning. The three types of mud huts with courtyards, with varying perimeter–area ratios ranging from 0.3 to 0.8, were studied in detail through temperature measurements in the south-side rooms, in addition to detailed software simulations of year-round total number of discomfort hours due to excess heat and excess cold, respectively, with their thermal performance during the peak of summer and winter months being observed. The most compact dwelling of the three studied dwellings, the sample hut sub-type 1, with a perimeter–area ratio of 0.3, recorded the highest temperatures during summer and showed the greatest number of discomfort hours due to excess heat. On contrary, dwellings with greater perimeter–area ratios (0.8 and 0.65) showed better thermal performance in summer based on simulations and measured data. Thus, compactly planned dwelling units do not necessarily show better thermal performance than less compactly planned dwellings in Ranchi's prevailing climate. The best thermal performance in summer was shown by Sample Hut 3, with a perimeter–area ratio of 0.65. (Figures 4 and 5). Thus, neither does having a compact plan nor does having a courtyard guarantee good thermal performance in summer. In Ranchi's prevailing climate, moderately spread out plans with good access to natural ventilation work best, as exemplified by the comparatively better thermal performance of the U-shaped sample dwelling unit 3 with a perimeter–area ratio of 0.65

3 'Harmonization between climate and architecture in vernacular heritage: A case study in Yazd, Iran'

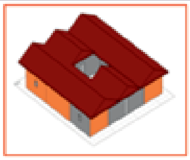
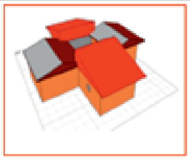
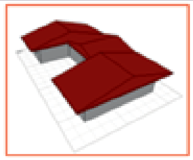
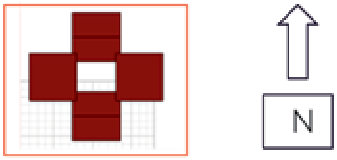
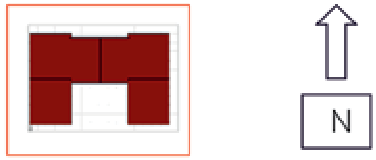
 Sample hut sub-type 1 Village: Nawatoli	 Sample hut sub-type 2 Village: Pancholi	 Sample hut sub-type 3 Village: Angara
		
Approximate area = 128 sq meters Perimeter by area ratio = 0.3	Approximate area = 100 sq meters Perimeter by area ratio = 0.8	Approximate area = 80 sq meters Perimeter by area ratio = 0.65

Figure 4 Description of three sample huts studied

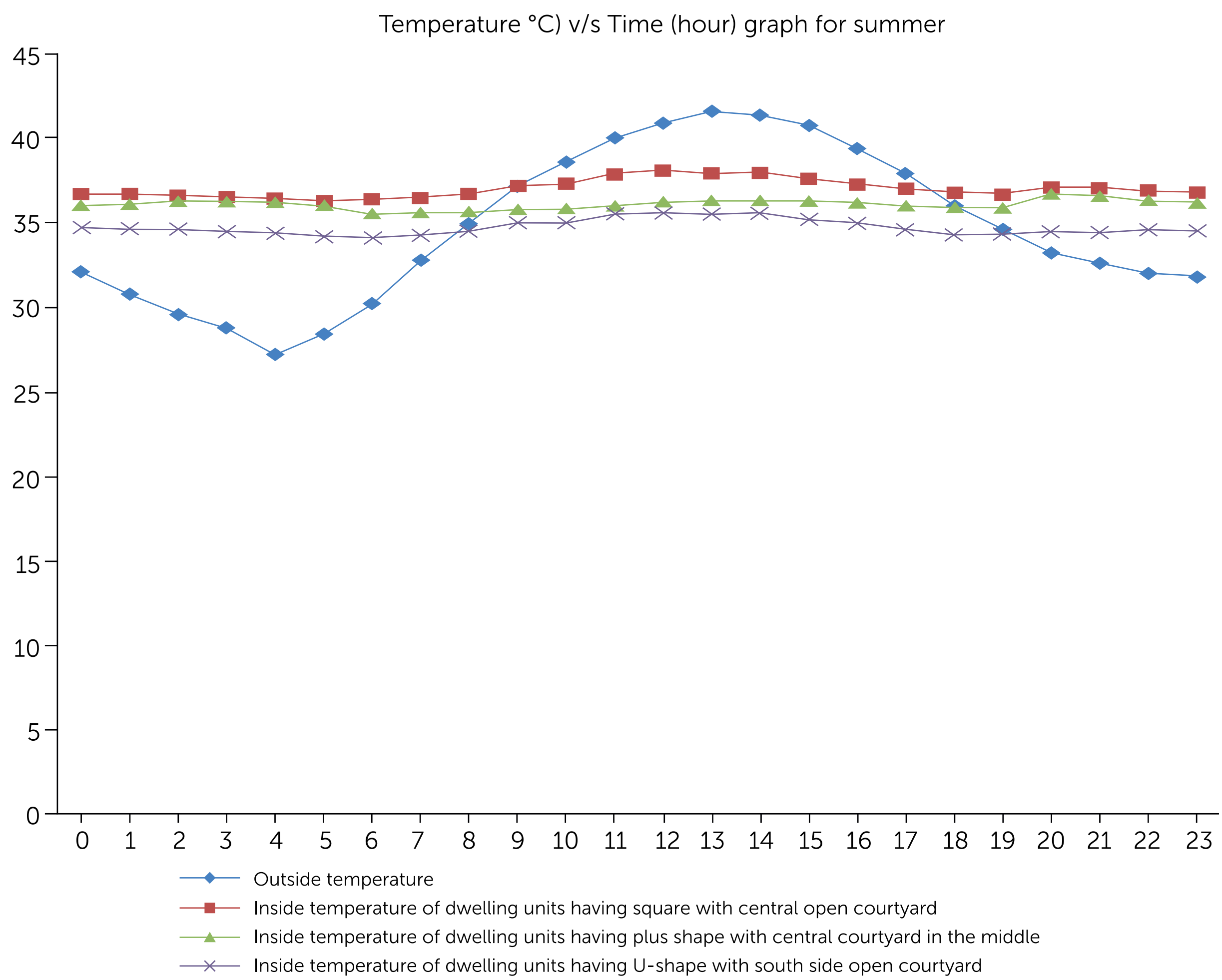


Figure 5 Recorded average temperatures in week May 29–June 4, hottest period of year

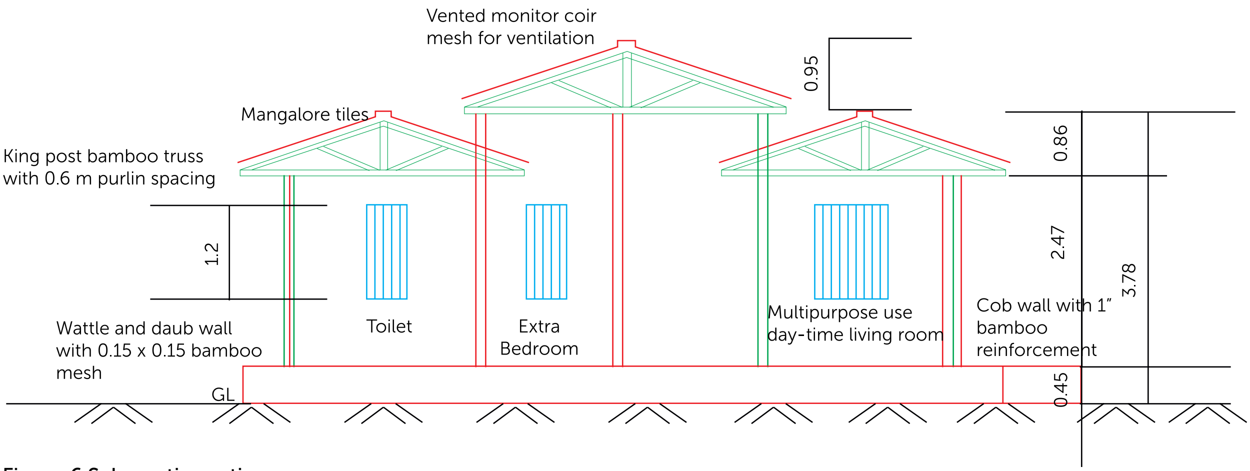


Figure 6 Schematic section

A model hut based on the above tenets suited for Ranchi's climate is as shown in Figures 6 and 7.

Conclusions

Based on detailed study of the four pronged attributes of climate, biology, technology, and architectural applications, as relevant to the composite climate of Ranchi, the following design strategies can be concluded for the rural mud huts of Ranchi:

- The huts should have adequate shading to keep the sun out in summers to reduce heat gain and glare.
- Screened porch, patio-like spaces, or courtyards should be provided to provide comfort cooling in summer.
- Separate summer-time and winter-time rooms can be used.
- To capture natural ventilation, wind direction can be changed up to 45 degrees towards the dwelling by exterior wing-walls and appropriate landscaping.
- Night-time flush ventilation is required to cool thermal mass. For better night-time flushing of heat in summer, wattle and daub walls of 150 mm/200 mm can be used for the summer-time sleeping rooms. For the winter-time rooms, using 300 mm walls (preferably with insulation), which have a lower *U*-value and have more insulation property, than the presently used 500 mm thick walls, can be an option.
- Arrangement of huts in a slight staggered variation of the already existing courtyard-type planning to channelize cooling breezes in summer is needed, ensuring each individual mud hut should have access to wind-flow and that one hut does not block the other hut's air flow.
- In Ranchi's prevailing climate, moderately spread out plans with good access to natural ventilation work best.

Glimpse from GRIHA 3-day training program for certified Professionals held at VVIP circuit house, Pune, January 2017.

IMPROVING THE ENERGY EFFICIENCY OF THE EXISTING BUILDING STOCK

Shabnam Bassi, is Secretary, GRIHA Council which administers the Green Rating for Integrated Habitat Assesment. Prior to joining TERI, she has worked with the UNDP and BEE, for promoting Energy Efficiency in Buildings and Implementation of Energy Conservation Building Code (ECBC).

The building stock in the world consumes approximately 40% energy, 25% water, and 40% energy, and is responsible for emitting one third of the total greenhouse gases (GHG) emissions. Global energy use in buildings is expected to grow as cities in developing countries continue to modernize and per capita income levels continue to increase. According to the International Energy Agency, by 2035, buildings will account for an approximate of 41% of global energy savings potential as compared with the industrial sector which will be 24% and the transport sector which will be 21%.

Building efficiency is the key to cutting energy consumption. Improving energy performance in existing buildings has been receiving significant attention recently, which entails reducing energy demand for building operations without affecting the health and comfort of its occupants. This approach requires strategies beyond mere technical advancements. Efficiency measures, such as building retrofits, represent a vast opportunity to improve energy efficiency. In some ways, they represent bypassed design and construction decisions which could have led to large reductions in energy use and carbon emissions. The challenge for existing building efficiency is to 'unlock' that vast potential and realize the benefits of a built environment that is comfortable, efficient, and cost effective.

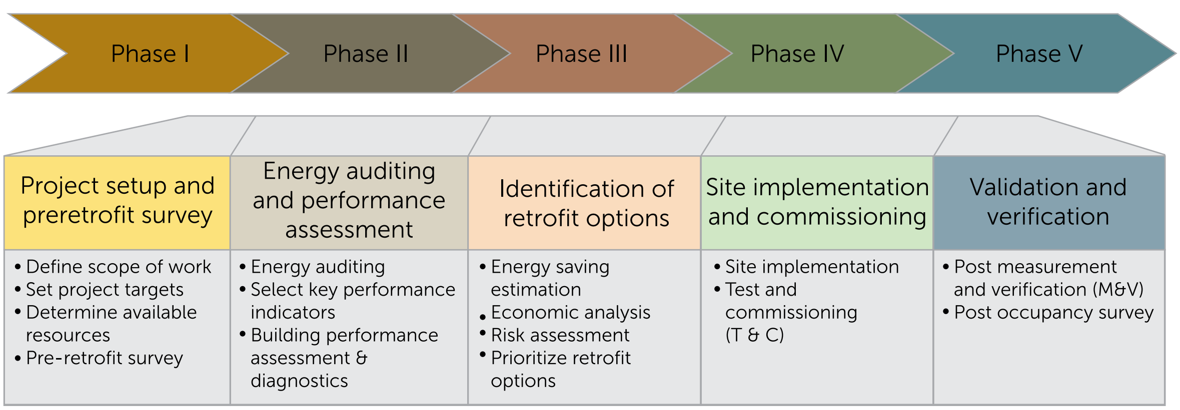
There are three primary ways in which energy efficiency can be improved in residential, public, and commercial buildings:

- **Through Improved Design and Construction**: Well-designed and well-constructed new buildings represent the best opportunity for reducing heating, cooling, ventilating, and lighting loads. The most effective way to ensure that energy efficiency is factored into the design and construction process is by introducing and enforcing building energy efficiency codes. A building energy efficiency code sets out the minimum energy efficiency requirements of a building, including the thermal performance of a building's 'envelope' and the energy efficiency standards of its internal equipment and devices.
- **Through Building Upgrades**: Retrofitting existing buildings and replacing energy consuming equipment are critical for improving energy efficiency in cities where building stock turnover is low. Cities need to be opportunistic in order to capture this potential by incentivizing and/or requiring energy efficiency upgrades as part of all significant renovations and equipment-replacement activities. For this to happen, an enabling environment and effective project financing and delivery mechanism must be in place.

- **By Actively Managing Energy Use**: Establishing and maintaining effective energy management systems for monitoring and controlling energy use in large public and commercial buildings is a low-cost means with which energy efficiency can be improved and energy demand can be reduced. Many researchers have emphasized the importance of adopting organizational changes to improve the energy efficiency of buildings. Modern energy codes require installation of advanced features, such as daylight and occupancy sensors, real-time monitoring and behavioural change could influence 40% of the building energy use in terms of savings. Smart metres allow building users to see daily energy consumption patterns and encourage changes in behaviour patterns to reduce the peak demand which in turn can be reduced by 13% when customers are warned about peak energy rates. Building zone level control, considering personalized occupancy patterns, is another viable approach for reducing energy consumption within buildings.
- **Building Commissioning**: Building commissioning is important, but remains a neglected area in building energy management. This approach helps to reduce energy consumption by streamlining the systems. Energy benchmarking defines a value that represents typical energy use, which will be used as the baseline against which buildings will be compared. Energy benchmarking improves the energy efficiency and transparency of energy consumption, promotes competition among institutions, established baseline for energy labelling programmes, and helps to investigate reasons for poor energy performance.

The key barriers to greater investment in energy efficiency are as follows:

- **Split Incentives Barriers**: In the existing buildings sector, principal-agent barriers are common in lease properties where a split incentive exists between the landlord or the owner's agent (the one who purchases or specifies what energy-consuming equipment will be installed in the building) and the tenant (the one who typically pays the utility bill). This issue arises in both the commercial leasing market and in rental housing. Similarly, a split incentive exists for homeowners and businesses that do not expect to hold a property long enough to realize the full financial benefit of an investment in energy-efficiency measures.
- **Information/transaction Cost Barriers**: Information/transaction cost barriers arise when the consumer lacks sufficient information or expertise to make purchasing decisions that optimize their overall cost and energy savings. The asymmetry of information available to the consumer versus other market actors can create confusion and distrust, thereby discouraging adoption of new technologies or services. Consumers may also face higher transaction costs associated with the additional time, effort, and inconvenience necessary to identify and purchase efficient products and services.
- **Externality Cost Barriers**: The large environmental and health impacts associated with energy production and transmission lead to large externality cost barriers such that the price of energy does not reflect its true cost to society. Addressing this requires broad policy-level changes.
- **Other Barriers and Economic Forces**: The building industry is very fragmented making it difficult to identify the



appropriate ESCOs to provide needed services, including retrofits, that can improve building energy performance. Once improvements are identified, the customer may have to manage the efforts of multiple contractors. In commercial buildings, institutional practices and organizational structures can inhibit investment in cost-effective, energy-efficiency projects. The process for approving capital and non-capital (operations and maintenance) projects, the methods for crediting energy cost savings within the organization, the level at which decisions are made, and the financial criteria used to judge proposed projects all have an impact on the decision-making process and can result in missed opportunities to invest in cost-effective, energy-efficiency projects.

The Opportunities

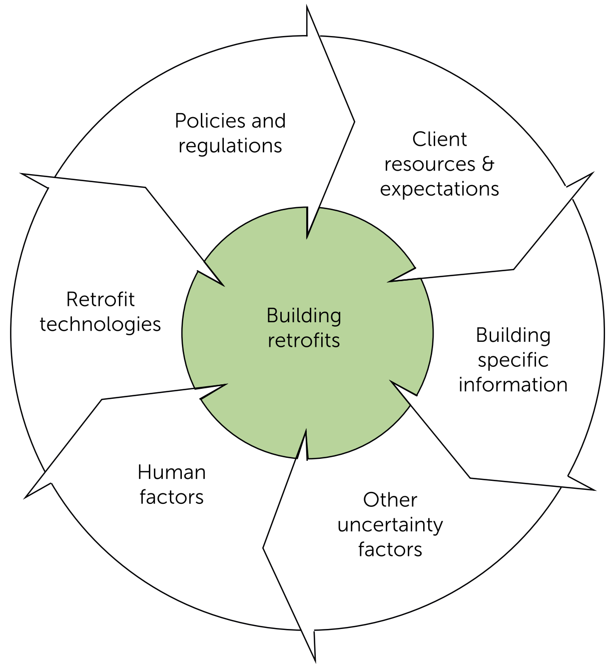
Scaling up energy efficiency in buildings is a value proposition for both mature and fast-growing cities. Given that most of the buildings in existence today were constructed with little or inadequate attention to EE, the global building sector is a huge untapped source for energy efficiency gains. City authorities should aim to pursue EE measures that make financial or economic sense, depending on local resources, on the basis of life cycle cost and benefit.

Simple payback time is a quick means of evaluating the financial attractiveness of energy-efficiency measures. Many energy-efficiency interventions can pay for themselves under five years, although their relative cost effectiveness depends on factors, such as whether, they are applied in new or retrofitted buildings, local climate conditions, and energy prices.

The entry points at which to increase energy efficiency in buildings fall into three focal areas: (i) reducing heating, cooling, ventilating, and lighting loads through improved building design and construction; (ii) increasing the efficiency of energy-using equipment through upgrades and replacement; and (iii) actively managing energy use in buildings.

Improving the energy efficiency should follow a structured process. There should be energy-efficiency promotion, reducing energy consumption, alternative energy production, and improving the social awareness through private initiatives that are supported by government intervention. Furthermore, it is important to seek and identify, beyond the common methods and state-of-the-art technologies. Several examples for the future vision by commercial and institutional buildings include, smart facades, intelligent buildings, new insulating materials which are cost effective and aesthetically acceptable, high-performance windows, etc.

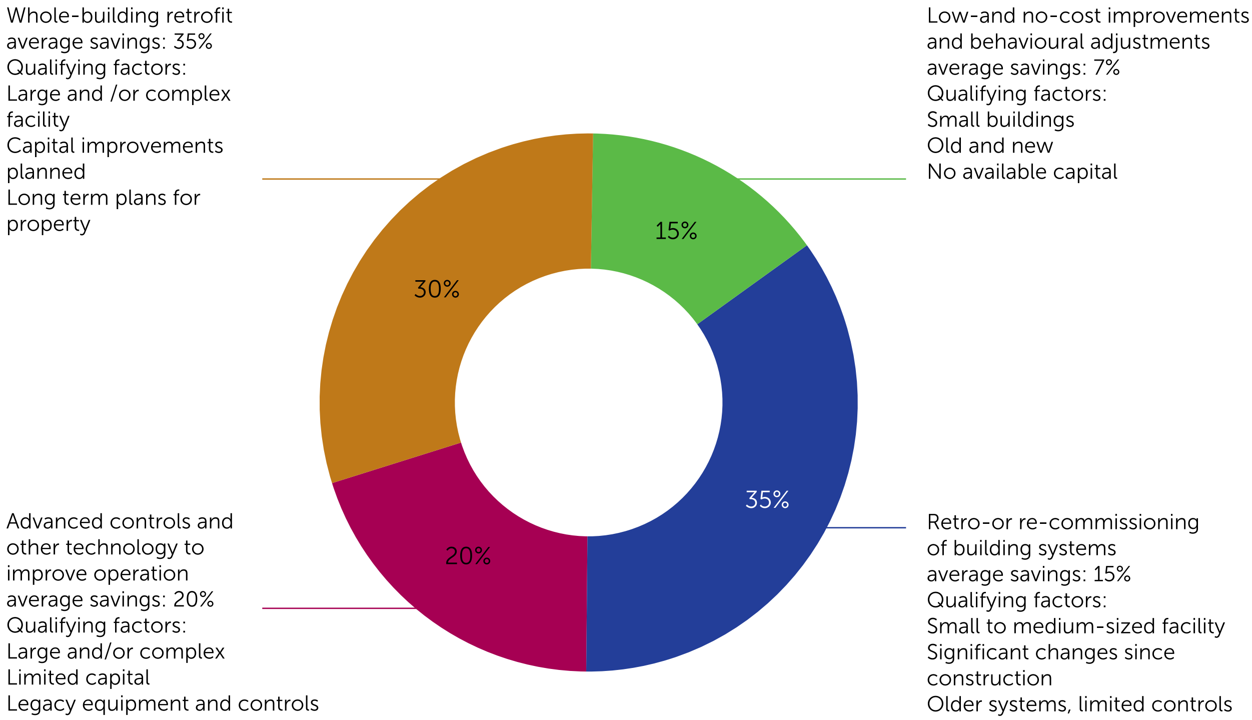
Energy regulatory policies formulated at the national or regional levels, address general inefficiencies in energy markets. Examples include policies to replace general-pricing subsidies



with targeted social-assistance schemes that require users of network-based energies be charged based on metered consumption. This would also introduce incentives encouraging energy utilities to carry out demand-side management activities.

