Shashwat

Volume 3 | Issue 4 | December 2017 ₹250

Let Nature Be

Sustainable is Affordable

A **GRIHA Council** Publication

FEATURE ARTICLES

IN CONVERSATION

THANKS TO OUR VALUED PARTNERS

ORGANIZED BY

teri
The Energy and Resources Institute

GRIHA

PREMIUM PARTNER

AIS

PREMIER PARTNER

Parryware

STATE PARTNERS

Government of Andhra Pradesh

उत्तर प्रदेश सरकार

GOVERNMENT PARTNERS

Ministry of New and Renewable Energy Government of India

ENERGY IS LIFE
BEE
CONSERVE IT

EESL

NBCC
A Navratna CPSE

NATIONAL HOUSING BANK

BILATERAL AND MULTILATERAL

UNDP

UN Information Centre for India and Bhutan

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

TECHNOLOGY PARTNERS

GLOBAL EVOLUTIONARY ENERGY DESIGN

Greenifyi
www.Greenifyi.com

ASSOCIATE PARTNER

armacell
engineered foams

GREEN PARTNERS

somfy

TATA CAPITAL
We only do what's right for you

TRAVEL PARTNER

Shuttl

REAL ESTATE PARTNERS

BAANI
real estate & beyond

EXPERION
THE POSITIVE SIDE OF LIFE

ireo

BESTECH

INTERNATIONAL TECH PARK
GURGAON

vatika
creating lasting value

PRAROOP PARTNERS

Berger

USG BORAL

REGENT
LIGHTING

mistry associates
architects

graphenstone
nanotechnology coatings

ActiveBuildings
by PiRhoAlpha

ELT INDIA
The Lifestyle Gardening

LIFE GREEN SYSTEMS
Green Cities | Clean Waters | Better Life

H&R JOHNSON

SARGE

SINICON

Wienerberger

MEDIA PARTNERS

ZEEBUSINESS

WINDOW & FACADE
MAGAZINE

GREEN DREAM FOUNDATION

TerraGreen

energetica
INDIA

THE ARCHITECT'S DIARY

Message from
President, GRIHA Council

> GRIHA is a market-driven approach for implementing sustainability in the built environment, which not only ensures resource-efficiency but also spurs technological innovation.

Dear Friends,

India is poised to become the third-largest economy in the world by 2028. However, while it is noteworthy that in terms of population, India is the second-largest country with 17% of the GLOBAL population, it uses only 6% of the world's energy. At 1,075 kWh, India's per capita electricity consumption is much lower than the developed countries and is about one-third of the world's average per capita electricity consumption. With economic development on the rise, India's per capita energy consumption is expected to double in the next 6 to 7 years.

The provision of adequate frameworks and basic services is central to the economic performance of this fast-growing infrastructure. Buildings alone contribute to 30% of the global greenhouse gas emissions and account for the consumption of one-third of the global raw materials, energy, and water. It is estimated that by 2021, electricity consumption due to space cooling and heating appliances will double as compared to the 2011 levels. Therefore, the key challenge facing the Indian construction industry is the necessity to ensure resource-efficiency and minimizing environmental degradation.

Green Rating for Integrated Habitat Assessment (GRIHA), has been at the forefront of the sustainable development movement in India since 2007. GRIHA is a market-driven approach for implementing sustainability in the built environment, which not only ensures resource-efficiency but also spurs technological innovation. Persisting in our endeavour, I am pleased to see the launch of a new rating variant, '*GRIHA for Affordable Housing*', aligned with the Government of India's target to combat the housing shortage by providing affordable housing for all by 2022. This rating variant is specifically developed to ensure that the new construction under the scheme is not only affordable but also sustainable.

Amaravati, the new capital township of Andhra Pradesh, aims to provide cutting-edge, sustainable, smart, and comfortable infrastructure for its people. It is indeed an honour for us to provide technical assistance to the Capital Region Development Authority of Andhra Pradesh (APCRDA) for designing the new and upcoming buildings as green buildings that are compliant with GRIHA. I am informed that the Government of Andhra Pradesh is also offering 25% subsidy of the total fixed capital investment of the project for GRIHA-rated projects as an incentive for the establishment of industrial enterprises as part of the Industrial Development Policy (IDP) 2015–20.