Mandatory standards and codes developed at the national and regional levels, and updated periodically, address key-market failures or inefficiencies, in this case, defined as situations in which rational decisions taken by market participants have led to negative or suboptimal economic outcomes for society as a whole. The case of split incentives is a main reason for introducing mandatory building energy-efficiency codes.

Minimum Energy Performance Standards (MEPS) for major energy-consuming equipment are targeted at manufacturers, but supported by demand-side promotions (e.g., rebate programmes for appliance replacement) implemented by energy utilities or city authorities.



Labels and certificates are means of recognizing and encouraging EE efforts that go above and beyond the mandatory requirements. Examples include the voluntary Energy Star Programme for buildings, components, and equipments by the Bureau of Energy Efficiency. This promotes the adoption of nationally/internationally recognized labels and certificates, report their EE performance, and compare with peers, thus helping improve operational and maintenance practices and identify opportunities for cost-effective retrofits. Energy-management requirements can also help municipal governments better target support for building retrofits and bridge existing-information gaps related to building energy performance and costs.

Financial facilitation schemes include fiscal and monetary incentives to encourage investments in energy efficiency. Examples include tax credits, cash rebates, and capital subsidies, as well as special funding vehicles and risk-sharing schemes to increase funding and lending for investments in EE.

Public-sector financial management and procurement policies can have a significant impact on municipal efforts to retrofit public buildings and upgrade inefficient energy-consuming equipment.

Awareness-raising and capacity-building initiatives can help increase the knowledge and know-how of stakeholders and enable the design and implementation of effective EE programmes and investment projects. These may involve general awareness campaigns, as well as initiatives to train specialized trades, such as architects, building managers, and construction workers. There is a great potential for energy saving in the existing building stock. City governments can exert significant leverage on improving energy efficiency in buildings. A rapid energy-efficiency assessment of the building sector to identify key opportunities and challenges, assess stakeholders and resources, and determine priorities and initial steps is required. Civil associations can mobilize local people through consciousness campaigns and by demanding a stronger commitment to the climate change fight from public authorities. Well-targeted policy packages with clear information about the financial benefits for each of the parties involved should be put in place. There is a need to combine the different instruments and adapt them to the national or regional specificities and needs of the different market segments.

ENERGY CONSERVATION BUILDING CODE IMPLEMENTATION IN THE STATES OF TELANGANA AND ANDHRA PRADESH

HYDERABAD MODEL




Chinta Shree Sowmya, ECBC Master trainer & Green building consultant; **Mr Rajkiran V Bilolikar**, Associate Professor, Centre for Energy, Environment, Urban Governance & Infrastructure Development, ASCI; **Abdullah Nisar Siddiqui**, Assistant Project Manager, UNDP–GEF–BEE; **Sameer Kwatra**, former NRDC Speth Fellow

By constructing energy-efficient buildings, cities and states in India have an opportunity to lock in energy savings for years and reduce climate-warming carbon emissions, while saving money and retaining occupant comfort. The Energy Conservation Building Code (ECBC) is the model energy code that sets standards for making buildings more energy efficient. With a combined population of 85 million,[1] the Telangana and Andhra Pradesh region represents one of the fastest growing regions in the country. Hyderabad, the capital of the state of Telangana, has taken the lead in ECBC implementation by developing a model framework for code compliance, which can be scaled to many other cities in the state and across the country.

Taking the lead on energy efficiency, the Government of Andhra Pradesh, supported by Administrative Staff College of India (ASCI), Hyderabad, and Natural Resources Defense Council (NRDC), USA, under UNDP–GEF–BEE (i.e., Bureau of Energy Efficiency) project "Energy Efficiency Improvements in Commercial Buildings" adapted ECBC in the state and appointed a technical committee to look into the integration of ECBC in Andhra Pradesh Building Rules (G.O.168) with a few modifications. On January 28, 2014, based on the recommendations by the technical committee, the state announced mandatory ECBC compliance for *all commercial buildings* by issuing Government Order MS No. 30 (by Amendment of G.O.168) from Municipal Administration and Urban Development Department *and became the first state to do so.* After bifurcation, both the states adapted the same GO (Government Order) and continued implementation of ECBC compliance for all commercial buildings.

Key Features of Telangana and Andhra Pradesh ECBC (TSECBC/APECBC)

For effective implementation of ECBC, few revisions have been done by the technical committee in the code before notifying it in the state of Telangana.
They are as follows:

1 http://censusindia.gov.in/2011census/censusinfodashboard/stock/profiles/en/IND028_Andhra%20Pradesh.pdf

- The applicability of ECBC compliance has been changed to 'The code is applicable to commercial buildings or building complexes with a plot area of 1,000 m^2 or more or 2,000 m^2 built up area whichever is higher' in TSECBC/APECBC.
- For certain categories of buildings, such as multiplexes, hospitals, hotels, and convention centres, TSECBC/APECBC have been made mandatory irrespective of their built up area.
- Star rating system has been incorporated in the code with AP*/TS*. The maximum star rating allotted to the buildings is AP*****/TS***** stars (five stars) with exemplary performance and minimum star rating of AP*/TS* (one star), which is mandatory for all commercial buildings. For buildings with AP**/TS** and above, the buildings will be given an expedited process for construction approval and occupancy certificate with highest priority.
- The code compliance will be checked through third party agency at two stages: first is at design approval stage and second is at occupancy stage.

Third Party Assessor (TPA) Mode Implementation

The Government of Telangana has adopted a two-tier code compliance approach. Third party assessors (TPAs), trained and empanelled by the government, inspect the building in two stages to ensure effective compliance: one at design approval stage and second at occupancy stage. This can be clearly understood from Figure 1. In the First Stage (Construction Stage), the owner in consultation with architects and mechanical, electrical, and plumbing consultants designs the building. Once the drawings are finalized, the building owner has to submit them to the TPA. The TPA checks the documents and drawings and gives an ECBC compliance certificate to the owner. Thereafter, the owner has to submit the documents/drawings to building committee of respective urban local body (ULB) of the state for approval. The ULB/development authority is responsible for approval of the documents in both the states.

This can also be done by online approval system of ULBs, *Greater Hyderabad Municipal Corporation (GHMC)—for the first time in India—incorporated ECBC compliance through its online building construction approval system.*

In the second stage of the process, that is, during the Occupancy Stage, the owner submits the data to TPA in order

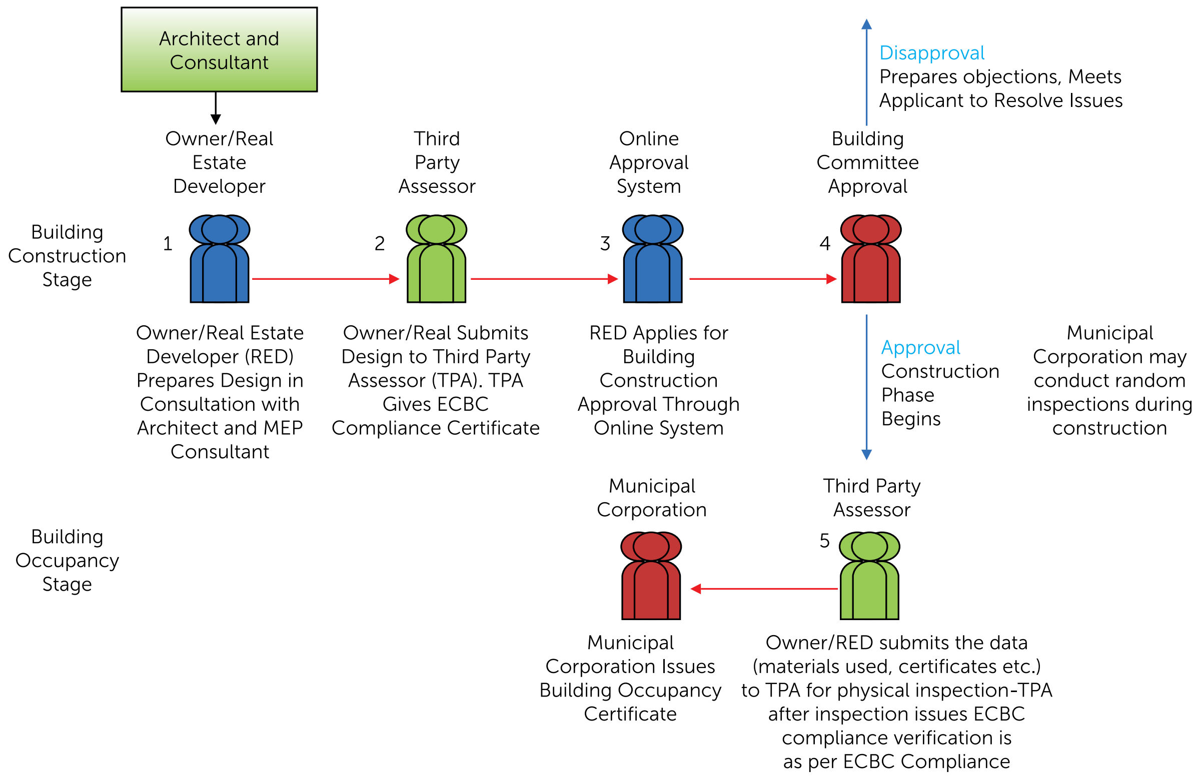


Figure 1 Schematic representation of building approval system showing the role of TPA

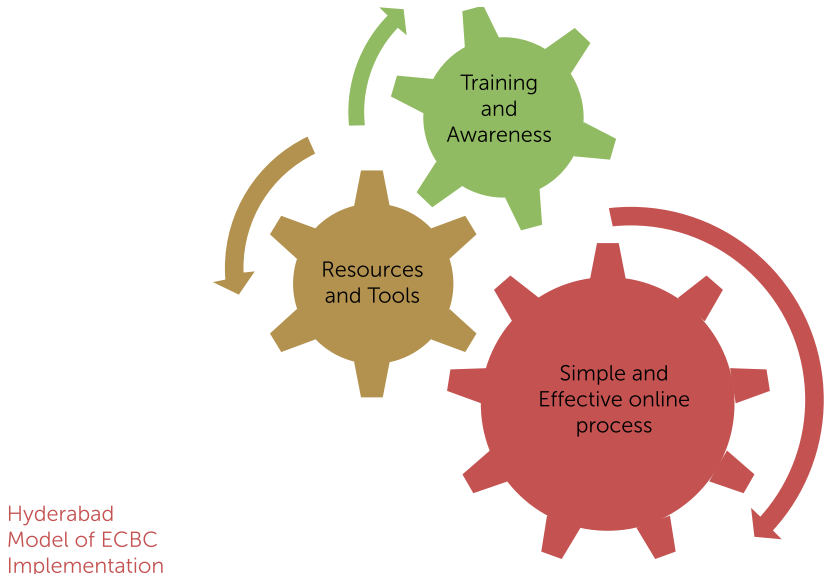


Figure 2 Schematic representation of Hyderabad Model for ECBC implementation

to undergo a physical inspection of building. TPA, after verification, finally issues a compliance certificate mentioning that the building construction is as per the code compliance.

Hyderabad Model

The city of Hyderabad is a leading destination for Indian and multinational hi-tech companies, including IT and IT-enabled services, software consulting firms, and business process outsourcing. Being the capital of Telangana, Hyderabad is also home to numerous government office buildings that cater to the administrative needs of the city and the state. This rapid growth will exponentially increase the energy use. Thus, it is right time to intervene in building construction to create energy-efficient built environment for future.

The Telangana State Government, supported by the ASCI with the support of UNDP–BEE–GEF and in partnership with International Institute of Information Technology (IIIT), Hyderabad, and NRDC, has focused on three key elements to develop the Hyderabad Model for effective, simple, and robust ECBC compliance as follows:

- Training and awareness
- Resources and tools
- Simple and effective online process

Training and Awareness

ASCI and NRDC, along with experts from BEE and IIIT Hyderabad, funded by UNDP, have trained more than 300 officials and real estate developers since the energy code became mandatory in the state of Telangana under the UNDP–GEF–BEE project named 'Energy Efficiency Improvements in Commercial Buildings'. Training the stakeholders has been a transformative step towards development of in-depth understanding of the code along with appreciation for complying with the ECBC code. Leading developers in Hyderabad have emerged as strong proponents of energy efficiency.

As per the compliance process, TPAs who have been empanelled by the Government are given authority to review the building in design and post-construction phases. The State Government has published a database of all empanelled TPAs so that project developers can contact them for compliance certification process. In anticipation of increased volume of ECBC applications via the online approval system, the GHMC is now conducting technical training workshops to expand the pool of TPAs,

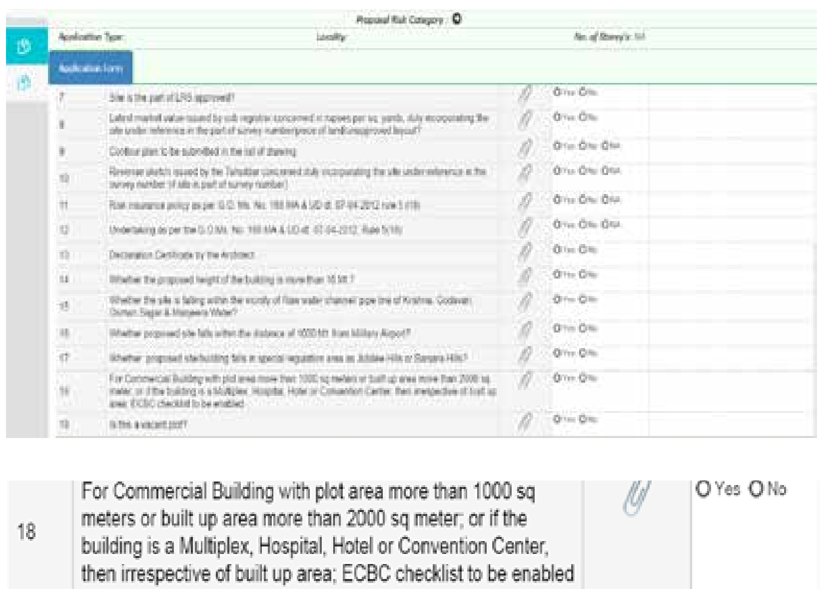


Figure 3: Screenshot of Online Application form in the GHMC website highlighting the clause of ECBC mandatory compliance

architects, engineers, and real estate developers with expertise in ECBC.

Simple and Effective Online Process

The heart of the Hyderabad Model is its online compliance system (Figure 3). *The Government of Telangana is the first in the country to incorporate ECBC provisions in its online web portal known as 'development permission management system'.* All new construction projects in the city have to submit an online application for getting permission of building construction.

Switching to the online system has helped reduce the time required for building approvals and also makes the process transparent and accountable.

The online system, which is currently live, checks all new applications for ECBC eligibility and prompts the applicants to enter the details of TPAs in the web form. Users can upload the supporting technical documents, which are then reviewed by the Chief City Planner Office in Hyderabad. NRDC, ASCI, and other partners have worked with the government and the software developers in establishing the online setup.

Technical Resources and Frequently Asked Questions (FAQs) in GHMC Website

The success in implementation of the code largely depends on a strong technical support structure. The Government of Telangana has established an ECBC Technical Cell with support from UNDP–GEF–BEE, comprising experts from ASCI, IIIT Hyderabad, and NRDC.

The aim of establishing a technical cell is to quickly address queries, especially in the initial stages as more projects start going through the code compliance process and to provide support in assessing the first 25 eligible commercial buildings for ECBC compliance.

In addition to the above, ASCI–NRDC has conducted a number of round table discussions with architects and engineers and, based on their feedback, it has developed a list of FAQs, which are available on the GHMC website, as shown in Figure 4.

The technical cell will further work on providing recommendations for streamlining the provisions of the Telangana State ECBC to be even more practical and simpler while still saving time and energy.

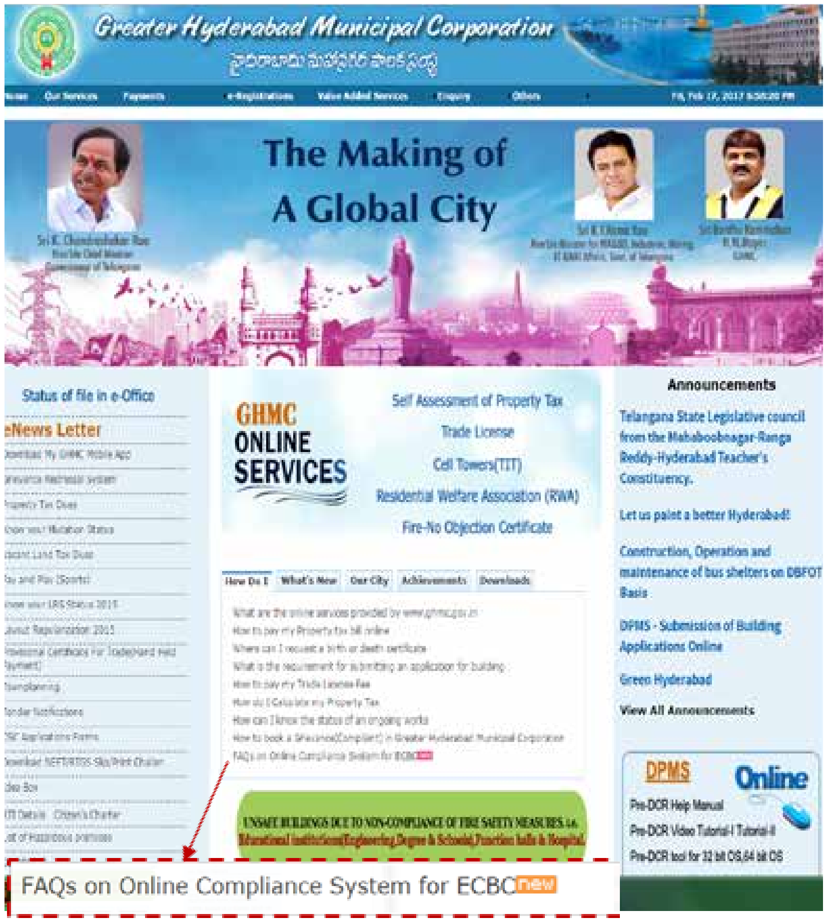


Figure 4: Screenshot highlighting the FAQ section on the GHMC website

Replicating Hyderabad Model in Other Cities

Clean energy development is a priority for the Indian government. Over a dozen states in India are at an advanced stage of incorporating the ECBC into the state and local building bye-laws. The Hyderabad Model is exemplary in actual implementation. The online process provides a simple, effective, and scalable approach to building modern India. With growing focus on smart cities in India, Hyderabad's implementation of the code will generate significant energy savings and lays a strong foundation for the city to set example as the leading energy efficient city and inspire other cities in India to follow suit.

HEATWAVES AND COOL ROOFS

REIMAGINING CONCRETE SOLUTIONS TO A RISING URBAN PROBLEM

Caroline Fouvet, is a policy researcher at Acclimatise where she works on climate finance and communications. She has worked on international cooperation issues with a focus on sustainable development and climate change.

Pedestrians and workers seeking refuge under trees, bus-shades, and flyovers to escape the stifling heat during peak summer—this is a common sight in many Indian cities. When mercury climbs, the official advice is often to 'remain indoors', but with current climate trends portending more intense heatwaves, buildings, especially low-cost homes lacking cooling facilities, are no longer safe spaces. Action is needed to protect people from extreme heat, and while 2016 was the year of initiating policies and solutions, 2017 can be the year of action and implementation.

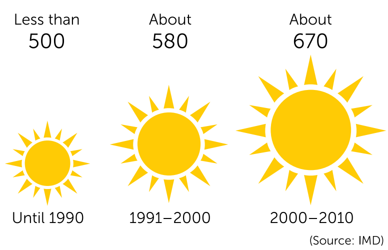


Figure 1: Heatwaves in India (per year)

Source: TARU Leading Edge, Roadmap for Planning Heatwave Management in India, 2016

In 2015, between the months of May and June, India experienced one of the deadliest heatwaves in its history. The extreme weather condition claimed 2,500 lives. With temperatures crossing 50°C in the states of Rajasthan, Uttar Pradesh, and Telangana, Indians realized how unprepared and vulnerable they were. Senior citizens, arguably among the worst hit, were reportedly hospitalized for heatstrokes. While the authorities issued urgent advisories on avoiding outdoor activities, ensuring adequate hydration, and suitable clothing, the situation remained grim.

A heatwave is defined as a prolonged period (usually more than five days) of 'abnormally' hot weather.[1] In India, such episodes have increased in frequency and intensity over the last decade and these extreme conditions are now arriving sooner than expected.

According to a recent study, while India experienced an average of less than 500 heatwaves per year until 1990, its number rose to around 580 between 1991 and 2000, and escalated over the following decade to 670 a year. This rising trend is expected to continue. On this, the Intergovernmental Panel on Climate Change is 90% certain noting that, 'surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heatwaves will occur more often and last longer....'

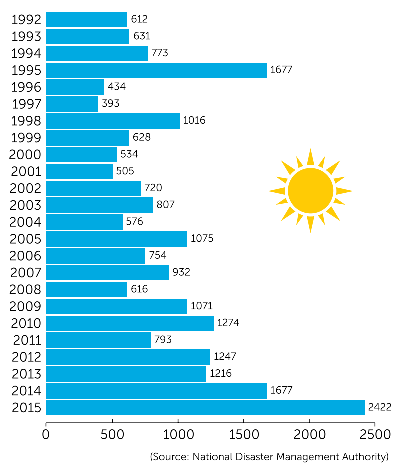


Figure 2: Rising Number of Heatwave Deaths Since 1992

Source: TARU Leading Edge, Roadmap for Planning Heatwave Management in India, 2016

[1] This is the World Meteorological Organization's official definition.

A Public Health Issue

Since 1992, India has seen a consistent rise in heatwave-related deaths. Figures compiled by the National Disaster Management Authority (NDMA), show that casualties due to heatwaves have almost doubled over the last 20 years, from an average yearly death toll of 668 between 1996 and 2005, it has risen to 1,200 in the next decade. It is no wonder then that the World Health Organization is now being urged to declare climate change as 'a global public emergency'.

Cities are the Most Vulnerable

While heatwaves affect people all over India, many of the casualties are concentrated in urban areas. Indian cities are growing fast, and are today home to a third of the population. Rapid urbanization has led to a spurt in infrastructure investments. However, as population density in cities increases, so does the danger posed by extreme heat. This is because congested urban areas and tightly-packed buildings are major contributors to what is known as the urban heat island (UHI) effect.

This phenomenon occurs when heat gets absorbed and then released by buildings, concrete surfaces, and asphalt. This process leaves air temperatures in densely built urban areas higher than in the surroundings. Although clearly affected by the climate, much of the UHI effect is within human control. Air pollution and inappropriate building materials are, for example, among the primary contributors.

Recognizing the Need for a Coordinated Institutional Response

For the first time in India, institutional plans to manage the occurrence of heatwaves have been initiated. Concrete steps have been taken at the city level. The city of Ahmedabad, for example, has developed a systematic heatwave management plan and the Urban Health and Climate Resilience Centre, has designed a municipal-level heatwave action plan for the north-western city of Surat which is now being tried in other coastal cities as well. At the regional level, states such as **Andhra Pradesh** and **Telangana** have also launched similar plans in 2016 and have issued guidelines to deal with the heatwave crises.

To increase India's heatwave readiness, the NDMA released the 'Guidelines for Preparation of Action Plan: Prevention and Management of Heatwave' in 2016. This was followed by a report by TARU Leading Edge, an organization working closely with a number of cities on urban climate resilience to provide a roadmap for heatwave planning. It suggests that policy responses should be designed to implement both short- and long-term measures that increase the population's preparedness to face heatwaves. It stresses, for instance, the importance of developing effective medical response systems and strengthening monitoring to analyse risk.

The Housing Sector's Potential

Government advisories on heatwaves often focus on citizens remaining indoors. However, when temperatures rise well above 40°C, children, elderly, and people with pre-existing health conditions such as heart diseases remain susceptible even when inside. Indoor heat-related dangers pose a particular threat to those living in poverty, under informally constructed tin or asbestos roofs, poorly insulated buildings, or those who work from home. Urban planning and building design are, therefore, important focus areas to reduce heat stress, and are especially important given **India's projected boom in the construction sector.**

In a 2010 report, the consulting firm McKinsey estimated that

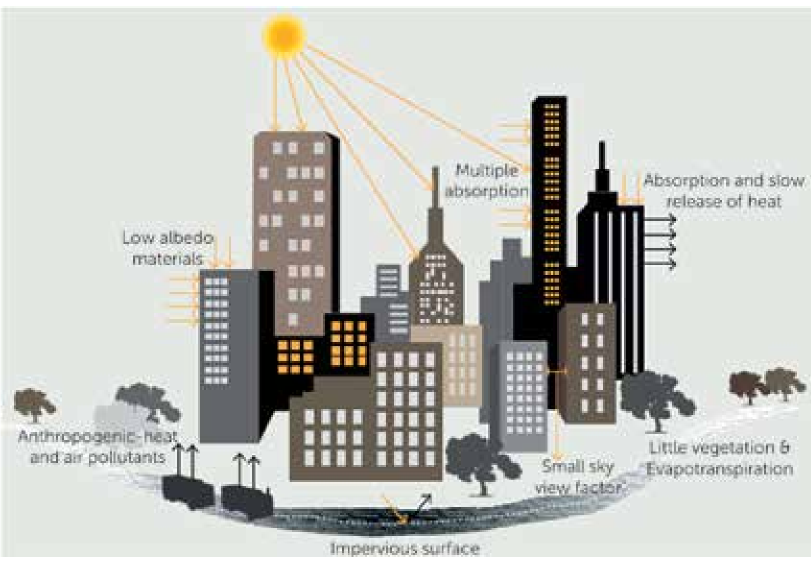


Figure 3: Heat Urban Island Effect, TARU Leading Edge, Handbook on Achieving Thermal Comfort, Volume I, 2014

'70% to 80% of the India of 2030 is yet to be built'. This represents a staggering 700–900 million sq. metres of commercial and residential space which is yet to be constructed in India every year. For heatwave resilience, this is a remarkable window of opportunity. To seize it, planners and the construction industry must be encouraged to take a sustainable, resilience-focused approach. Tackling India's housing challenge while protecting the population from heatwaves and other climate risks can go hand in hand.

Cool Roofs: An Effective Alternative

In India, an increasing reliance on electricity for cooling purposes has overshadowed more traditional methods to deal with hot weather. As temperatures rise, so does the demand for air conditioning. It is estimated that a demand for it will rise from 4.7 million units in 2011 to 48 million by 2031. Air conditioning represents about **40%–60% of the total energy load in hot climates on typical summer days in metropolitan areas like Delhi**; hence, its increased use will place a significant burden on the grid. Moreover, poorer households, without the luxury of such cooling solutions, will continue to remain vulnerable.

Do inventive, low-cost technologies hold the answer to this problem? Recognizing the importance of housing design in tackling thermal discomfort, TARU Leading Edge tested various cool roof options in houses in Surat and Indore.

This simple principle entails designing roofs that reflect sunlight and absorb less heat. They can be surprisingly effective, delivering a 1°–4° reduction in indoor temperatures. With negligible operational costs (from ₹25 per square foot to ₹175), a one-off investment in cool roof technology provides good value for money, with potential reductions of up to 20% on energy bills. Many of these solutions have been part of traditional building practices, and some are more recent technological interventions, but together they hold the potential to improve thermal comfort.

The performance of each option was monitored with temperature and humidity data loggers, installed inside and outside buildings with cool roofs, as well as in houses without cool-roof systems. The findings were then compiled into a book for the benefit of builders, architects, and home owners for immediate implementation.

Some of the most striking examples from the book include:

Cool Roof Paint (see Figure 4)

Cooling Potential: 2°–4°

The application of reflective paints to roofs can help reduce the amount of indoor heat by reflecting heat away from the building.

Bamboo Shading Screen

Cooling Potential: 3°–4°

A bamboo shading screen for the roof is placed on a basic support structure which provides an air gap between the panel and roof surface. This creates shade and encourages air flow beneath the panel, reducing temperatures.

Green Mat Shading

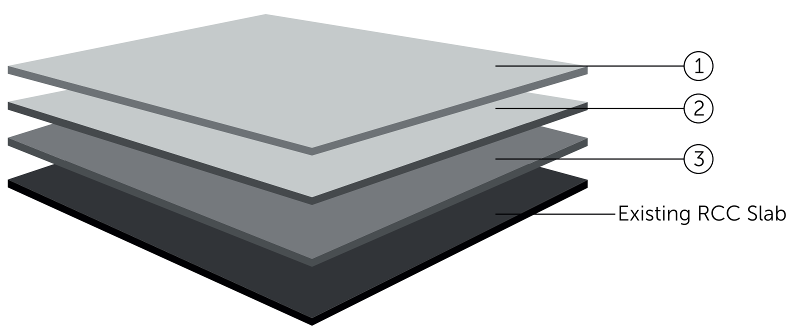
Cooling Potential: 2.5°–3°

Simply by adding green matting (widely available as a covering for greenhouses to grow plants) can provide shade of up to 70%. This simple, low-cost application makes it an attractive option to increase thermal comfort by reducing the roof surface temperature. It also makes flat terraces more usable during the hot season.

Lime Concrete

Cooling Potential: 2°–3°

Lime concrete has traditionally been used as a weathering layer for roofs, mostly for buildings constructed more than 50 years ago. The principle is to install a layer of concrete made with lime-surkhi mortar along with broken bricks as coarse aggregate. This mixture is enhanced with natural water-proofing agents such as



(1) Final reflective coat: Thin polymer-silicon based water repellent transparent film
(2) First reflective coat over the base coat
(3) Base coat of white paint

Figure 4: TARU Leading Edge, Handbook on Achieving Thermal Comfort, Volume II, 2014.

jaggery, gall-nut, and *bael* fruit. The lime concrete can then be covered with terracing material such as tiles.

Thermocrete

Cooling Potential: 2°–3°

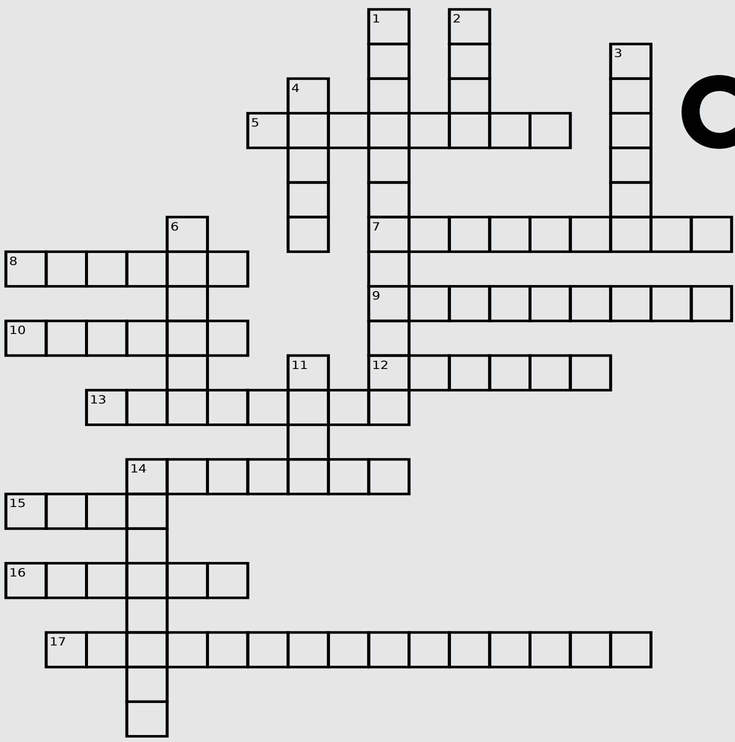
Thermocrete is a kind of concrete mixed with thermocol (extruded polystyrene) balls.

These balls act as air cavities which prevent some amount of heat from travelling through the material. Thermocol balls can be conveniently sourced from packaging industries or manufacturers of bean bags.

The Future of Heatwave Management

As India braces itself for the inevitable and intense heatwaves, city governments need to develop plans to tackle the phenomenon, and include building design as one of their core adaptation measures. It is clear that the housing sector offers considerable potential to increase heatwave resilience, using sustainable, energy-efficient, and cost-effective measures. While climate change will subject India's cities to conditions more adverse, policy makers must continue to address the issue, moving from planning to implementation at the earliest opportunity. Additionally, the low cost of many effective adaptation measures means that homeowners and builders do not have to wait to act. The simple fact is that a failure to do so will cost lives, and it will be the most socially vulnerable who will pay the biggest price.

Crossword Puzzle



Across

5. World Environment Day is observed on 5th of........
8. The use of earthworms to convert organic waste into fertilizer.
10. This country consumes the most energy in the world.
12. Carbon-dioxide and .... constitute the two major greenhouse gasses.
14. What gets .... gets managed.
16. According to a UN study on sanitation, far more people in India have access to a .... than to a toilet.
17. A .... Vehicle uses two or more power sources to run.
18. This country produces the most energy in the world.

Down

1. There are total ....Sustainable Development Goals.
2. .... Wastewater Treatment Technology is a biological sewage treatment system.
3. According to the World Health Organization this is the most polluted city in the world.
4. 27,000 trees are felled each day for making....... paper.
6. It takes a Styrofoam cup .... hundred years to decompose.
7. Name given to fuels derived form vegetable oils, biomass, corn, soyabean etc.
9. India's first electric powered car.
11. kWh/m^2/year is the unit of ...... performance index
13. ....can be recycled infinite number of times.
15. Unit in which ozone layer thickness is measured.

Answers

See on page : 103

SMALL CHANGE, BIGGER GAIN

Akash Deep, as Program Manager, with GRIHA Council spearheads the team, and works on supervising evaluation of projects, development and streamlining the various rating processes. He has headed the design and development of various IT tools and organized multiple trainings.

Green building and sustainability have become the basic necessity of new constructions happening across the country. Projects targeting sustainability through green building design integration generally focus on energy, water, and waste efficiency. However, the first and foremost step of introducing sustainability through design actually results in efficiency in optimum use of resources with the project automatically.

With around 850 projects located in different climate zones across the country aiming to get Green Rating for Integrated Habitat Assessment (i.e., GRIHA) certification under different variants for small, medium, and large city scale projects; we come across multiple, innovative integrated design features implemented and performing, achieving sustainability in every smallest way possible and resulting in a major saving for all stakeholders, that is, developer/user/development authority.

Following are some of the innovative design strategies:

Main Entry/Exit Placement

In many projects the entry/exit gate is placed right on the abutting access road. It results in traffic spill on to the access road during peak hours due to the growing personal vehicle (cars) usage in the city and the frisking security facility placed at the entry gate. A recessed main gate with provision of waiting area for at least three to four cars outside the gate helps reduce traffic spillage on the access road during peak hours.

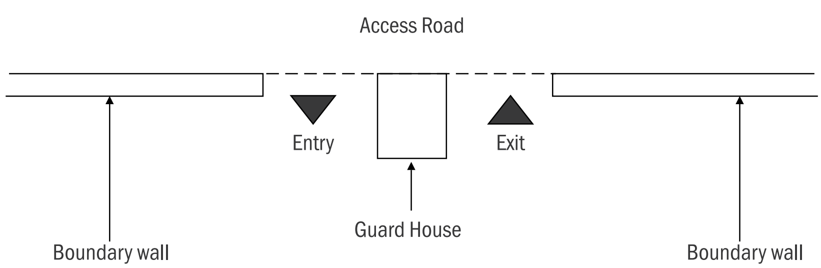


Figure 1: Plan Showing Entry/Exist Gate Abutting Main Road.

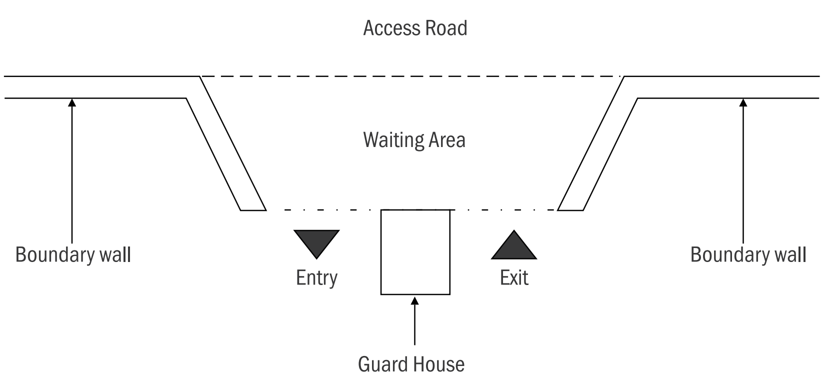


Figure 2: Plan Showing Recessed Access Gate.

Tree Plantation on Parking and Podiums

With growing number of cars in residential and office complexes, the construction of basements and podium results in reduced tree cover. This in turn decreased the social interactive space from the landscaped areas and also increases the ambient temperature around the buildings. Columns can be used as stand/support for providing trees plantation at the podium/parking roof level.

Column Used as Recharging Pits

With growing urban area, the run off from sites has increased exponentially and the lack of soft cover has reduced the recharging capacity of site through natural percolation resulting in the depth of deep bore recharge, which poses greater contamination threat to ground water.

The major open area available for recharging ground water is the setback area in site and usually these recharge pits are placed near the boundary wall due to paucity of space. Almost all sites in the highly urbanized areas follow the same practice, which results in concentrated recharge of the same land parcel. The major land available to recharge the ground water is below the structure on site. The solution could be design of podium/parking columns as storage and recharge pits.

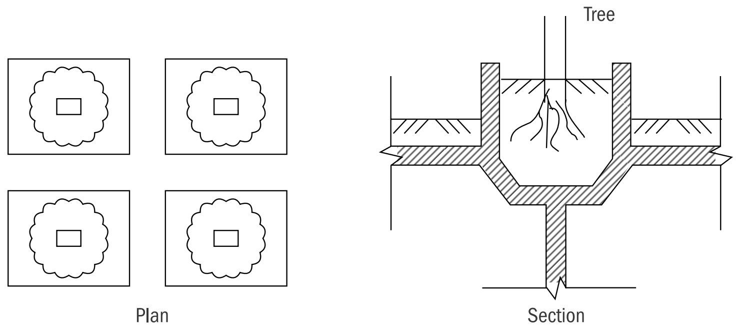


Figure 3: Column Converted into a Pot.

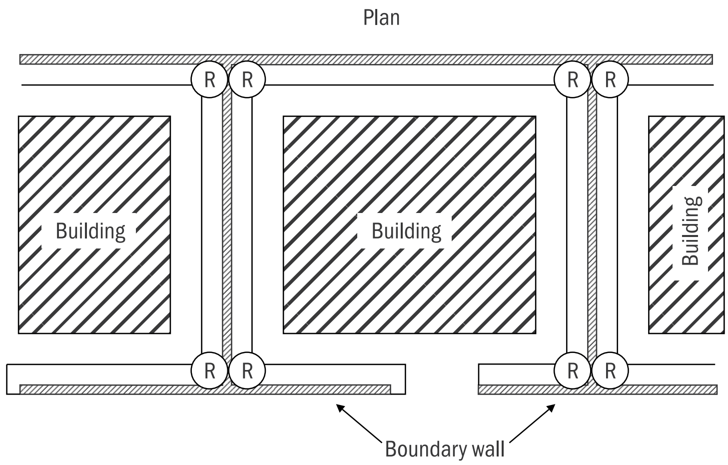


Figure 4: Recharging Wells Placed at Site Boundary.