The 9th GRIHA summit with its theme, 'Sustainable is Affordable', shall provide a platform to discuss affordable solutions for sustainable products and green business opportunities to the participants. It will showcase the latest environment-friendly construction technologies and provide an opportunity to policymakers, decision makers, buyers, and sellers to stimulate and foster further partnerships.

As another fulfilling year ends, I am grateful for your unwavering support and look forward to your continued participation at the GRIHA Summit.

With best wishes for the ensuing New Year 2018!

Dr Ajay Mathur
President, GRIHA Council

GRIHA Timeline

2000

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

2005

- TERI GRIHA released as an indigenous green building rating in 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

Developed by

The Energy and Resources Institute

Supported by

Ministry of New and Renewable Energy, GoI

Contact Details

GRIHA Council

A-260 • Bhishma Pitamah Marg • Defence Colony • New Delhi-110024 • India •
Phone: 91.11.46444500, 91.11.24339606 - 08
Fax: 91.11.24339609 • E-mail: info@grihaindia.org • Website: www.grihaindia.org

GRIHA App on >

Download on the App Store

ANDROID APP ON Google play

GRIHA recognized as India's own green building rating system in **INDIA's INDC** submitted to the **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
- A 25% subsidy on FCI for GRIHA rated Industrial projects in AP

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 the Indo-Italian Chamber of Commerce and Industry (IICCI)

2017

- GRIHA EB launched
- MoU signed with Madhya Pradesh Police Housing and Infrastructure Development Corporation Ltd. (MPPH&IDC), Pune Municipal Corporation (PMC), BESTECH, Ireo, Vatika, CONSCIENT, ADANI Realty, and Godrej Properties
- Circular issued to all the State Police Housing Corporations for the incorporation of GRIHA in the ongoing and future projects by the BPRD
- Revamped evaluators module and exam launched
- SPARSH installed at the UN office to celebrate the UN Day 2017
- AFD, NHB, and EU launched the SUNREF Housing India programme

हरदीप एस पुरी
HARDEEP S PURI

आवासन और शहरी कार्य
राज्य मंत्री (स्वतंत्र प्रभार)
भारत सरकार
MINISTER OF STATE(I/C)
HOUSING AND URBAN AFFAIRS
GOVERNMENT OF INDIA

MESSAGE

It gives me great pleasure to know that GRIHA Council is organizing The 9th GRIHA Summit on 18th & 19th December, 2017 with the theme 'Sustainable is Affordable'.

The urban population in India has been rising sharply over the past decade and is estimated to reach 814 million by 2050. This immense increase in population is set to pose serious challenges in terms of providing affordable, safe and sustainable housing for all in the burgeoning urban centres all over the country.

Government of India has taken up the task of providing 'Housing for All' as an initiative under the 'Pradhan Mantri Awas Yojana, on a mission mode. The objective of the mission is to provide 20 million housing units by 2022 for the masses while also providing a major stimulus to economic activities through creation of direct and indirect employment opportunities.

To impart impetus to this mission of 'Housing for All', we have recently unveiled a new PPP policy to encourage private investments in affordable housing segment.

The theme for the GRIHA Summit – 'Sustainable is Affordable' is apt and, I am sure, shall dispel the myth that sustainable is not affordable. My ministry has also been on the forefront in promoting innovative and sustainable technologies in housing.

Affordable, climate resilient and sustainable buildings are the need of the hour and it is a matter of great satisfaction to know that the GRIHA Council is launching a new variant for the 'Affordable Housing' segment.

I sincerely hope and trust that deliberations of the experts and stakeholders in the summit shall trigger and facilitate integration of relevant features for optimal sustainability in the affordable housing segment as well.

I wish the summit all success and convey my best wishes to the GRIHA Council in all its future endeavours.