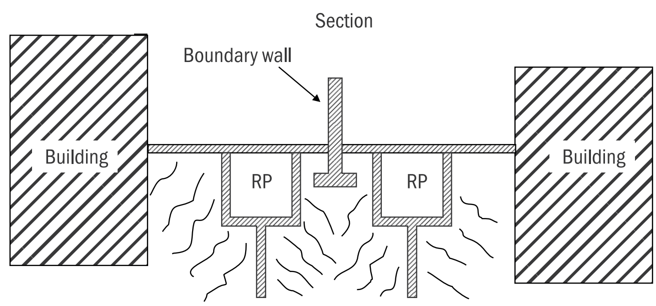


Figure 5: Section Indicating Recharge of Common Soil.

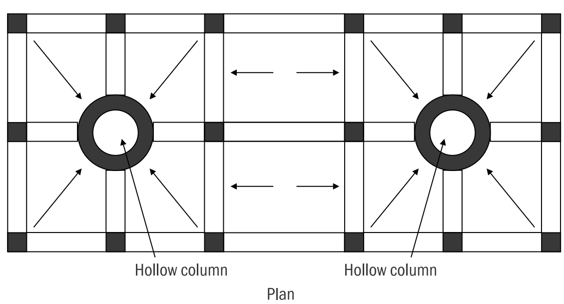


Figure 6a: Plan Indicating Location of Hollow Column.

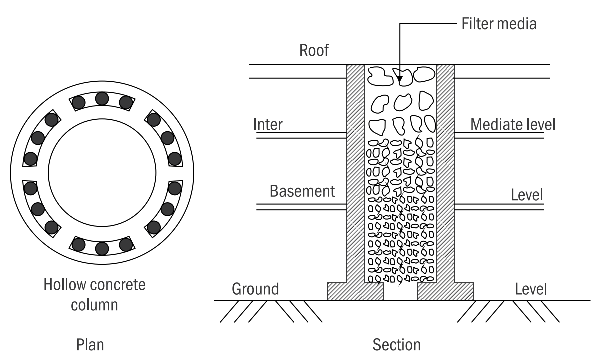


Figure 6b: Hollow Column Facilitates Recharging Rainwater Directly Under the Inaccessible Building Footprint.

Window Usable in High Rise Apartments

Natural ventilation is a key parameter towards reducing high energy demand in housing sector. As we move higher, the wind velocity is high, which results in less use of open windows due to the high wind velocity to reduce discomfort inside the spaces. In general, sliding windows are provided, which results in wind gushing in the apartment, even through a small opening. However, high wind velocity can be controlled by providing top hung windows for tenth storey and above. The top hung windows also forms a protection from rain. These windows act as weather protection and also achieve desired air velocity with the opening size normally regulated by occupants.

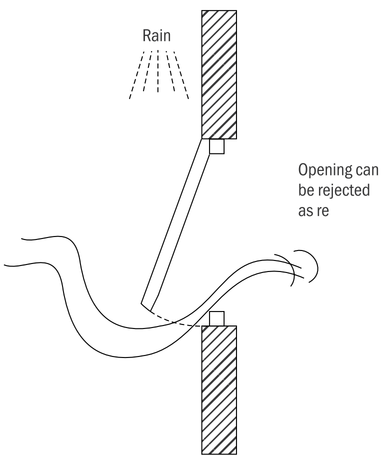


Figure 7: Top-hung Window Facilitates Controlled Wind Flow.

Ventilating the Roof

Roof is a component of the building envelop that receives maximum heat and results in discomfort of the people staying on top floor. There are a variety of under deck and over deck insulation options available to reduce the heat gain from roof. However, a simple design feature in parapet helps ventilate the roof and reduce heat gain significantly. Providing cut outs in the parapet helps to ventilate the roofs and reduce the heat absorbed by the roof.

Designer Doors Ventilating House

It has become difficult, to provide provisions for cross ventilation in rooms with no/less accessibility to outside wall due to the reduced floor heights. In such cases, door is the only available component that can help in providing cross ventilation and achieving thermal comfort. *Jalis* can be embedded in door with an option of sliding and closing the opening in case of AC usage.

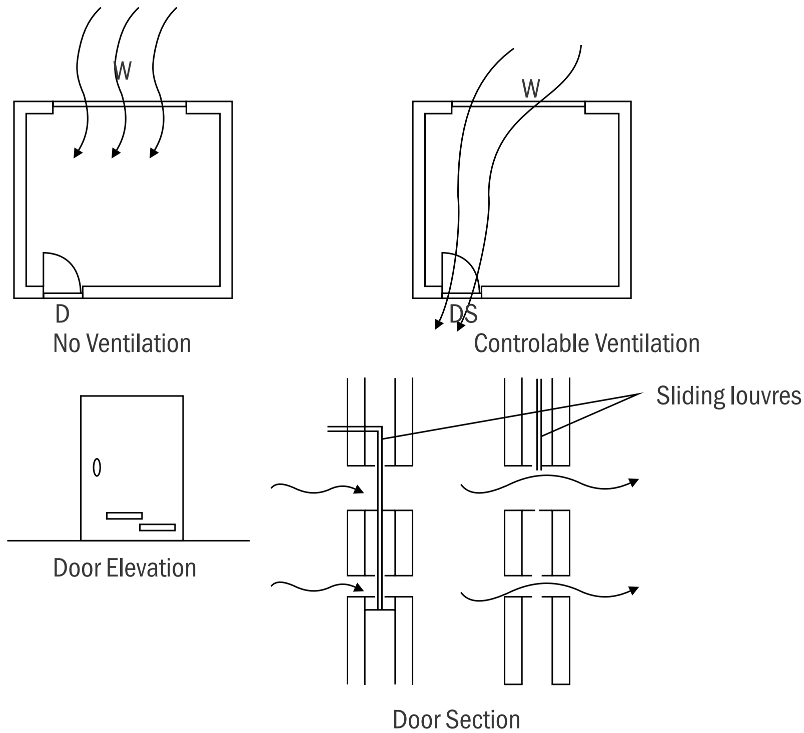


Figure 9: Controlable Louvers to Facilitate Cross Ventilation.

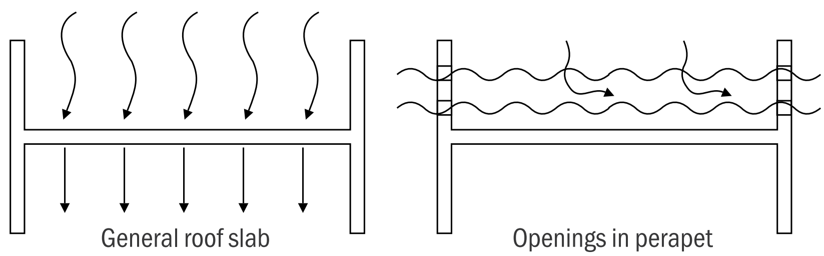


Figure 8: Designer Parapet Facilitate Heat Extraction.

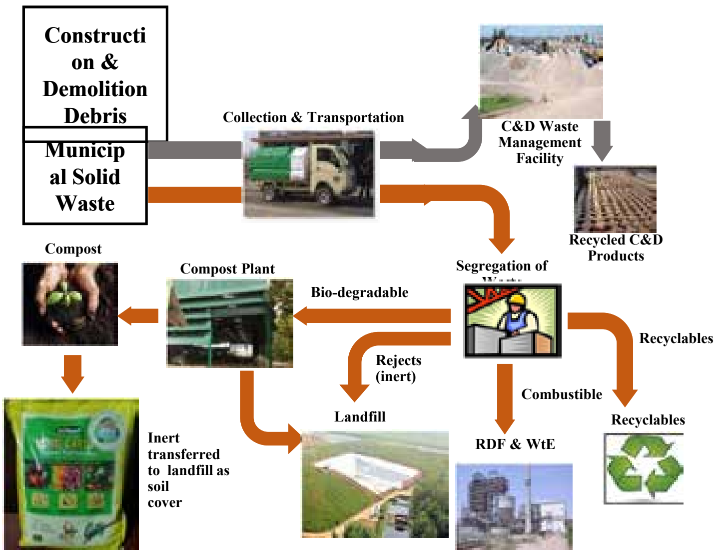
These are some of the innovative design interventions implemented by projects across the country to find a localized solution to achieve sustainability in their own way.


C&D Waste Management Plant, Burari


Waste to Energy Plant, Ghazipur

- ♣ Amongst the first to mainstream Carbon financing in Waste Management
- ♣ Over 14000 tons per day (TPD) of waste management mandates across 33 sites in 10 States
- ♣ Established benchmarks in Integrated Waste Management (IWM

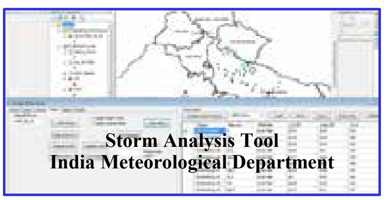
Integrated Municipal Solid Waste Management



The waste management facilities set up by IEISL scientifically processes and recycle waste into organic compost, building products and green energy

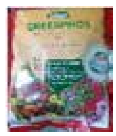
IL&FS Environment

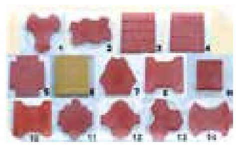

Sabarimala Master Plan

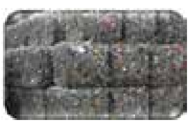

Storm Analysis Tool
India Meteorological Department

PROJECTS

PRODUCTS


Organic, Carbon rich Compost



Recycled C&D products



Refuse Derived Fuel

IL&FS Environmental Infrastructure & Services Ltd.
4th Floor, Dr. Gopal Das Bhawan,
28, Barakhamba Road, New Delhi – 110001

Ph: 011-49691000/2000, +91 9810709003; Email: ieisl.contact@ilfsindia.com

BIGEE.NET

YOUR GUIDE TO ENERGY EFFICIENCY IN BUILDINGS



Dr Stefan Thomas, Director; **Sriraj Gokarakonda**, Research Fellow; and **Christopher Moore**, Research Fellow, Energy, Transport and Climate Policy at the Wuppertal Institute for Climate, Environment and Energy.

The project bigEE—'Bridging the Information Gap on Energy Efficiency in Buildings'—started from the discovery that information on energy-efficiency technologies and policies is, albeit abundant, very scattered, which decision makers find it difficult to access. The project seeks to address this problem by summarizing knowledge and presenting comprehensive, independent, and high-quality information on energy efficiency in buildings on its international website. In particular, the project aims to make the information about existing policies, energy-efficient buildings and technologies, and appliances throughout the world comparable and present it in a targeted way so as to support investors and policymakers in making the right, energy-efficient choices. bigEE is a project by the Wuppertal Institute and its international partners, with financial support from the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

The main result that the project continues to develop is the international, internet-based knowledge platform 'bigEE—your guide to energy efficiency in buildings' for energy efficiency in appliances, building-related technologies, and buildings overall. The online platform is available at bigEE.net. It addresses the needs of decision makers in businesses and policy; a structured presentation makes it easy to find the information essential. The three comprehensive guides—for building design and technologies, for policy implementation, and for appliance energy efficiency—present detailed information about how to increase energy efficiency in buildings and appliances and how policy can support those savings.

Apart from information being universally applicable, bigEE has teamed up with three partner countries: China, South Africa, and India. A central task for bigEE is collecting and updating information on best available technologies (BAT) on a comparable basis, as well as the gathering of energy saving potentials, net economic benefits, and good practice policies. To achieve the required quality of information, the bigEE team collaborates with scientific institutes and with existing initiatives and international platforms, such as UNEP and IEA, and in partner countries, including, CSUSIBR and top10.cn in China, TERI and BEE in India, SANEDI in South Africa, and CSCP in Germany. Furthermore, bigEE engages in the active dissemination of information relevant for investors and policymakers in the partner countries by setting up and cooperating with a network of local partners.

Buildings Guide

The buildings guide explores energy levels and savings of energy-efficient buildings. It assists investors, policymakers, and others interested in the subject to find design strategies and recommendations for different climate and building types and find an appropriate combination of techniques and technologies to make Ultra-Low-Energy Buildings the standard.

It is based on a holistic approach of energy-efficient design, technologies, and intelligent building management. It explores which energy efficiency levels and energy savings one could achieve, design strategies for achieving energy-efficient new and existing buildings, recommendations for different climates and building types, which design options and technologies to combine, and good practice-example buildings for many climates and building types. A brief description guide of each of the sections of buildings is given below.

Strategic Approach

Buildings are extremely complex. Each component can be improved upon, but none can bring about full energy efficiency in buildings on their own. There are combinations of different options for improving energy efficiency in buildings. The strategic approach follows the premise of first implementing load-reducing 'Passive Options' for building design, followed by energy-efficient 'Active Options' for thermal conditioning and ventilation as needed and then fine-tuning building operation through 'User Behaviour and Energy Management'. Easy-efficiency approach should be implemented first, which can reduce primary energy consumption by 40% to 60% followed by advanced approach which further reduces the consumption by up to 90% and thereafter targeting towards being (nearly) Zero-Energy Buildings (nZEB) and net energy producer Plus-Energy Buildings (PEB) by the addition of renewables. All energy efficiency options are interdependent to some degree and, therefore, an integrated design approach is indispensable to ensure that the architectural elements and the engineering systems work effectively together.

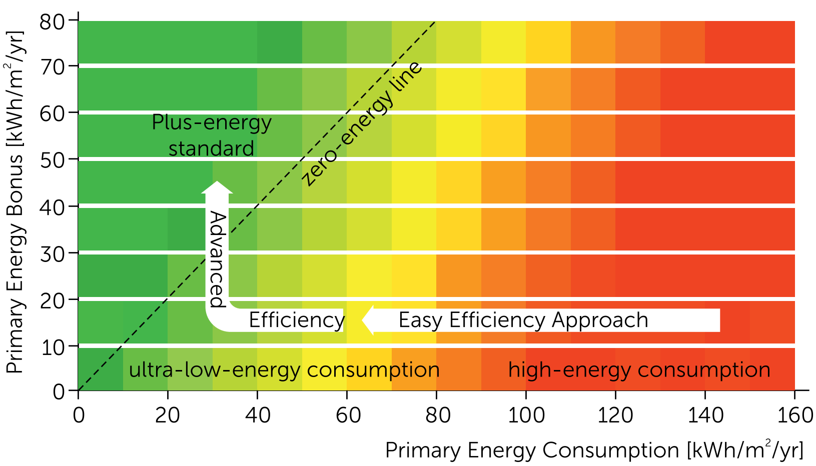


Figure 1: Strategic Approach

Recommendations

For suiting individual investors' needs, but also for ease of comparison, an interactive tool allows one to systematically browse and sort through recommendations applicable to major world climates and 24 types of each residential and office buildings. The recommendations list gives a detailed description of what can be done to achieve either Low-Energy Buildings, Ultra-Low-Energy Buildings, or nearly Zero and Plus-Energy Buildings and their potential savings. Care must also be taken as a combination of certain techniques and technologies can be counterproductive. To show good examples of combinations, there is in each case a good practice example which shows how a building can reach these low energy levels through a combination of passive strategies and techniques, active technologies, and user behaviour.

Options

A more detailed version of the short descriptions listed in the recommendations can be found in the options section. The 12 options have been divided into five passive, six active, and user behaviour and these contain a list of technology groups, e.g., space cooling, space heating, etc., under each division. Each 'technology group' further contains a list of 'individual technologies' under that group, e.g., unitary air conditioners, ground source heat pumps, etc. A technology group gives information on the worldwide market for that group, demand drivers, and provides for a comparison of costs and efficiencies of different individual technologies and suggests key improvements that make them more energy efficient. Individual

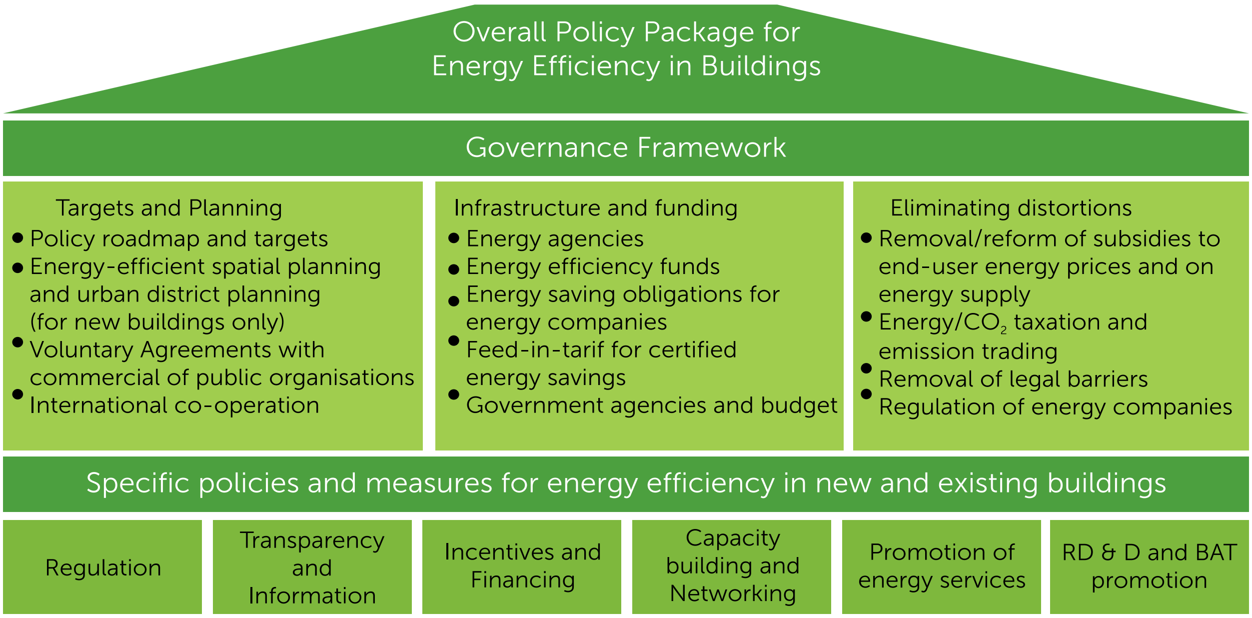


Figure 2: Policy Package

technologies give information on the worldwide market for that individual technology, a technological description, component technology improvements for that technology, cost and energy savings possible by using the best available technologies, and examples of the best available technologies.

Building Examples

This section recounts the best practice examples from the world over. Worldwide examples of holistically planned, good-practice buildings with comprehensive information are discussed. Here, the focus will also be on their implementation, techniques, and technologies, as well as on special features and energy cost savings.

Policy Guide

The policy guide acknowledges the importance of implementing a package of policies and measures in supporting all market actors to overcome various market barriers. It explores which policies to combine and how they interact in a policy package, presents example packages from advanced countries, tips and information for different individual policy instruments (i.e., package elements), and good practice individual policy instruments from several countries. Two policy guides, one each for buildings and appliances, are available. A brief description of each section of the policy guide is given below.

Recommended Policy Package

In our recommended package, bigEE distinguishes between the set of specific policies and measures for energy efficiency in buildings and the common governance framework policies needed to guide and enable the former. Figure 2 shows the components of the bigEE recommended policy package: as a framework, clear vision, and targets for energy efficiency need to be established at the highest government level. This should be accompanied by allocating finance and resources for implementation of sectorial policies and addressing market imperfections simultaneously. At the sector-specific level, policy instruments, such as regulations, information, incentives and financing, and capacity building are important components of a comprehensive policy package for energy efficiency in buildings.

Individual Types of Policies (Package Elements)

Whatever the policy or measure to be designed or implemented, few guiding principles are useful to take into account, such as to build confidence in stable framework conditions; determine priorities based on status quo analysis; involve the market and assess the needs of market actors; make goals, instruments, and benefits transparent; increase uptake through highlighting co-benefits; monitor, evaluate and review policies; policy dynamics, maximizing benefits and minimizing negative side effects; consider the social dimension; take national or local circumstances into account.

A thorough check of these guiding principles for over 30 types of policy instruments is

Picture 1: Good Practice Building in India; the Indira Paryavaran Bhawan

described in detail in the following section.

Policy Package Examples

This section consists of case studies from Denmark, Germany, Singapore, Tunisia, and the United States. These case studies demonstrate the experience which these countries face in designing and implementing the policy package for energy efficiency in buildings. It has been found that their combination of policy instruments is usually similar to the bigEE-recommended policy package.

Many instruments which these countries combine target new build, retrofit, and operation alike; hence the packages that are presented here appear to be integrated. Policymakers from other countries can learn from the experiences of these countries and adapt policy packages according to their national circumstances. A link is offered if one of the policies is also presented as an example of a good-practice individual policy.

Individual Policy Examples

A set of selection criteria has been developed for the purpose of bigEE project which can be used to determine whether or not a certain policy qualifies as a 'good practice'. These criteria range, for instance, from the appropriateness of the policy design to the availability of an ex-post evaluation to questions of effectiveness. We also differentiate between the so-called proven and innovative policies and measures. The latter feature promises design elements that seek to make policy more effective by, for instance, targeting actors and/or barriers so far neglected. Around 20 of such shortlisted examples are presented in this section for buildings, and 16 for policies, to improve energy efficiency of appliances. They are analysed to show how they implement the guiding principles elaborated for their type of policy instrument in the 'package elements' section.

Appliances Guide

The appliances guide presents knowledge regarding the energy-saving potential and design options of efficient appliances. It also presents the latest information vis-à-vis the current and potential energy-efficient appliances, as well as the ones that are capable of saving energy between 60 to 85%. Furthermore, it also explores which of these are the most energy-efficient appliances of today and tomorrow; how much energy can one save per unit; and which are the different countries that can save on their energy balance and design options for optimizing energy efficiency.

Country Guide with a Focus on India

The bigEE country pages offer an overview of energy efficiency in the building sector of a country as well as specific policy, building and appliances information, and good practice. Country pages are also combined with dissemination activities conducted in partner countries such as stakeholder capacity building workshops. Centre for Research on Sustainable Building Science (CRSBS), TERI, and Bureau of Energy Efficiency (BEE) in partnership with Wuppertal Institute, Germany, organized one such one-day stakeholder workshop on 'bigEE initiative for optimizing energy efficiency in buildings' on November 17, 2016 at the Amaltas Hall, India Habitat Centre, New Delhi. The strategic approach and the database of good-practice buildings received a great interest.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ROLE OF SUSTAINABILITY STANDARDS AND PRACTICES FOR SUSTAINABLE HOUSING DELIVERY

Prof. Dr Chitrarekha Kabre, Professor and former Dean, Faculty of Architecture, Urban and Town Planning, DCRUST, Murthal, India. She was Fulbright Visiting Professor of NDSU, Fargo, USA. She has 25 years of academic and professional experience in the architecture and building profession.

Introduction

India's construction industry is one of the largest economic sectors which contributes to around 8.5 per cent of the nation's gross value added at basic price (at current prices) (RBI 2015). Residential buildings make up for 75 per cent of the entire construction market in India (EIU 2013). As per the 2011 Census, the total number of households in India was 246.69 million. The residential sector has the highest number of electricity consumers among all the sectors and is second only to the industry in terms of consumption (Figure 1).

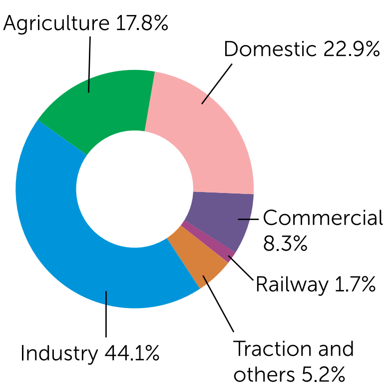


Figure 1: Sector-Wise Electricity Consumption of India in 2014
Source: (MOSPI 2016)

The energy use in buildings during their operation is the domain of the building designer (the architect, engineer, or planner). Depending on the level of energy services, the operational energy consumption can be up to 80 per cent of the total energy demand of a building, with the balance being the energy consumed in construction, demolition, and the embodied energy in the materials (WBCSD 2009). The buildings sector represents a great potential for reducing energy consumption in both new and existing buildings by an estimated 30% to 50% (UNEP 2009).

Whilst the real estate industry has adopted a somewhat positive response to sustainable development since the last few years, there remains significant ambiguity in the sector possibly due to the enormous amount of sustainability-related information available and the challenges of implementing in specific geographic, economic, and climatic regions. Responsibility for sustainability appears to be passed between stakeholders, as a result of a lack of financial justification on the market value of sustainable housing (Warren-Myers 2012). This problem could be addressed by acknowledging the key role of government regulations whereby all stakeholders would have to comply with the minimum standards of sustainability and the important role of real estate market wherein all stakeholders can assess the tangible benefits of sustainability.

Sustainability Indicators

A definition of 'sustainability' has been attempted by taking into account different approaches. The Brundtland Report has introduced the term 'sustainable development' by weaving together social, economic, cultural, and environmental issues as well as global solutions (WCED 1987).

The Agenda 21 formulated at the 1992 United Nations Conference on Environment and Development (UNCED), 'Earth Summit' at Rio de Janeiro, prescribed the key points for a sustainable construction industry: the utilization of indigenous and local materials and technologies; labour-intensive construction and maintenance technologies; energy-efficient designs and technologies and sustainable utilization of natural resources (i.e., recycling of materials and waste prevention); development of knowledge on the environmental impacts of buildings; and self-help housing for the urban and rural poor (UNSD 1992).

This need for comprehensive sustainability indicators and effective implementation can be illustrated by comparing approaches, needs, and motivations of different stakeholders in their approaches to sustainable development. A research and technical approach to this problem is the development of international standards relating to sustainability and buildings. ISO 21929-1 defines a framework for the development of sustainability indicators for buildings based on the premise that buildings contribute to sustainable development about the required performance and functionality with minimum adverse environmental impact, while improving economic and social (and cultural) aspects at local, regional, and global levels (ISO 2011).

The National Building Code (NBC) of India, provides a minimum amenity, safety, health, and sustainability standard in the design and construction phases of new buildings in the country. Here, while the purpose is to prescribe minimum-acceptable performance standards in a limited number of criteria, the scope is on the design and construction of the buildings (BIS 2005, BIS 2015).

The Small Versatile Affordable Green Rating for Integrated Habitat Assessment (SVA GRIHA) was conceived by The Energy and Resources Institute and the Association for Development and Research of Sustainable Habitat (TERI-ADaRSH 2013) for rating small standalone buildings, such as residences, schools, etc. and/or set of buildings with a cumulative built-up area of 2,500 sq. m or less. SVA GRIHA intends to reduce the environmental impact of these small developments.

Table 1: Synopsis of Technical, Regulatory, and Market Approaches to Building Sustainability Indicators

	Technical Approach	Regulatory Approach	Market Approach
	ISO 21929-1:2011 Core Sustainability Indicators	**Indian NBC-part 11 (BIS 2015)**	**SVA GRIHA (TERI 2013)**
BUILDING LIFE CYCLE IMPACTS	▪ Emissions to air (global warming potential and ozone depletion potential)	Minimum energy efficiency requirements for building envelope	▪ Reduce exposed, hard-paved surface on site and maintain native vegetation cover on site ▪ Reduce embodied energy of building ▪ Use of low-energy materials in interiors
	▪ Amount of non-renewable resources consumption (natural raw materials and non-renewable energy)	Requirements to use energy more efficiently, life cycle assessment for materials	▪ Passive architectural design and systems ▪ Efficient artificial lighting system ▪ Thermal efficiency of building envelope ▪ Use of energy-efficient appliances ▪ Use of renewable energy on site
	▪ Amount of fresh water consumption	Water efficiency and rainwater (some regions)	▪ Reduction in building and landscape water demand ▪ Rainwater harvesting

Contd.

Contd.

	Technical Approach	Regulatory Approach	Market Approach
	ISO 21929-1:2011 Core Sustainability Indicators	**Indian NBC-part 11 (BIS 2015)**	**SVA GRIHA (TERI 2013)**
	▪ Amount of waste generated (hazardous and non-hazardous)	Solid waste management, construction waste	▪ Generate resource from waste
LAND USE	▪ Site: change of land use assesses	Change of land use to be approved by the authority	
ACCESS	▪ Location: access to services (public and private transport, green and open areas, basic user services)	External access design	▪ Access to public transport
	▪ Accessibility of the building site (cartilage) ▪ accessibility of the building	Barrier free design	
INDOORS	▪ Indoor condition (thermal, acoustic conditions, visual conditions, air quality)	▪ Indoor environment quality, temperature and humidity, and ventilation; minimum daylight factor	▪ Passive architectural design and systems ▪ Good fenestration design for reducing direct heat gain and glare while maximizing daylight penetration ▪ Thermal efficiency of building envelope
	▪ Adaptability (change of use or user needs, climate change)	▪ -	
USE	▪ Life cycle costs	▪ Energy efficient	▪ Energy efficient
	▪ Maintainability	▪ Operation and maintenance schedule	▪ Adoption of green lifestyle ▪ Innovation
	▪ Safety (structural stability, fire safety, safety in use)	▪ Structural stability	
	▪ Serviceability	▪ Design service life	
	▪ Aesthetic quality		

Table 2: Percentage Increase in House Price for 1 Step Improvement in Energy Efficiency

Country	Increment in sales price (%)	Increment in rental price (%)
Australia	3	-
Austria	8	4.4
Belgium	4.3	3.2
Ireland	2.8	1.4

Source: DEWHA (2008), Mudgal *et al.* (2013)

These three approaches, each with different motivations, purpose, and scope are shown in Table 1 revealing two key messages. Firstly, 12 of the core-ISO indicators are addressed to some extent by the NBC and 10 by the market's checklist. Secondly, the market's checklist approach is about descriptive information to the extent of sustainability outcomes. The Indian NBC tends to be qualitative (with no measures of outcomes), whilst the ISO implies that core indicators are quantitative, qualitative, and descriptive (though not all indicators can be quantifiably measured). A simple analysis on the real estate databases on housing data reveals that only basic-property information, such as location, number of bedrooms and bathrooms are covered. Property attributes that influence the sustainability of houses, such as thermal performance of the building envelope, size of solar power systems, and ceiling height (important for tropical climates) are not included in the database.

Value of Sustainable Housing

In contrast to the life cycle approach of ISO 21929-1, the real estate industry and its clients are inclined to focus on the short-term benefits rather than on the long-term savings (Robinson 2005). One of the main challenges for the application of sustainable development is the lack of the benefit-cost relationship. Real estate agents, insurers, valuers, and mortgage lenders rarely include advice about sustainability features to their clients. Internationally, a number of studies show the positive relationship between sustainability-related information and house price for stakeholders for achieving sustainable (energy efficient) housing development (Table 2). A study to analyse the impact of energy efficiency on residential sales and rental prices in European countries revealed that the majority of countries showed a positive relationship between energy efficiency and house price (Mudgal *et al.* 2013). For example, one letter of energy efficiency improvement in Austria was estimated to result in an 8% increment in sales price. In one Australian market, a one-star level of improvement in a house's energy performance was equated to a 3 per cent market value improvement as shown on the Energy Efficiency Rating (EER) on detached house prices in the Australian Capital Territory (ACT) (DEWHA 2008).

Conclusions

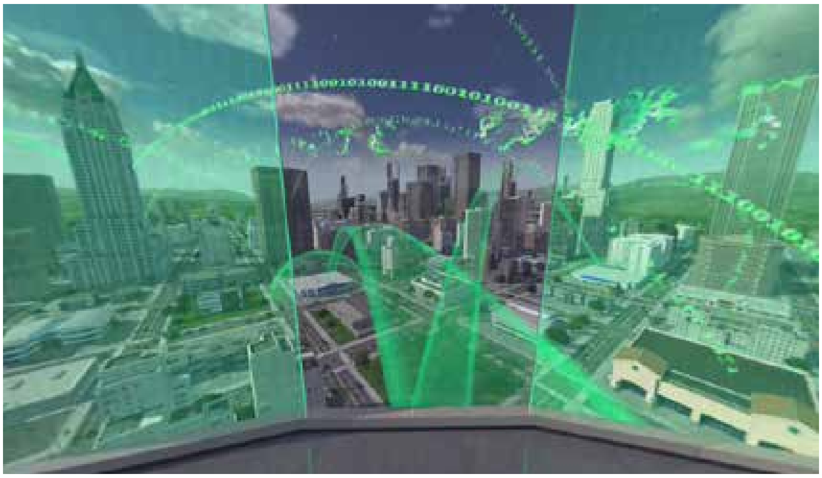
This article identifies that the gap between the sustainable-development emphasis and the effective sustainability-related indicators in the housing sector have not yet been bridged. As shown previously (Table 1), technical, regulatory, and market approaches to promote the delivery of sustainable housing result in different documentation, descriptions, and guidelines. The sustainability parameters in the NBC have limitations in their implementation and information dissemination: they do not clearly show how they could be transformed into practical decision making during the various property transactions throughout the lifespan of a property. Policies or government regulations are required for setting the minimum standards for housing design covering all aspects of core sustainability indicators in qualitative, quantitative, and descriptive terms associated during the life cycle. Secondly, it is important to make it mandatory to consider sustainability features in the decision making processes in the real estate industry as this will influence market supply and demand of sustainable housing.

SHAPING THE CITIES OF FUTURE WITH SMARTER AND GREENER BUILDINGS

Rohit Chashta, Senior Engineer; **Aalok A Deshmukh**, General Manager and Head, Energy Efficiency, Schneider Electric India.

By the year 2050, the global urban population will grow by 66% from 2014, to reach 6.3 billion.[1] The cities that exist today will get bigger and there will be new cities in emerging countries. Today, more than half of the world's population lives in cities, and the number of urban residents is increasing by 60 million each year—that is roughly two persons every second. These daunting prospects have led architects, engineers, developers, technology experts, and companies across the world to start imagining, and even begin shaping and building the cities of the future.

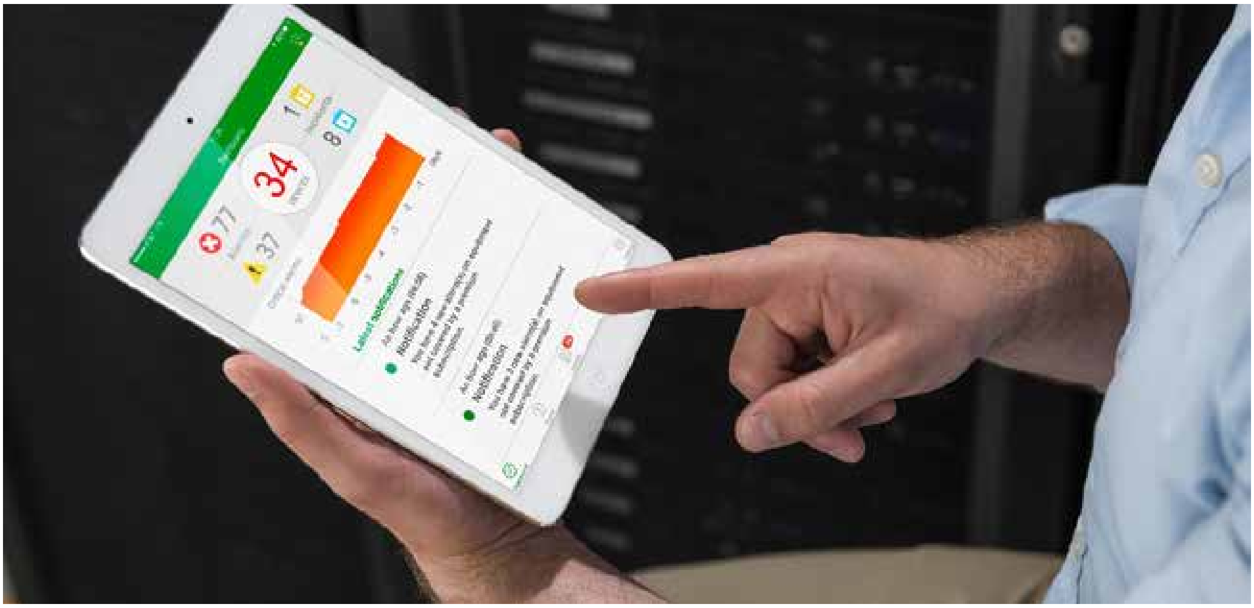
One thing that all cities have in common is that cities have lots of buildings and these buildings require energy, most of which is electricity. Buildings consume one-third of world's energy and more than half of the world's electricity.[2] Buildings—small and



large—not only have a voracious appetite for energy use but function as a complex system of systems, including heating, ventilation, and air conditioning; lighting; equipment; safety and security; and more. These systems have historically been managed in isolation, which makes these inefficient in terms of energy use and space utilization. Electricity consumption in buildings is expected to grow by 80%[3] in the next 25 years; hence, the need for building energy management and efficiency has never been more pressing. With 82% of energy efficiency potential yet to be tapped in buildings and data centres and 30%–50% of potential achievable through active control of building space,[4] there are many opportunities for buildings to be more energy efficient.

Now, let's connect these potential end-use efficiency

1 World Urbanization Prospects, 2014
2 4Degree Scenario
3 World Energy Outlook 2012
4 US Department of Energy, August 2010



opportunities with the fact that over two-thirds of the building stock that will exist in India in 2030 is yet to be built. A best-in-class (super-efficient) office building in India uses only a third to a quarter of the energy that average office buildings use. Best-in-class hospitals and hotels in India consume only half of the energy that average hospitals and hotels use. With a whole-building design approach, these super-efficient buildings are being built today at no added costs as compared to business as usual. But, a building cannot reach the best-in-class level just with energy-efficient design and construction. Although the whole focus of cost management in buildings is centred around the construction phase, a majority of the costs are incurred after the construction phase—during maintenance and operations. A building's 75%[4] lifetime costs go towards maintenance and operations. Therefore, an operationally efficient approach focussed on predictive maintenance and analytics can save up to 20% per year on maintenance and energy costs and provide very attractive returns on investments.

To get these savings and returns, we need to devise an effective strategy and use building energy performance data to help drive a KPI-driven energy management approach that makes energy use visible, meaningful, and actionable. If we include right-timed retrofits in addition to systematic energy monitoring and real-time control of all energy use, we can achieve up to 30% reduction in energy costs. Thus, energy waste in all forms can be measured and minimized.

Since we spend nearly 90% of our lives indoors, we need to create homes and buildings of tomorrow which sense, think, and adapt. These homes and buildings will have to be safer, more connected and secure, greener with more renewable energy, more collaborative, and more efficient and comfortable. Furthermore, to make an impact on the bottom line, energy efficiency in these homes and buildings must go beyond the device and system level and include whole-systems or whole-building approach. Besides, an intelligent building system and energy management solution must deliver efficiency, safety, reliability, and sustainability. Safety, as India loses around 25,000 lives to fire every year with 65% of those due to fire caused by electrical short circuits. Reliability, since in today's digital world, we expect to have 'quality and uninterrupted energy' and one hour of downtime can cost in huge amount of monetary losses (depending upon the process). And sustainability, besides being an opportunity in itself, sustainable energy is a must.

Our world is becoming more electric, more connected, and more distributed; and new disruptive technologies are catalysts for significant efficiency gains. With the world's cities expected to be home to an additional 2.5 billion people by 2050, connectivity has to reshape our world. The basis of our approach in energy management and automation should be to make the demand for and consumption of energy more efficient. The transformational development that is driving the new opportunities and advances in energy efficiency is the convergence of Operational Technology (OT) and Information

Technology (IT), driven by the Internet of Things (IoT). More than 7 billion[5] devices in homes and buildings, four times more as compared to 2014, are likely to be connected in the next three years. Traditionally, IT managed information for humans and OT managed data for machines. But this paradigm is undergoing a radical change as OT systems now are connected to the same networks as IT resources. IoT is growing very fast and reducing in cost. The operational intelligence that allows IoT devices to communicate in a bi-directional fashion enables implementing an active energy efficiency approach. Active energy efficiency leverages connected 'smart' technology to automatically measure, monitor, and control energy consumption and demand. (This is different from 'passive energy efficiency' efforts, e.g., LED light bulbs, building insulation, low-energy appliances, etc., which are basically measures that reduce the connected loads.) Hence, to thrive in a more electric, more digitized, more decarbonized, and more decentralized world, we need to combine connected products and systems, controls and real-time operating systems, analytics and services. The aspect of automated control is critical in achieving maximum operational efficiency, thus offering a great value and opportunity in buildings for real-time optimization with systems connected to analytics.