(Hardeep S Puri)

Office:- Room No. 104-C, Nirman Bhawan, New Delhi-110011; Phone: 011-23061166, 23061162, 23062089 (Fax)

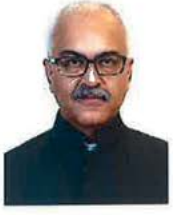
अजय भल्ला
सचिव
भारत सरकार
AJAY BHALLA
Secretary
Government of India

सत्यमेव जयते

Ministry of Power
Shram Shakti Bhawan
New Delhi - 110001

विद्युत मंत्रालय
श्रम शक्ति भवन
नई दिल्ली–110001
Tele : 23710271/23711316
Fax : 23721487
E-mail : secy-power@nic.in

December 05, 2017



MESSAGE

Energy efficiency has assumed enhanced importance with a view to conserve depleting energy resources. Energy has emerged as a critical economic issue and top priority for policymakers. Improving the energy efficiency meets the dual objectives of promoting sustainable development and of making the economy competitive. While on one hand the Government is promoting greater use of renewable in the energy mix, on the other side, efforts are being made to efficiently use the energy in the demand side through various innovative policy measures under the overall ambit of Energy Conservation Act 2001.

Under the Energy Conservation Act 2001, Bureau of Energy Efficiency (BEE) is responsible for spearheading the improvement of energy efficiency through various regulatory and promotional instruments. Ministry of Power, through BEE, has initiated a number of energy efficiency initiatives in the areas of household lighting, commercial buildings, standards and labelling of appliances, demand side management in agriculture/municipalities, SME's and large industries including the initiation of the process for development of energy consumption norms for industrial sub sectors, capacity building of SDA's etc.

Today building sector industry appears to be entering another era of change, with a view toward minimizing a different kind of footprint: the energy, carbon, and environmental footprint of commercial and residential buildings. Once again, change is being driven by a need to optimize and conserve resources — this time, clean air, water, and energy as well as land. And, once again, transformative technologies may hold the key to meeting the challenges. The use of environmentally-sensitive design strategies, the improvement of buildings envelope, the change of energy consumption patterns in people through information and awareness, the combination of sustainable technologies and dynamic strategies, and the use of renewable energy are the main alternative ways to improve energy efficiency and reduce emissions.

I am confident that, with this year's theme 'Sustainable is Affordable' the GRIHA Summit will showcase emerging technologies and solutions in the buildings sector which would act as a catalyst to green policies.

I convey my best wishes to the GRIHA council and wish them success for the future.

(A. K. Bhalla)

RIGHT TO INFORMATION

स्वच्छ भारत
एक कदम स्वच्छता की ओर

डॉ. गुरुप्रसाद महापात्र, आई.ए.एस
DR. GURUPRASAD MOHAPATRA, IAS
अध्यक्ष
Chairman
दूरभाष / Phone 011-24632930
24622796
फैक्स / Fax : 011-24641088
ई-मेल / E-mail . chairman@aai.aero

भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA
राजीव गाँधी भवन
Rajiv Gandhi Bhawan
सफदरजंग हवाई अड्डा, नई दिल्ली-110003
Safdarjung Airport, New Delhi-110003

No. AAI/CHMN/2017

November 30, 2017

Airports Authority of India (AAI) is committed to develop sustainable and affordable air connectivity. It gives me pleasure to note that 'Sustainable is Affordable' is the theme of the 9th GRIHA Summit. It supports the core objective of our Mission UDAN "Ude Desh ka Aam Nagarik".

Our Construction team understood the value in Green Rating Integrated Habitat Assessment (GRIHA) certification at an early stage. Our associate with GRIHA Council for the past three years has paid rich sustainability dividends in the form of measurable energy, water and other resource savings, besides making our habits healthier and comfortable. It is a matter of pride that the very first airport building to be rated under GRIHA is our New Integrated Passenger Terminal Building at Chandigarh Airport.

AAI is now ensuring that our entire proposed airport terminal aspire to have 5 star GRIHA rating. This would provide maximum contribution to our Sustainable Development Targets that are verifiable from the concept stage itself.

I am sure that the "9th GRIHA Summit" on the 18th and 19th December, 2017 at New Delhi would result in new valuable ideas that would make sustainable affordability a reality and an imperative. On behalf of the Airports Authority of India (AAI), I convey my warm wishes for successful outcomes of the Summit. I also take this opportunity to wish GRIHA Council all success for their future endeavours.

(Dr. Guruprasad Mohapatra)

ABHAI SINHA
Director General

सत्यमेव जयते
भारत सरकार
Government of India

CPWD
केन्द्रीय लोक निर्माण विभाग
निर्माण भवन, नई दिल्ली – 110011
Central Public Works Department

Nirman Bhawan, New Delhi-110011
Tel. : 23062556/1317, Fax : 23061884
E-mail : cpwd_dgw@nic.in

MESSAGE

It gives me immense pleasure to know that the GRIHA Council is organizing its annual flagship event – **'The 9th GRIHA Summit'** in New Delhi on 18th & 19th December 2017.

The theme chosen for the summit – **'Sustainable is Affordable'** is contextually relevant and in line with the Government of India's efforts for achieving the Sustainable Development Goals.

We all are concerned about the over exploitation of the natural resources and the resulting environmental degradation. CPWD as a Principal Engineering Organization of Government of India is playing an important role towards sustainable and affordable development by adopting greener construction practices in its works. Technical publications of CPWD are aligned with the National Building Code (NBC), Energy Conservation Building Code and GRIHA norms.

I take this opportunity to extend my deep appreciation to GRIHA Council for the initiatives taken in the domain of **'sustainable habitats'**. I am glad to know that GRIHA rating is being increasingly adopted by more and more organizations for developing their buildings and habitats.

I compliment GRIHA Council and extend my best wishes for success of the Summit.

30/11/2017

(Abhai Sinha)

अनूप कुमार मित्तल
अध्यक्ष एवं प्रबंध निदेशक
ANOOP KUMAR MITTAL
Chairman-cum-Managing Director

एन बी सी सी
NBCC
A Navratna CPSE

MESSAGE

It gives me immense pleasure to learn that the GRIHA Council is organizing its annual flagship event –"9th GRIHA Summit" in New Delhi from 18th -19th December 2017.

NBCC (India) Limited is a blue –chip Government of India Enterprise under Ministry of Housing and Urban Affairs with a Navratna Status. We have the mission of being a leading company with excellence in construction business, offering sustainable, innovative and cost effective buildings and complexes of all kinds all over the country and also abroad. We offer multifaceted service like (i) Project Management Consultancy (PMC), (ii) Real Estate & Redevelopment Projects (iii) EPC Contracting in the domain of construction sector.

NBCC is committed to building Green Buildings and Habitats. In this regard, we appreciate the support and cooperation extended to us by TERI / GRIHA Council for organizing trainings and capacity building programmes for our professionals all over the country on the concepts of Green Buildings, as part of our "Memorandum of Understanding".

We are committed to our collaboration with the GRIHA Council for obtaining ratings for our buildings and certifying them as models of sustainable habitats.

The theme of the summit, **"Sustainable is Affordable"** has been chosen appropriately, in line with country's initiatives for sustainable development. Sustainable buildings and infrastructure are the need of the hour. I sincerely hope that the summit provides a platform for exchange of ideas, as to how to achieve affordability in the sustainability agenda.

I wish the GRIHA summit all success.

Dr. Anoop Kumar Mittal

एनबीसीसी (इंडिया) लिमिटेड
(भारत सरकार का उद्यम)
NBCC (INDIA) LIMITED
(A Government of India Enterprise)
(Formerly National Buildings Construction Corporation Ltd.)
NBCC Bhawan, Lodhi Road, New Delhi - 110 003 I CIN-L7489DL1960GOI003335
Tel. : 91-11-24368893 I Fax : 91-11-24365661
E-mail : cmdsectt@nbccindia.com I www.nbccindia.com

Message from CEO, GRIHA Council

> It is heartening to note that we have more than doubled the number of buildings registered annually in the past ... Personally, for me, this year's journey with GRIHA has been extremely fulfilling and enriching.