As approximately 75%[6] of building energy consumption comes from the residential sector, we need products and solutions that improve the quality of life of every resident. Widespread integration of renewable energy such as solar along with active control inside homes will help create 'net positive energy' homes and contribute to significantly change the paradigm of electricity generation and distribution by solving peak load issues and realizing massive amounts of investment potential. Furthermore, a drastic decrease in prices of solar and storage technologies is allowing us to reach grid parity; driving exponential deployment of renewable energy sources. Lastly, digitization across the lifecycle of buildings is spreading fast. Using building information modelling, building users are able to get better efficiencies through the design, build, and operation stages.

Expanding the Green Building Footprint

Driven by cost savings for home owners and occupants and responding to the incentives offered by state governments, an increasing number of developers are greening their portfolio. Features, such as rainwater harvesting, outdoor window shades, energy efficient electrical fixtures, and waste treatment plants are helping economize resource consumption. Even existing home owners and users are opting for retrofits as a smart investment. It is thus not enough to ascertain how structurally sound a building is, it is also important to see how well it will perform.

India had only around 1,850 sq.m of certified commercial green floor space in 2001, which

5 http://www.memoori.com/portfolio/market-building-performance-software-2016-2020/

6 www.gbpn.org/sites/default/files/08.%20INDIA%20Baseline_TR_low.pdf

rose to 22 million sq.m by 2008.[7] Despite a rapid increase in the first fifteen years of the Twenty-first century, the green floor space still accounts for only 3%–5% of all the construction in India. In comparison, around 20% of all construction in the US is estimated to be green floor space. The potential is indeed enormous. It has been estimated that India's green building footprint can be the largest in the world by 2022, if we achieve higher levels of green building penetration.

Over the past few years, the importance of sustainability in the design, construction, operations, and maintenance of buildings has become increasingly pronounced. Whether constructing a new building or operating or retrofitting an existing facility, asset managers, property developers, property managers, and users are under mounting pressure to achieve higher performance with lower capital and operating costs. The growing recognition of various green building rating schemes has provided an impetus to this movement.

As countries, such as India, continue to urbanize at a breath-taking pace, there is a dire need for tools that support stable and sustainable economic growth. Also, the changing lifestyles of people, which include increasing use of energy for thermal comfort, have exacerbated the impact of global warming. All these challenges also mean that the approach of sustainable green buildings and use of green products can witness unprecedented growth. Even the government is focussing on use of cleaner and energy-efficient technologies for its highly ambitious Smart Cities mission. Both residential and commercial areas have seen similar growth trends in adopting green technologies. There has been an overwhelming response from organizations in adopting green rating systems and implementing green solutions. Especially with a growing need and focus on sustainable development and energy efficiency, it is becoming imperative for developers and builders to adopt green innovations.

All these efforts and initiatives will not only help cities maximize energy savings, but it could also complement the government's ambitious target of 100 smart cities and ensuring the fact that India becomes an energy secure nation sooner rather than later.

7 //housing.com/news/india-offer-enough-incentives-build-green-homes/

INCREASING THE UPTAKE OF SUSTAINABLE ACTIVE COOLING TECHNOLOGIES IN RESIDENTIAL BUILDINGS

fAIR CONDITIONING

The Fairconditioning programme is an energy demand management (DSM) programme with a focus on achieving indoor thermal comfort, in tropical climates, while reducing or avoiding conventional air -conditioning in order to reduce energy demand, and thereby improve energy access and lower GHG emissions.

The cooling demand from buildings in India is relatively nascent as India is yet to construct 70% of the buildings that will exist in 2030. However, this is expected to grow spectacularly as installed room ACs in India balloon from 32 million in 2015 to 225 million in 2035 and commercial ACs grow from 9 Million-TR in 2015 to 104 Million-TR in 2035. ACs installed in Indian—commercial, and residential buildings are expected to emit 338 M-TR CO_2e by the year 2030 (approximately 12% of GHG emissions in 2010). The contribution of the alarming rise anticipated in the cooling demand from India's current and future buildings to its energy-security issues is substantial; power required to run ACs installed in Indian commercial and residential buildings are expected to require construction of 1010 standard-sized power plants (245 MW each) by the year 2030. This makes it necessary to design buildings with no- or minimal-cooling loads and energy-efficient cooling systems.

In addition to the power used to run the ACs, emissions are added through the use of fluorinated gas refrigerants (CFCs, HFCs, and HCFCs) in conventional systems. Currently, 90% of India's cooling capacity and annual refrigeration and air conditioning (RAC) is based on hydrofluorcarbons (HFCs) and hydrochlorofluorocarbons (HCFC) refrigerants.[1] A phase-down plan for the F-gases is essential to meet the targets set by national and international agreements on climate change mitigation. Natural alternatives for refrigerants have low Global Warming Potential (GWP), are non-patented, and energy efficient. Prioritizing the use of natural refrigerant-based ACs can result in direct emissions saving up to 50 million tonnes of CO_2e annually by 2030. This accounts for more than 50% of the current emissions from HCFC and HFC use.

1 Prioritizing Natural Refrigerants in India

Natural Refrigerant-Based Air Conditioning Systems

Natural refrigerants used in air conditioning include hydrocarbons, ammonia, carbon dioxide, water, ethers, and even air. Air conditioning systems using these refrigerants are proving to be more energy efficient and cause less or no damage to the environment due to the low GWP. They also have low Ozone Depleting Potential (ODP). Several technologies are available for air conditioning in buildings that use natural refrigerants:

- **Air Conditioning System Using Propane (R290/Hydrocarbon):** Slit-type air conditioners which use propane as the refrigerant are manufactured with 1 TR–1.5TR capacity in India.

Picture 1: - R290 Chiller Installed at Church House, Westminster Abbey

The number of ACs increased from 3,000 units in 2012 to 1,40,000 units by 2015. This product was developed by Godrej & Boyce in association with German Development Agency and GIZ Proklima and is estimated to give 23% power savings.[2]

- **Solar Vapour Absorption Machines (SVAM):** Solar-cooling technologies convert solar thermal energy directly into cooling power by means of thermally driven chillers. The combination of solar thermal energy and natural refrigerants make the perfect business case for sustainable-cooling technologies. The technology used in solar-cooling systems is absorption technology in which ammonia or water is used as a refrigerant. In the case of a SVAM, the solar collector directly heats the refrigerant through the help of collector tubes and then circulates it to achieve cooling. On comparison to conventional chiller systems, SVAM of 10TR and 75TR can lead to energy savings of 84.62% and 43.75%, respectively.[3]

- **Structure and Radiant Cooling:** By the use of structure and radiant cooling, mean radiant temperature of the rooms is reduced, thus ensuring thermal comfort of the occupants. Structure cooling works on three basic principles which are:

(a) Thermal Barriers: Barriers are created against sunlight in the form of hollow walls, trees, or shading devices. The barriers act as resistors to the incident heat and help in reducing the temperatures, (b) Mass as Heat Sink: Thick walls do not let heat get transmitted to the inside of the building, thus acting as a capacitor. During the day, the walls absorb heat without much change in the interior temperature and during the night, they radiate the heat back to the atmosphere, (c) Heat Drainage: The residual heat is channelled to be drained out into flowing water or flowing wind during the night to prevent the interiors from heating up. Hence, water behaves as the refrigerant in this system. As a result, the GWP and ODP for these systems is very low, leading to significant reductions in GHG emissions.

In a radiant cooling system, the heat is removed from the roof and the floor by laying plastic pipes in loops between the slab and the tiles; the pipes are filled with water. A radiator is connected to the water loop which cools the water passed in the pipes. Thus, the structural heat load is removed, thereby reducing the cooling load imposed on the air conditioning system. In a structure-cooling system, the water remains at room temperature. These systems can be used for heating as well as cooling. The design capacity of the structure-cooling system ranges from as low as 300 sq. ft. to a maximum of 1,00,000 (installed till date in India). Radiant cooling systems have been successfully installed to cool areas as small as 500 sq. ft. to a maximum of 4,19,000 sq. ft (installed till date in India).

Picture 2: Solar Air Conditioning System Using Vapour-absorption Technology and Parabolic Concentrators.

2 'Cool Technologies: Working without HFCs—Example of HFC-Free Cooling Technologies in Various Industrial Sectors'

3 'cBalance Solutions Hub Analysis'

Picture 3 - Radiant Cooling System Installed at Infosys, Hyderabad

- **Direct/Indirect Evaporative Cooling:** The evaporative-cooling technology works on the same principle as the perspiration of our body. When dry air comes in contact with water, some of the water in the liquid state evaporates into vapour state and in this process heat is taken away from the dry and hot air leaving it cool and moist. There are three types of evaporative cooling. In Indirect Evaporative Cooling, air from the outside enters the system and its temperature is reduced without increasing the relative humidity as it is passed through the dry part of the opening. Outside air is cooled without gaining moisture as it is passed through the dry section of an evaporative cooling heat exchanger. Energy efficiency is increased by passing pre-cooled air through the system. In the Direct Evaporative Cooling technique, the hot and dry air passes through the wet media converting it into cool air with added humidity. For increasing efficiency, this technique is used for pre-cooling the air for the vapour compression cycle. Indirect-Direct Evaporative Cooling (IDEC) is used for cooling the ambient air before it enters the condenser coil and the while indirect evaporation is used for cooling the make-up air through the heat exchanger. An IDEC system can lead to almost 66.40% operational cost savings as compared to a conventional system of similar tonnage.[2] These systems are largely used in industries; however, customized systems can be manufactured for commercial as well as residential buildings.

Picture 4 - IDEC System Installed for Circulation Spaces, Foyers, and Atrium Spaces at Suzlon One Earth Campus, Pune

There is considerable know-how and information within the industry to design sustainable buildings with adequate indoor thermal-comfort conditions. However, the rate of uptake of these approaches in building design remains marginal. Energy demand and GHG emissions can be reduced, provided these strategies and practices become mainstream amongst all key stakeholders responsible for the design and construction of buildings. The Fairconditioning Programme is an energy demand management (DSM) programme with a focus on achieving indoor thermal comfort in tropical climates while reducing or avoiding conventional air conditioning in order to reduce energy demand, and thereby improve energy access and lower GHG emissions.

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CONSTRUCTION MANAGEMENT QUOTIENT IN NATIONAL GREEN BUILDING RATING SYSTEM OF INDIA

Namrata Kaur Mahal, Fellow, TERI and Program Associate, GRIHA Council. With over 8 years of experience, she has developed expertise in conceptualizing and implementing strategic plans, programmes and projects keeping context and sustainability at the core.

Construction projects are considered successful only if delivered on time, within the allocated budget, and to a quality desired by the client. Apart from the above-mentioned indicators for a successful project, due to social, cultural, technological and climatic changes in recent times, aspects such as health and safety and environmental performance have also become a domineering aspect for project management and performance.[1] Therefore, construction management skills play a decisive role in asserting the success of a project. Furthermore, given that sustainability is at the forefront of many global organizations and governments' commitment to promote energy and environmental stewardship,[2] the rating systems may act as a guiding tool in achieving these cohesive objectives in a smarter way. Realizing the need of the hour and having known the status of the growing and projected population growth in India, The Energy and Resources Institute (TERI) in the year 2007 conceptualized the Green Rating for Integrated Habitat Assessment (GRIHA) rating system for addressing the key challenges of the built environment, such as diminishing water resources and snowballing energy use in urban areas.

GRIHA is a rating tool to help design, construct, and maintain the built environment and in turn measure the greenness of the built forms in line with the nationally accepted benchmarks, such as National Building Code (NBC) and Energy Conservation Building Code (ECBC). The robust scientific approach adopted for developing the context-specific rating system and the integration of the national codes, compelled the Ministry of New and Renewable Energy, Government of India, to adopt the rating system as the 'National Rating System for Green Buildings in India'. Even though there is a widespread agreement on the fact that rating systems streamline the efforts for achieving sustainability in the built forms, it is still a voluntary process in India. This article attempts to understand the construction management quotient in the national green building rating system.

In GRIHA, there are nine sections, namely, Sustainable site planning, Construction management, Energy, Occupant comfort and well-being, Water,

1 'Appraisal of construction project procurement policies in Nigeria'

2 'Cost justification for investing in LEED projects'

Picture 1: Few sources of air pollution on a construction site

Source: http://in.reuters.com/article/india-oil-kemp-idINKCN0Y91M8, http://contractorreport.blogspot.in/; https://www.newham.gov.uk/Pages/Services/Pollution-control-construction-sites.aspx

Sustainable building materials, Solid waste management, Socio-economic strategies, and Performance monitoring and validation, making a total of 100 points. Of which, the weightage given to construction management-related aspects is approximately 9%, and under this section, the following aspects are covered:

- Air and water pollution control—1 point
- Preserve and protect landscape during construction—4 points
- Construction management practices—4 points

Air and Water Pollution

The construction activities that contribute to air pollution include land clearing, operation of diesel engines, vehicular and material movement within the site, burning and working with toxic materials, etc. The cutting of concrete and stone in open air generates huge dust clouds, which contain varying degrees of quartz.[3] These dust particles are generally less than 10 microns in diameter, invisible to the naked eyes. Thus, construction dust is classified as PM_{10}, and research has shown that PM_{10} causes health problems, such as asthma, bronchitis, and even cancer, given that these particles penetrate deep into the lungs. In addition, another major source of PM_{10} on construction sites is diesel engine exhausts of vehicles and heavy equipment, known as diesel particulate matter, consisting of soot, sulphates, and silicates, all of which readily syndicate with other toxins in the atmosphere, increasing the health risks of particle inhalation. Hence, utmost care needs to be taken to ensure that the standards set by the Central Pollution Control Board and/or State Pollution Control Board are not violated at any given point.

Furthermore, regarding water pollution, the major polluting sources on construction sites include diesel and oil, paint, solvents, cleaners, and other harmful chemicals and construction debris. The land-clearing process leads to soil erosion, and in absence of prevention techniques, the silt bearing run-off and sediments pollute the natural wetlands/waterways within the vicinity and down the streams. Moreover, surface water run-off may also carry other pollutants, such as traces of diesel, oil, toxic chemicals, and also cement residues. There also exists high probability of these pollutants entering the groundwater through fissures, thus polluting the human drinking water source. Therefore, it is important to understand the gravity of this situation, because once the groundwater is contaminated, it is very difficult to treat as compared to the surface water sources, incurring considerable fiscal expenditure. Thus, in the national rating system, emphasis has been laid on implementing the following:[4]

- Provision of 3 m high barricading around the construction area *(This is mandatory under this criterion, rest are optional. However, the project proponent must adopt any of the three measures mentioned below on site to curb air pollution during construction.);*
- Wheel washing facility at the vehicular entrance of the site;
- Covering of fine aggregate and excavated earth on site with plastic/geotextile sheets;
- Water sprinkling on fine aggregate (sand) and excavated earth to suppress the dust particles; and
- All diesel generator sets on site to have proper chimneys with their vents facing away from the site.

Also, emphasis has been placed on developing and implementing a spill prevention plan, controlling effects of spill from hazardous materials, such as diesel, oil, bitumen, and so on. Upon

3 'Measurements of the effectiveness of dust control on cut-off saws used in the construction industry'

4 http://www.grihaindia.org/files/GRIHA_V2015_May2016.pdf

Picture 2: Measures and strategies to curb air pollution on site

Source: http://srivenkateswaraandco.com/Scaffold%20Site%20Gallery.html and http://hvusss.eksx.com/environment.html

adhering to both these aspects, a point weightage (1 point) gets credited to the overall score of the project.

Preserve and Protect Landscape during Construction

The intent of this criterion is to minimize the detrimental impacts of construction activities on the existing natural landscape within the site, by ensuring preservation of mature trees and fertile top soil. For this criterion, one has to check the applicability with respect to the project. For instance, if there are no mature trees on the site, then this particular criterion becomes non-applicable to the project and the points allocated get detached from the overall scoring system. Similarly, if the top soil is not fertile and cannot be made fertile through organic means, then the project is exempt from this part of the criterion. The appraisal under this criterion is as mentioned below:

- Ensuring that no existing mature trees are cut on site. If the design of the built form demands cutting of trees, then transplantation of the cut mature trees within the site should be done and preventive measures should be taken to ensure that they survive. In case, the survival rate is not 100%, then one has to plant three trees for every one tree cut of the same native/naturalized species *(This is a mandatory part of this criterion)*.
- Increasing the total number of trees on site by 25% post-construction phase or planting four trees for every one tree cut of the same native/naturalized species. The project gets entitled for two points under this criterion.
- During construction phase, preserving top soil and maintaining its fertility and using the same fertile soil for landscape post-construction, having a point weightage of 2.

It is important to preserve the existing landscape during construction because of the following benefits:

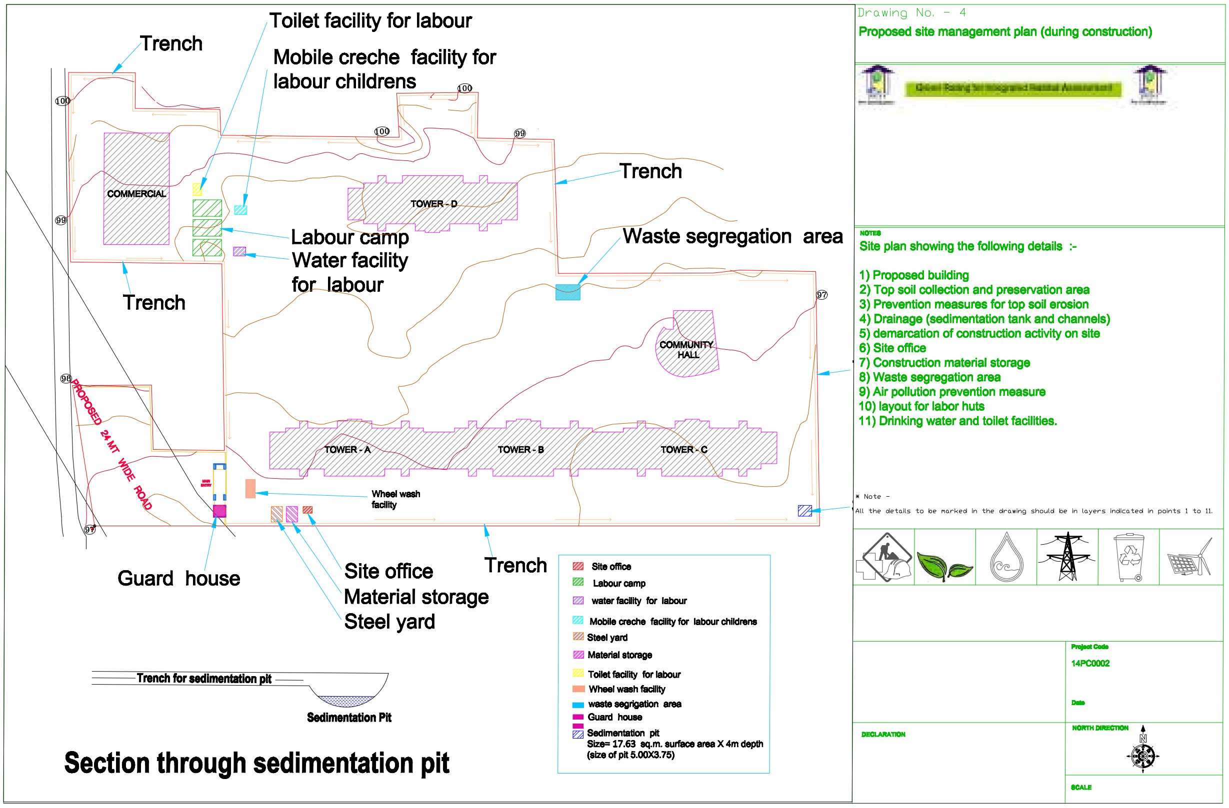
- Mature trees/green belts help maintain the micro climate of the area and thus reduce the urban heat island effect.
- The roots of the mature trees also hold back the soil on site, thus reducing the probability of soil erosion.
- Planting native trees also ensure that their water requirement would be less as compared to a non-native/exotic species.
- Further, the fertile soil, which otherwise takes years to generate, gets preserved and utilized. Thus, saving on the cost for procuring fertile soil from nursery, post-construction for final landscaping.