Dear Friends & Colleagues,

The year 2017 was dotted with important milestones and significant developments for the GRIHA community. More than 1,000 buildings having been registered thus far under the GRIHA variants with a footprint exceeding 45 million square metres. It is heartening to note that we have more than doubled the number of buildings registered annually in the past. The number of projects to have received ratings, annually, has also increased three-fold over the past years.

The India Pavilion at CoP 23 at Bonn, Germany, saw GRIHA displayed as India's own green building rating system. In our endeavour to promote GRIHA as a more transparent and robust rating tool, we were able to develop two new variants, 'GRIHA for Existing Buildings' and 'GRIHA for Affordable Housing'. To expand its outreach, GRIHA has established two regional centres at Bangalore and Mumbai and simultaneously created two project management units at the Capital Region Development Authority of Andhra Pradesh (APCRDA) and Pimpri-Chinchwad Municipal Corporation (PCMC), respectively.

The 8th GRIHA Summit 2017 displayed 'SPARSH#GRIHA4all', an integrated, life-size model which enhanced the user's experience of a green building. This mock-up structure displayed all the components of a green building, such as insulated walls and roofs, flooring with recycled material, efficient glazing systems, energy- and water-efficient appliances, and renewable technologies, in an integrated manner. The United Nations Information Centre for India and Bhutan invited the GRIHA Council to showcase 'SPARSH#GRIHA4all' on the United Nations Day on October 24, 2017. The mock-up structure is now being considered to be on the permanent display at the UN House to showcase the works in innovation. This is a proud moment for us all.

Strategic innovation driven by sustainable development will play a key role in lowering the costs associated with constructing climate-resilient buildings. Now, more so than ever, it has become critical to be a part of the solution towards sustainable development.

Career progression is key and we at GRIHA understand the strategic importance of this key aspect. To motivate staff and help them learn, contribute, and grow, we at GRIHA Council have created a well-defined organizational structure with clear roles and responsibilities. This has started to yield the desired results both in terms of quality and timeliness

> Strategic innovation driven by sustainable development will play a key role in lowering the costs associated with constructing climate-resilient buildings. Now, more so than ever, it has become critical to be a part of the solution towards sustainable development.

of deliverables as well as passion and dedication demonstrated by the GRIHA team.

The 9th GRIHA Summit has received an overwhelming response from our partners across international, national, and subnational development agencies, private developers, manufacturers, academia, and professionals. As a precursor to the summit, a tree plantation drive 'Chhaya', was initiated jointly by GRIHA and the Airports Authority of India (AAI) as a year-long programme to promote sustainability in Delhi and other cities across the country. The summit is going to witness several new partnerships with esteemed organizations, such as the National Building Construction Corporation Ltd. (NBCC), Energy Efficiency Services Ltd. (EESL), National Housing Bank (NHB), Rajasthan Police Housing & Construction Corporation Ltd. (RPHCCL), and Indian Society for Heating, Refrigeration & Air Conditioning Engineers (ISHRAE).

Personally, for me, this year's journey with GRIHA has been extremely fulfilling and enriching. I also acknowledge the passion, dedication, and hard work of the GRIHA team in achieving all of the above milestones. I express my gratitude to all those associated with the brand GRIHA for their confidence and wholehearted support.

Friends, on behalf of the President and Team GRIHA, I look forward to welcoming you all to the '9th GRIHA Summit' to deliberate on the theme, 'Sustainable is Affordable'.

Sanjay Seth
Chief Executive Officer
GRIHA Council

Shashwat

DECEMBER 2017

Volume 3 • Issue 4

An annual magazine of
the GRIHA Council,
(Published in English)

PRODUCED BY
TERI Press, TERI

PUBLISHER
GRIHA Council
First Floor, A-260, Defence Colony,
New Delhi - 110024
Tel: (+91 11) 46444500/24339606-08
www.grihaindia.org

Published, printed, and edited for and on behalf of the GRIHA Council (TERI) from A-260, Bhishma Pitamah Marg, Defence Colony, New Delhi-110024. Printed at SVS Press, A 13, Naraina Industrial Area, Phase II, New Delhi-110 028, India.

FEATURE ARTICLES

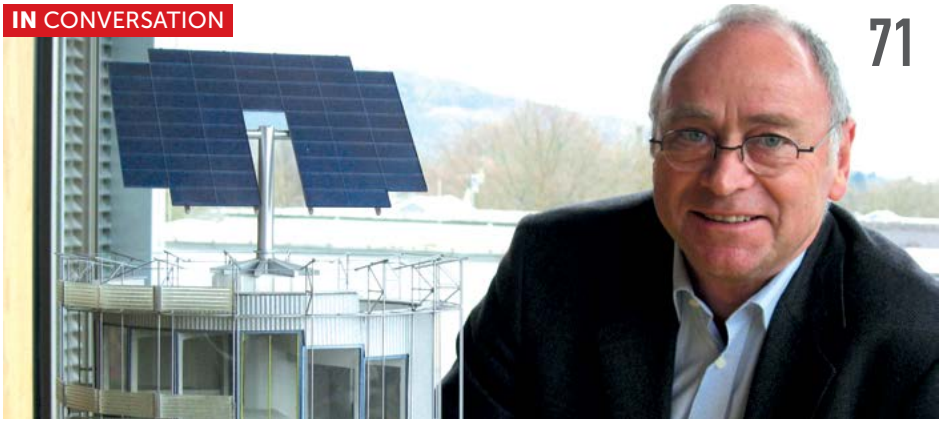
IN CONVERSATION

The architectural industry is taking adequate steps to face the challenge of combating limited resources and is deploying passive strategies to address these issues.

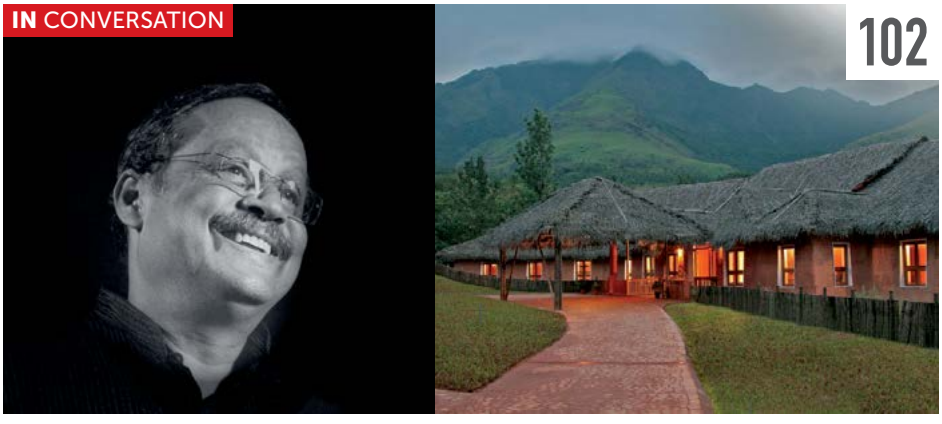
Sustainable living is our target and we are all exploring ways to live and work in a manner that helps us to be in synchrony with nature and coexist with the environment without disturbing it.

The importance of the Sustainable Development Goals (SDGs) have never been more acutely felt. Designed to improve climatic conditions and our way of life, SDG 11, especially aims at striking the much-needed balance between the economy, environment, and various human needs.

IN CONVERSATION



IN CONVERSATION

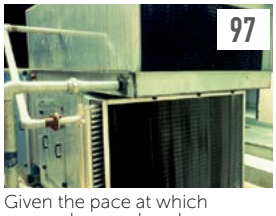


FEATURE ARTICLES

TESTIMONIALS

Nature, our oldest muse, has inspired legions of green builders and architects. Be it art, literature, economics, or architecture, if we look closely, our best works reflect an unmistakable relationship with nature.