Construction Management Practices

The intent of this criterion is to encourage and adopt good construction practices to minimize wastage and timely completion of projects. One of the important factors adversely affecting the performance of construction projects is the improper management of materials during

Picture 3: Preservation of mature trees on site

Source: http://arborscapesllc.com/construction-preservation/



Picture 4: Sample of construction management plan.
Source: http://constructiontuts.com/construction-management-plan/

site activities (Kasim 2008).[5] Thus, if management techniques are inadvertent, may lead to a major project cost variation. Under this criterion, the following aspects are looked at:

- Adopting staging during construction on site *(Point weightage is 1)*.
- Adopting strategies to prevent/ reduce movement of soil (not top soil) outside the site through adoption of various strategies (such as soil erosion channels, sedimentation control, and so on) *(Point weightage is 1)*.
- Adopting at least three strategies from the list given below, to manage water during construction *(Point weightage is 1)*.
  - » Using wet hessian cloth for curing and using ponding technique,
  - » Monitoring to avoid leaks and water wastage,
  - » Use of additives to reduce water requirements during curing.
  - » Using treated waste water/ captured storm water/ harvested rainwater, and
- Building a waste management plan for segregation of construction waste, its safe storage, and on-site/off-site recycling and implementation of the same in the project *(Point weightage is 1)*.

Conclusion

- The construction management attributes have been integrated in the national green building rating system with a view to minimize the environmental impact. However, only two aspects are mandatory under this section, rest are optional.

Until this quotient gains momentum in practice, either by mandatory enforcement or voluntary, a good management practice needs to be developed as an integral part of the organization while planning, just as profit making is. A conducive and well-managed project shall ensure reduced risks of workplace accidents and other associated losses, such as financial and materials. The GRIHA rating system attempts to address this segment in a holistic way such that the project proponents are more responsive towards these needs of the construction projects.

5 'Improving materials management on construction projects', PhD Thesis.

MAINSTREAMING GREEN BUILDINGS

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Although sustainability has been integral to the country's varied and vibrant vernacular architecture, its emergence as a measure to evaluate buildings is a recent phenomenon in India. Built in response to the climate, natural features and resources of the site, as well as the socioeconomic fabric and traditions, it is a holistic building design which has been created keeping in mind urgent concerns of the environment and ecology.

Conventional buildings often consume huge quantities of material and natural resources, deplete non-renewable resources, have high-embodied energy, and pollute the air, water, and soil in the process of manufacture. The indoor environment quality in these buildings is also a major concern. They lack the checks and balances inherent in vernacular design.

More than a decade since the introduction of green buildings in India, we can boast of several green building rating systems including the national green building rating system, GRIHA. These ratings have addressed environmental concerns broadly in five major areas, namely, site planning, energy efficiency (including passive design), water and waste management, building materials, and indoor air quality.

However, despite a steadily growing footprint—and being identified as one of eight investment opportunities in the construction sector by the central government's 'Make-in-India' campaign—green buildings are still not part of the mainstream.

Current Challenges and Gaps

Integration of Green Building Codes

India is largely a self-built country. Architects contribute between 2–5% of building design and construction mainly in urban areas in an economy in which building construction contributes 8% to the GDP and employs more than 35 million people. Single-dwelling units across the country are mostly constructed by owners with little or no technical inputs, while the vast majority is executed—even designed—by untrained contractors. There is barely any research or survey to study and address this situation.

Existing green building standards and benchmarks are voluntary, that is, these are design codes that provide guidelines for setting the building, design of the building's envelope, water and waste management, improvement of indoor air quality, lighting systems, Heating Ventilation and Air Conditioning (HVAC) systems, as well as electrical and use of renewable energy. Moreover, there is little or no incentive from the government for project developers to implement these standards. There is no sufficient awareness generated or information that can be provided to indicate the long-term benefits and lifecycle cost analysis of green buildings.

Voluntary green building codes are not sufficient if green buildings are to be scaled up. Integrating the green building standards and codes into the Development Control Regulations (DCR), and other building planning and design process, is important for these criteria to become a part of standard practice.

Outcome-based Compliance Approach

Most of the existing green buildings rating system criteria are prescriptive in nature, that is, they specify required minimum or maximum values for discrete components or features of a building. For example, the prescription of using a dual flushing cistern in toilets or for the HVAC system to have a certain minimum Coefficient of Performance (COP), are prescriptive criteria. Some other criteria are based on modelled performance paths such as the simulation for a building that achieves a certain projected day lighting level or energy usage per square metre. Few benchmarks are outcome based and test the actual performance of a building in use.

An outcome-based approach is not concerned with the approach. For example, it will not specify what window to wall area ratio should be for the envelope of a green building, but rather the building does not consume energy beyond a certain level. The energy performance index is one such outcome-based measure (the unit of which is kWh/m²/year). For example, the Bureau of Energy Efficiency (BEE) awards star ratings to buildings on the basis of their EPI. The designer or developer has to ensure that the building meets the specific output standards as specified in the code, whether it is related to water, waste, or energy.

Unlike a prescriptive approach, an outcome-based approach will have direct quantifiable environmental benefits and can provide a better understanding of factors, such as user behaviour, occupancy patterns, commissioning, and maintenance (Yu, Evans, and Delgado 2014). Its implementation will require serious thought about the benchmarks specified, methods of assessment, as well as the penalties that could be imposed.

Alternative to Conventional Building Materials

Raw materials of commonly used building materials are finite and either mined from deep within the earth or extracted from quarries. Limestone, Silica, Coal, Iron ore, and Alumina, and even topsoil for bricks, are limited. The extraction and processing of building materials involve energy-intensive processes such as smelting and calcination while transportation is another source of greenhouse gas emission. Materials such as steel can be recycled; however, the energy involved in recycling is considerable. The availability of sand for use in concrete is already a serious concern in many towns and cities. Recycled debris, quarry waste, and manufactured sand have been suggested as alternatives.

Carbon dioxide emissions from fossil fuel use and cement production accounted for 2,100 million tonnes in India in 2014. Forty per cent of the CO_2 emissions from the production

Table of BEE rating for office building less than 50% air condtioned build-up-area

Composit

EPI KWH/SQ.M/YEAR	Star Label
80-70	1 Star
70-60	2 Star
60-50	3 Star
50-40	4 Star
Below 40	5 Star

Warm and Humid

EPI KWH/SQ.M/YEAR	Star Label
85-75	1 Star
75-65	2 Star
65-55	3 Star
55-45	4 Star
Below 45	5 Star

Hot and humid

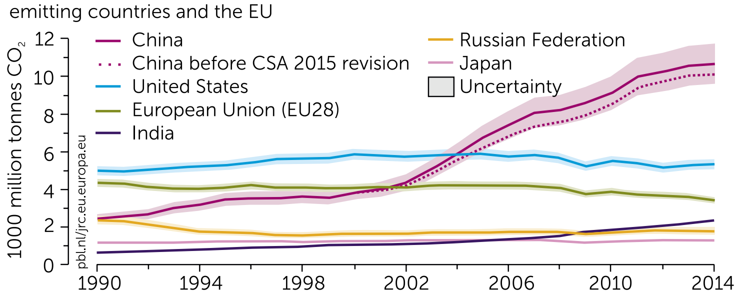
EPI KWH/SQ.M/YEAR	Star Label
75-65	1 Star
65-55	2 Star
55-45	3 Star
45-35	4 Star
Below 35	5 Star

Figure 1: BEE Star Rating for Buildings with Less than 50% Air-Conditioned Space
Source: Bureau of Energy Efficiency

Figure 2: Fly Ash, Slag and Silica Fume offer environmental and Performance benefits when optimally combined with portland cement in concrete mix designs

(Source: America's Cement Manufacturers (2015); Using Concrete as a Sustainable Solution for Buildings)

CO_2 emissions from fossil-fuel use and cement production in the top 5 emitting countries and the EU



Source: EDGAR 4.3 (JRC/PBL, 2015) (1970-2012; notably IEA 2014 and NBS 2015); FT 2014 (2013-2014): BP 2015; GGFR 2015; USGS 2015; WSA 2015

Figure 3: CO_2 Emissions from Fossil-fuel use and Cement Production in the top 5 emitting Countries and the EU.

of cement is on account of combustion and 60% on account of calcination of limestone (along with clay, iron ore, sand, alumina, iron, and silica) at 2,700⁰F in a clinker. Alternative fuels in place of coal for combustion, such as waste oil, solvents, scrap items, and municipal solid waste can reduce this impact.

The bulk of building material is presently derived from locally available clay, soil, sand, and gravel. Solid fired clay bricks are the most widely used walling materials in the country. However, over the past few decades, the development of other materials, such as solid/hollow concrete blocks, fly ash bricks, Cement Stabilized Soil Blocks (CSSB), Fly Ash Lime Gypsum (FaL-G) blocks, Autoclaved Aerated Concrete (AAC) blocks, etc., has created viable alternatives to bricks that have also penetrated the market.[1]

Many more alternatives to both external and internal building materials are required so that builders and designers have an array to choose from. This will require R&D on walling, roofing, and other building materials on a war footing. We need materials and techniques that have low embodied energy, are recyclable or biodegradable, and have lower impact on air, water, soil, as well as indoor environment quality.

Interdisciplinary Approach in Environmental Education

To meet the challenges of environmental sustainability, we need people with technical and human skills that transcend conventional disciplines of architecture, civil engineering, environmental science, and communication. These boxed divisions, in an effort towards more and more specialization, have created watertight compartments while environmental sustainability demands a holistic approach. Gated disciplines generate graduates who are not able to tackle complex challenges such as answering human needs while maintaining the integrity of the supporting ecosystem. [2]

Many researchers are, therefore, calling for a pedagogical shift from education that encourages knowledge and skill accumulation to an education which is based on facing real-life complex problems. They call for education that encourages contextual understanding of the physical sources together with human values and perceptions that caused the problem. There is a quest for education that will teach students that it is their professional responsibility to lead towards sustainable change.[3]

The field of sustainability may be perceived as a new field created from the combination of many traditional fields. This abundance is a fertile ground for innovation, which can be intensified through academic collaboration with organizations and industries.[4]

Changing Human Behaviour: The Key

Today, most attempts to mitigate the effects of environmental impact on the construction industry focus mainly on technological developments that

1 'Strategies for Cleaner Walling Material in India'.

2 Epilogue: 'Ecological Literacy'

3 'Currents in Environmental Education: Mapping a Complex and Devolving Pedagogical Field'

4 'Why Sustainability Is Now the Key Driver of Innovation'

improve the efficiency of building systems and performance of building mechanical systems and electrical systems. However, more and more evidence suggests that these actions are insufficient in our struggle to decouple buildings from wielding a destructive impact on the environment.

In recent years, a new environmental approach has started to develop that advocates measures focussed on the consumer rather than the continued encouragement of the producers to adopt constant technological innovation. Efforts on technologically advanced building systems can continue but designs that trigger change in human behaviour and attitude is required, because even the greenest of buildings need environmentally sensitive and proactive inhabitants to achieve sustainability targets.

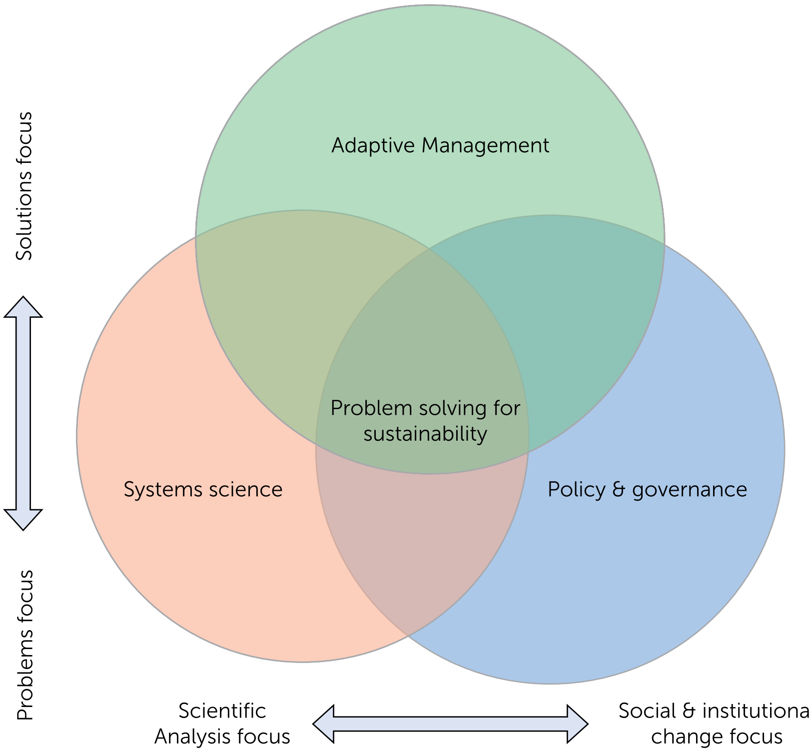


Figure 5: Framework for Understanding Interdisciplinary Environment Education
(Source: Vincent, S., & Focht, W., (2011). Interdisciplinary Environmental Education: Elements of field identity & curriculum design)

Conclusion

Mainstreaming green buildings will require a manifold approach and strategy. Environmental awareness will generate demand and thoughtfully designed curriculum can generate skilled professionals ready to take on green jobs. Policies and regulations are required to favour the easy integration and application of green building codes. The existing codes, criteria and rating systems while enlarging their footprint need to simultaneously develop credible and quantifiable environmental benefits.

A glimpse from student training programme held at Indian Institute of Technology, Roorkee, September 2016.

PROCESS FOR FORMULATING AND INTEGRATING BUILDING DESIGN DECISIONS FOR ECBC COMPLIANCE

A CASE STUDY OF A RETAIL SPACE IN WARM AND HUMID CLIMATE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Energy is one of the major inputs required for economic growth in a developing country, such as India. The annual energy consumption of India is more than 420.6 Mtoe. India faces an overall energy shortage of 9.8% and a peak shortage of 16.6%. Owing to the ever-increasing energy demands, it is vital to work on the demand side of the projects by achieving energy efficiency in buildings. Energy Conservation Building Code (ECBC) of India was introduced in the year 2007 to promote building energy efficiency in the country. The purpose of this code is to provide minimum requirements for energy-efficient design and construction of buildings that have a connected load of 100 kW or higher or a contract demand of 120 kVA or higher. Various building simulation studies showing the potential of ECBC to achieve energy efficiency through demand reduction have already been done. The ECBC implementation is currently voluntary, but it is proposed that the code be mandated. At this juncture, it is imperative to understand the on-ground application of the code. The purpose of this article is to highlight the process of formulating and integrating building design decisions and inputs to meet the intent and goal of the ECBC. The method includes use of charrette for forging integrated design approach. Further, climatology-based simulation tools, building energy simulation tools for whole building performance, and simple payback analysis are also used for technical and financial feasibility. Alternative design decisions for technical and financial feasibility that suit the context are developed, which will highlight the flexibility offered in the framework of ECBC.

Implementing ECBC can lead to rethinking on design decisions depending on the approach of ECBC compliance mode—prescriptive or whole building performance. Design decisions are often guided by a logical brief that is developed based on the client's vision, functionality, and aesthetics; in simple words, it is guided by a vision—'what the project should be' once in operation. When a project decides to be ECBC compliant, the design brief has to incorporate new requirements. In order to allow energy efficiency and conservation to trickle into the design through the brief, an integrated process of design development with a strong interface between building performance and design decisions is required. This article reveals the process and experience in implementation of the ECBC during the design development stage of a shopping mall—a retail space located in a warm and humid climate in India.

Retail Spaces and Energy

Every building typology is different from the other. Even among commercial buildings, the energy consumption patterns, occupancy, and project requirements shall be drastically different and so will the energy consumption trends and hence the energy saving measures. Prioritizing the energy saving opportunities plays an important role in achieving financial feasibility along with technical compliances. The function of a shopping mall has expanded from being only retail shops to activities, such as entertainment, congregation spaces, hangout areas, eateries, etc., thus have become heterogeneous in character with varied spatial character and functions due to varied tenancy.[1] The variation in operations and energy consumptions in shopping malls calls for provision of flexibility in design and energy saving measures. Studies reveal that some of the retail spaces with smaller areas have higher consumptions due to the fact that these spaces use equipment that use relatively higher energy, such as refrigerating or heating units in case of food and beverage stores

Table 1: The process for the Shopping Mall Project

Building Design	HVAC and Lighting
Generally envisaged as completely air-conditioned, completely glazed, and artificially lit spaces with a 'wow' factor for the masses Lack of integration between building design and active energy systems	Non-integration of passive techniques, overdesign, and use of non-energy efficient systems Lack of variable controls based on tenant requirements Lack of control on energy consumption of individual installations Sometimes, the base building is not provided with any HVAC system for issues, such as metering and uncertainty in shop sizes resulting in installation of stand-alone systems that are comparatively less efficient

and bright lighting in case of fashion retails for higher customer attraction. Some of the major reasons for increased energy consumption in malls, based on its building design and operating systems, are as follows:[1]

Bureau of Energy Efficiency (BEE) has developed a star-rating programme for commercial buildings, including shopping malls. It is based on actual performance of a building in terms of its specific energy usage in kWh/sq.m/year. For a shopping mall in a warm and humid climate, the energy performance index (EPI) is in the range of 250–450 kWh/sq.m/year with star rating of 5 to 1 star.[2] The EPI as per the BEE star rating programme was referred to as a guiding figure to achieve energy conservation.

Formulation and Integration Process

Energy efficiency and conservation is affected by design decisions and choices any project makes. For a shopping mall, the end user and their functions are unknown. The uncertainty and lack of information on end user requirements was identified as a potential hurdle in making design decisions ECBC complaint and yet flexible enough to accommodate the needs of the unknown tenant. The process for this project has been elaborated in Table 1.

Thus, while implementing ECBC for a shopping mall, the efforts were widened beyond the code to achieve the desired end result.

Options of ECMs for ECBC Compliance

Demand Reduction Using Passive Low-Cost Measures

The architectural design decisions directly influence the HVAC sizing, lighting design, and all other systems. Hence, the intervention in architectural design was the first step taken. The orientation, massing, solar insolation, window-to-wall ratio (WWR), shading analysis, and day lighting performance of the project were studied based on simulations to enhance the proposed design and reduce energy demand. The WWR of the 'as is' case was more than 75% against the maximum permissible value of 60% as per ECBC. Being a shopping mall, restricting the WWR was challenging. Since the shape of the site was triangular, a strong site constraint existed due to which the orientation could not

1 http://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2009/Panel_4/4.118/paper

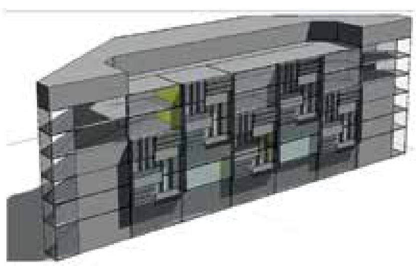
2 'Scheme of BEE Star Rating for Shopping Mall'

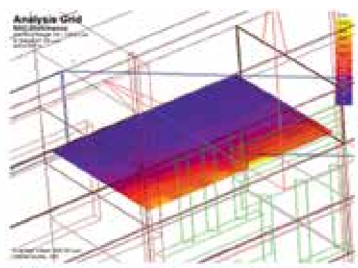
Step	Description
Decision and Determination for ECBC compliance	The top management decision to envisage the project as a ECBC compliant and energy responsible project is important, since its directs all actions involved in making of the project and loudly tells everyone on board to work towards the common goal
↓ Introducing ECBC	The code and its requirements are presented to the entire team and how the project shall generally benefit by compliance.
↓ Understanding the Project	A meeting was conducted to understand the project proposal; study the architectural design; services design basis reports, expected occupancy trend, working hours, and project context
↓ Decide a Compliance Path—Prescriptive or Whole Building	Obviously choosing the best of systems & materials will lead to maximum energy savings as per the prescriptive method of ECBC. However, it is important to tailor make the energy conservation measures (ECMs) to arrive at technically and financially feasible solution instead of a blanket solution. Hence, whole building performance method was chosen.
↓ Mandatory Compliance of ECBC	Irrespective of the compliance path, following the mandatory points of ECBC are of utmost importance. The mandates of the code were explained and requirements were submitted for inclusions in design and BOQ with the costs.
↓ Simulation of the Standard ECBC Case to Establish Target Reduction	As a part of the whole building performance method, the ECBC standard case was simulated. The goal of the project was set to reduce its annual energy consumption lower than the ECBC standard case.
**Simulation of the "As is" Case Consumption	Additionally, energy simulation was conducted for the 'as is' case. This step, though not a part of ECBC compliance methodology, was crucial since it gave clarity to the client regarding the budgetary provisions required in relation to the energy savings
↓ Identify the ECM's for the Project to Comply with ECBC	ECM's were identified for each ECBC focus area—building envelope, HVAC, lighting, electrical and hot water supply. The underlying approach in identification of these ECM's was Priority 1: Demand Reduction Using Passive Low Cost Measures: Massing, orientation, building envelope design—Control on window-to-wall ratio (WWR), solar heat gain coefficient, visible light transmittance, and U-values (choice of materials), day lighting, space planning, HVAC zoning, and lighting design corresponding to day light availability Priority 2: Operational Reduction Using Active Measures: Average cost; choice of HVAC equipment and controls; selection of lighting luminaries and controls in adherence to the lighting power densities; electrical system design equipment selection; choice of water heating equipment, monitoring, and metering provisions—basically choosing high-efficiency equipment for operational control Priority 3: Recover and Offset Consumption Using Advanced Measures: High cost, enhancement of HVAC design, thermal storage, heat recovery, etc., and renewable energy
↓ Summarize Options for ECBC Compliance along with Cost Repercussions, Annual Energy Consumption for Each Set of Option along with the Cascading Effect of Energy Savings to Understand the Cost Benefit of Each	Three sets of ECM options for each building component in the ECBC focus areas—building envelope, HVAC, lighting, hot water, and power were compiled along with cost repercussions and annual consumption for each option
↓ Present a Feasibility Report and Finalize ECM's to be incorporated in Design	The analysis and recommendations were conveyed to the project team in form of a feasibility report that included technical and fiscal aspects, to enable the final choices and design decisions for ECBC compliance
↓ **Cater to the Tenant Spaces	Uncertainty in tenancy was identified as a hurdle in the background study. To address this hurdle, tenant design and construction guidelines were formulated to include mandatory and energy conserving ECBC compliances. This was done to ensure that the tenants are aware about the energy conservation drive of the base building and comprehend the same, also in their own interest of saving energy bills.

**The steps mentioned in green boxes are not directly a part of the ECBC compliance methodology.

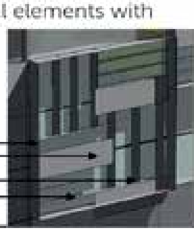
be improvised. Three options of shading strategy for each façade along with daylighting analysis were worked out to ensure optimum daylight while restricting the heat ingress. Availability of the high-performance building envelope materials was discussed. The additional fenestration costs for each of the options proposed was also computed and presented. For each of the building envelope component—external walls, roof, fenestration ECBC—three options along with cost repercussions were provided to facilitate final selection.

Solar shading image for option-3.2





Daylighting levels at mid level_option 3.2

Description and image fore reference	Compliance with ECBC	Solar shading percentage	Daylighting availability
Combination of horizontal and vertical elements with opaque surface. Module for 3floors (11m x 10.8m high) with single glazing unit -Outer boxing -Opaque wall -Horizontal and vertical Shading elements 0.5m wide 	Yes Selection of glass with max solar factor: 0.32	Annual average solar shading: 85% Solar shading during summer (March-June): 91%	Average lux levels- 360-900 lux Considering overcast sky condition & 27% visual light transmittance

Matrix Presenting Three Options for ECBC Compliance along with Summary of Additional Costs

For all five sections of ECBC—building envelope, HVAC, lighting, service hot water, and electrical power—three sets of options were recommended. Representative snapshots of the matrix have been presented:

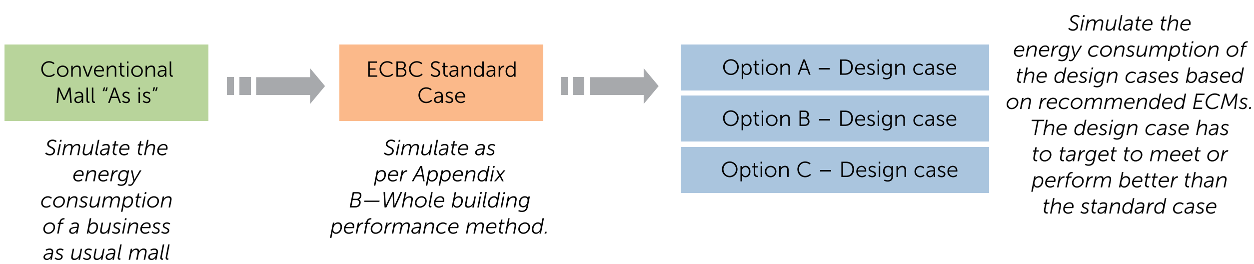
Criteria	'As is' Case	ECBC Case	Recommended Set of Option A	Recommended Set of Option B	Recommended Set of Option C
Building envelope = Roof	6 mm tiles + 35 mm screed + 150 mm BBC W/P + 225 mm PT slab with int plaster *U*-value = 2.1 W/m²xK	*U*-value = 0.409 W/m²xK	35 mm screed + 150 mm BBC W/P + 75 mm board insulation + 225 mm PT slab with int plaster *U*-value = 0.55 W/m²xK	High SRI Tile + 35 mm screed + 150 mm BBC W/P + 225 mm PT slab with int plaster + aluminium reflective insulation *U*-value = 0.27 W/m²xK	High SRI tile + 35 mm screed + 30 mm foam insulation + 150 mm BBC W/P + 225 mm PT Slab with int plasters *U*-value = 0.45 W/m²xK
Cost	Rate =₹3200/m² Total cost = ₹4,320,000/-	NA	Rate = 4080/m² Total cost = ₹5,508,000/-	Rate = 3900/m² Total cost = ₹5,265,000/-	Rate = 5,030/m² Total cost = ₹6,790,500/-
HVAC system selection	Air-cooled screw chiller	Water-cooled screw chiller	Water-cooled VSD screw chiller	Water-cooled 2-stage centrifugal chiller	Water-cooled screw chillers for large shops, common areas and air-cooled VRF for small shops/offices
Cost impact	18,400,000/-	NA	21,800,000/-	25,200,000/-	20,600,000/-
Benefit			Reduction in chiller power consumption by around 10% and starting current shall be 1 Amp per chiller	Reduction in chiller power consumption of chillers by around 15%	Elimination of large chiller piping. Btu metres. Total flexibility of operation for all shops in case of VRF Reduction in HVAC power consumption by around 15%
Other ECMs	NA	NA	Thermal storage with screw chillers		
Cost Impact	NA	NA	2,500,000/- (Will be compensated due to reduction in chiller, DG-set, transformer capacity		

The additional costs as compared to the 'as is' case were computed for all the building components

Table 1: Additional Costs for ECBC Compliance

Sl. No.	ECM	Option A (₹)	Option B (₹)	Option C (₹)
1	External wall	2,007,500	3,327,500	4,785,000
2	Roof	1,188,000	945,000	2,470,500
3	Fenestration	5,474,250	10,574,250	5,200,500
4	Reduction in WWR	0	0	0
5	HVAC base system	3,400,000	6,800,000	2,200,000
6	Multiple AHU's	4,760,000	3,400,000	-57000000
7	HVAC pumps	125,000	125,000	0
8	Controls and BMS	0	18,000,000	-7000000
9	Thermal storage	500,000	500,000	500,000
10	HVAC metering	1,000,000	600,000	0
11	Water heating system	223,125	1,899,525	8,375
12	Internal lighting	84,653	920,700	4,104,850
13	External lightning	23,520	163,000	235,575
14	Separate DB for lighting	250,000	250,000	250,000
Total Addition Cost(in INR)		**₹19,036,048**	**₹47,504,975**	**₹13,354,800**

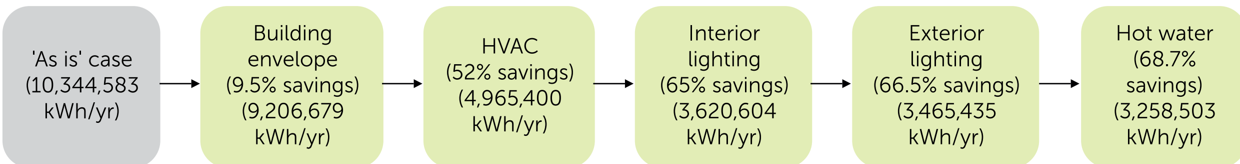
Building Energy Simulations and Simple Payback Analysis



In accordance with the ECBC whole building performance method, the modelling and simulations for the standard ECBC case and design cases (three options) were conducted as per Appendix B of the code. Design Builder with Energy Plus software was used for conducting simulations. Additionally, simulation was also conducted for the 'as is' case with parametric inputs based on the projects first choices without the considerations of ECBC compliance. The annual energy consumption results are summarized in the table 2.

Table 2: Summary of the Annual Energy Consumption Results

Particulars	'As is' Case	ECBC Case	Option A	Option B	Option C
Miscellaneous (kWh)	243,061	243,061	243,061	243,061	243,061
Internal utility (kWh)	410,625	410,625	410,625	410,625	410,625
Internal lighting (kWh)	639,773	576,960	340,221	293,203	214,523
External lighting (kWh)	39,588	32,990	19,794	19,794	19,794
HVAC (kWh)	9,011,536	3,381,617	2,244,802	1,759,027	1,341,263
Annual consumption (kWh)	10,344,583	4,645,253	3,258,503	2,725,710	2,229,266
EPI (kWh/ sq. m/year)	676	304	213	178	146
Cost (Rs@7.5/kWh)	77,584,374	34,839,395	24,438,776	20,442,822	16,719,498
Percentile scoring	Compared to 'as is' case	55%	69%	74%	78%
	Compared to ECBC case		30%	41%	52%



Step-by-step integration of ECBC compliances in design and its impact on energy consumption was obtained by performing the cascading simulations

Simple Payback Analysis

The results obtained from the energy simulation analysis were compared with the additional costs required for ECBC compliance. Life-cycle cost analysis was done in the form of a simple payback calculation.

Conclusions

Cost's Description	Unit	As is case	Option A	Option B	Option C
For additional recommendations	`	NA	19,036,048	47,504,975	13,354,800
For ECBC mandatory requirement	`	NA	1,063,500	1,063,500	1,063,500
Misc. contingency cost	`	NA	4,019,910	9,713,695	2,883,660
Grand total	`	NA	24,119,458	58,282,170	17,301,960
Annual energy consumption	kWh	10,344,583	3,258,503	2,725,710	2,229,266
Annual energy cost (@7.5/kWh)	`	77,584,174	24,438,776	20,442,822	16,719,498
Annual savings	`	NA	53,145,598	57,141,552	60,864,876
Simple payback period	Years		0.5	1.0	0.3

ECBC compliance was feasible for the project both technically and financially. The involvement of the entire project team in understanding the mandatory ECBC compliances and the recommendations to improve energy performance was required to ensure infusion of the ECMs in the design documents. The whole building performance approach enabled flexibility in choice of ECMs for ECBC compliance. Some key findings during the process of design integration given below.

For a warm and humid climate, compliance with the ECBC prescriptive *U*-values of 0.409 W/sq. m °C for roofs and 0.44 W/sq. m °C for walls is difficult without the use of insulation. The cost of double glazing worked out to be near around or even lower than the cost of single glazing with shading devices. Double glazing gave better energy savings since it could reduce not just the radiative gains but also the conductive heat gains.

The fulfilment of the ECBC mandatory requirements related to control of air leakages was challenging since the Indian market does not offer rated assemblies. General practice is to assemble the frames and glazing or shutters *in situ*, which makes estimating the air leakages an issue. Strong control on the construction quality to avoid cracks and gaps and use of gaskets and sealants in a proper way is required. Blower test was suggested to ascertain the values of air leakage.

The compliance with HVAC efficiency requirements and lighting power density requirements as per ECBC was easily possible owing to the market availability for high-efficiency equipment, fittings, and awareness in this regards. Along with the choice of the system, HVAC zoning to reduce losses in the system was also required.

The threshold of electrical losses of 1% required by ECBC was difficult to achieve since it substantially increases the width of wiring and thereby the cost.

In order to successfully infuse the design with ECBC requirements, interventions at the right stage of the project is of utmost importance. Building envelope section of ECBC requires intervention at an early stage, so that passive measures can be incorporated as a part of the design brief of the project.

Acknowledgements

We wish to acknowledge the project team under the UNDP–GEF–BEE programme for ECBC Demonstration project—Shopping mall in warm and humid climate zone.

A glimpse from GRIHA 3-day Training Programme for Certified Professionals held at Kolkata, September 2016.

ANSWER KEY FOR CROSSWORD (See page 64)

1. Seventeen, 2. Phytorid, 3. Mexico, 4. Toilet, 5. June, 6. Four, 7. Bio-fuel, 8. Vermicomposting, 9. Reva, 10. United State, 11. Energy, 12. Methane, 13. Aluminium, 14. Measured, 15. Dobson, 16. Mobile, 17. Hybrid, 18. China.

TESTIMONIALS

Regional Office of Engineer India Bhawan, Chennai

Our project team had great exposure in the field of sustainable development in building sector while working for GRIHA rating. The GRIHA team is highly passionate about sustainability in Indian context. They have a proactive attitude in understanding the project situation and suggesting innovative solutions.

We, green building consultants with national and international experience, really felt that the GRIHA officials are principle driven, systematic, and highly knowledgeable in interpreting sustainability concepts with respect to the Indian context.

Apart from the overall process of rating, our team had a fantastic work experience with GRIHA team, in terms of coordination (site visits and review), providing the feedback on submittals, and keeping us on track to achieve 4-Star rating. We have understood the tangible benefits of adopting GRIHA rating and would strongly recommend GRIHA certification to all our building owners and architect associates.

Mr Abdul Muthalib M

Director – Sustainability Research,
Innowell Engineering International Pvt Ltd,
Chennai 600 087

Vastukar Design Studio

In 2012, when I started designing my own design studio, I was already in the architectural practice for more than 25 years. I wanted to build a structure sensitive to tropical warm humid climate of Odisha. The building had to accommodate needs of our architectural practice and independent research foundation, where practice and research can collaborate retaining their independent identity. The building got built: contextual, functional, and sustainable. In 2015, we registered for GRIHA rating. As a part of the rating process, we started fulfilling the criteria by adding more and more green feature. We could feel, step by step, that the building became climate-wise friendlier. In 2016 June, Vastukar became the First 5-Star rated SVA GRIHA building of Odisha. But most importantly, this is now a place where we enjoy working.

My association with GRIHA is long. In 2008–09, during my tenure as chairman, Indian Institute of Architects, Odisha Chapter, we got great support from TERI in conducting GRIHA Awareness Session and also subsequently in organizing two-day technical training programme on GRIHA.

In December 2012, Vastukar Foundation hosted GRIHA workshop where eminent speakers from GRIHA delivered Illustrative Talks. Our association became stronger. In 2013, Vastukar was elevated to the status of GRIHA patron.

In 2013, I started serving as its founding Director. 'Excellence in Sustainable Architecture' became a major thrust. Supported by team GRIHA, we conducted evaluators' training programmes, awareness workshops, and also consulted them in improving our course structure. They became a continued partner to realize our dreams.

GRIHA is a team of passionate professionals and their contribution towards energy-efficient architectural practices in this region is commendable.

S S Ray
Principal Architect
Vastukar Design Studio

smartData Enterprises India Ltd

Proud to be associated with GRIHA

What a Green Journey it has been while working with team GRIHA, to realize the dream of Fuji Tower—a Green Building. The beginning itself was memorable and speaks volumes on how one 'YES' can actually result in a 4-Star Rated building, causing a small yet positive impact. Had it not been for the positive team of GRIHA and the 'YES' attitude their team carried, we would have probably missed out with the registration of our project Fuji Tower. It has been quite an amazing experience and tremendous education, working with GRIHA to realize the dream of a Green Building.

GRIHA helped us learn and implement various environment-friendly strategies leading to construction of a sustainable and energy-efficient building. The most satisfying human factor though was to witness a 'Zero Casualty' Construction. No damage to man and material was caused, and surely, GRIHA has much to be credited for the same as also smartData team, who enforced all the requisite green building norms in letter and spirit. Under the guidance of GRIHA Council, our project team worked hard which resulted in award of 4-Star GRIHA rating to our Fuji Tower building at Nagpur—Vidharbha's first commercial green building.

We greatly appreciate the efforts done by GRIHA. Their young team was available on field and for any consultancy as and when desired. There was never a delay in decision making or providing alternate solutions. We greatly admired their support and wish to work with GRIHA for our future projects too. As they say, 'In one drop of water, are found all the secrets of the oceans'.

Abhijeet Shahi

Senior Director—Operations
smartData Enterprise (I) Ltd

Achieving a SVAGRIHA 5 Star rating award for Design Associates Inc. Office

Achieving a SVA GRIHA 5 Star rating award for Design Associates Inc. Office is a huge achievement for the team. This is an outcome of efficient designing and management along with GRIHA Council's support. Throughout the SVA GRIHA rating process, the GRIHA Council team's support was commendable in terms of guidance, discussions, and site visits. The SVA GRIHA is an effective tool to ascertain the project performance in energy, water, and climate responsiveness. It helps in sustainable site planning, using low embodied energy building materials, ensuring indoor environmental quality, and green lifestyle verticals.

This remarkable journey has inspired Design Associates Inc. to promote green buildings.

The SVA GRIHA is an effective tool to ascertain the project performance in energy, water, and climate responsiveness.

Salient features of 'Office Building' for Design Associates Inc.

- Over 94% of total living area falls under day lit zone.
- The Lighting Power Density of the project is 3.59 W/m^2.
- A 3 kWp solar photovoltaic panel has been installed at the rooftop.
- All air-conditioners installed in the building are Bureau of Energy Efficiency (BEE) 5-star rated. In addition, Variable Refrigerant Volume system has been installed in the control room building, with an energy efficiency ratio more than that of a 5-star BEE rated air-conditioner.
- The project has reduced building water demand by 70.63% below the SVA GRIHA base case through use of low-flow fixtures.
- The project has reduced landscape water demand by more than 57% below the SVA GRIHA base case.
- There is a provision of dedicated rest room and toilet for the service staff within the site.
- The project has maintained a kitchen garden for growing fruits/vegetables for their own use.
- Separate space and multi-coloured bins have been provided for collection of dry, wet, and e-waste generated within the building.

The Team

Client: Design Associates Inc.

Architect: M/s Design Associates Inc., NOIDA
Green Building Consultant: Udit Gaurav, Head Green Building – Tecton Project Services Pvt Ltd

सत्यमेव जयते
Ministry of New and Renewable Energy
Government of India

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LET'S FOCUS !
PHOTOGRAPHY COMPETITION FOR GRIHA SUMMIT 2017

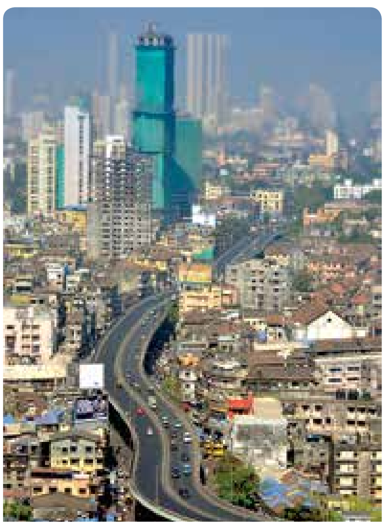
Click a Photo, Win a Camera!

ABSTRACT

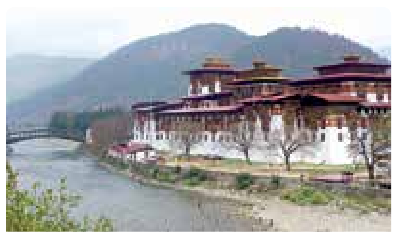
We are living in a world which is evolving at an unprecedented rate. We are looking for **photographers** who are in pursuit to capture this **dynamic** nature of our cities, environment, mobility and spaces we live in. The Jury would be looking for **photographs** which appropriately depict the theme: **TRANSFORMING HABITATS** towards sustainability.

TOP 5 ENTRIES

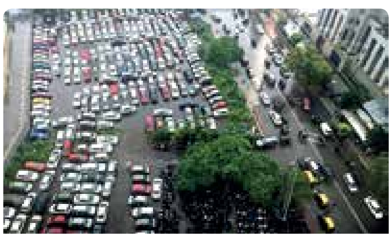
Rooftop Organic Garden with a production of 70 kgs of vegetables on top of a multistoried building in Kolkata. –***Sudipto Das***



Retrogressive Metamorphosis, analogous to the dynamic evolution of our cities. Mumbai –***Vedang Bagwe***



Sustainability can bring about happiness.
Punakha Dzong, Bhutan –***Tarun Suneja***



"We adore chaos because we love to produce order."
Bandra Kurla Complex, Mumbai. –***Suryadeep Das***

Reducing carbon footprint through sustaining natural landscapes.
Yamuna Biodiversity Park, Delhi –***Mohan Singh***

Two Awards will be presented at the GRIHA SUMMIT 2017—
Jury's Choice and People's Choice.

#GRIHA4all

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