Of late, the construction sector has received much attention as one of the biggest contributors of waste and greenhouse gas emissions.



Given the pace at which we produce and package a number of perishable items, not to mention how a considerable portion is exported as well, cooling and heating have emerged as one of the prominent factors that determine the efficiency of this sector.

Given the financial proximity between the economic and housing sectors, it is no wonder that, of late, a lot of focussed attention is being given to this.

Essentially an energy-saving measure, insulation is a way to inhibit heat loss during winters and the excessive heating up of buildings during summers.

MAKE IN INDIA

भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

अत्याधुनिक तकनीक एवं अंतरराष्ट्रीय मापदंड के साथ भा.वि.प्रा. का सुरक्षित हाथ

With state-of-the-art technology, International benchmarks You are in safe hands of AAI

126 स्थान जहाँ भरें भा.वि.प्रा. के संग उड़ान
126 Destinations to FLY with AAI

AAI अपने वर्ग में विश्व का सर्वश्रेष्ठ सेवा प्रदाता
AAI amongst World's **Best Service Provider** *in its respective category*

23		**08**		**76**		**19**		**126**		
अंतरराष्ट्रीय हवाई अड्डे (3 सिविल एन्कलेव तथा 3 संयुक्त उद्यम हवाई अड्डे) **International Airports** (3 Civil Enclaves & 3 Joint Venture Airports)	+	कस्टम हवाई अड्डे (4 सिविल एन्कलेव) **Custom Airports** (4 Civil Enclaves)	+	अन्तर्देशीय हवाई अड्डे **Domestic Airports**	+	अन्य सिविल एन्कलेव **Other Civil Enclaves**	=	हवाई अड्डे **Airports**		

Transit-Oriented Development: Planning Tool for Sustainable and Affordable Urban Development

Case of Delhi

While the benefits of urbanization are many—in fact, it is now the yardstick with which the success of an economy is measured—its disadvantages, however, have reached a certain unprecedented height. In this article, with a special emphasis on transit-oriented development, **P S Uttarwar** identifies and discusses the problems that have surfaced in the recent past.

P S Uttarwar is visiting faculty at the Department of Urban Planning, School of Planning and Architecture, Delhi. In a recent engagement, he was advisor of planning at Delhi Developmental Authority. He was actively involved in the micro planning of Rohini and Dwarka sub-cities. He can be reached at: psuttarwar@gmail.com

Background

Urbanization all over the world is causing concern not only amongst the urban planners but also amongst the world leaders, particularly in the developing world. The three 'P's associated with urbanization, that is, population, poverty, and pollution are major problems that require relatively low-cost affordable solutions. Cities all over the world are facing problems of people migrating to cities seeking better opportunities for various reasons, ranging from poverty-related issues to political. The appalling conditions in slums render access to clean water and health services far from affordable, thereby resulting in various environmental hazards. Densification of central areas within the cities causes extreme traffic congestion, air pollution, greenhouse gas (GHG) emissions, and climate change considerations. Planning intervention is required to bring in some kind of symmetry in the quality of life in cities which requires capital-intensive investment from the private sector and a slew of tax incentives/reforms from the government sector. Due to depressed real estate market, large investments in redevelopment of cities are unlikely. What then is a viable solution making city development sustainable and, at the same time, affordable.

Advent of Transit-Oriented Development

Solutions for the redevelopment and regeneration of cities have to evolve from within. Redevelopment should result in community development that includes a mix of housing, offices, shops, and other amenities integrated within walkable neighbourhoods and located

within easy reach of public transportation centres. Such development/redevelopment is called transit-oriented development (TOD). It brings with it a relatively low cost and affordable solutions to property development as residents themselves are stakeholders/ partners in the redevelopment/ regeneration of the area. They contribute in terms of property/ land parcels and partial cost of construction, whereas a private developer brings in investment in lieu of additional floor area made available to him by stakeholders/ state/local bodies by way of development control regulations. It is an alliance of convenience. TOD is seen as a relatively low-cost solution to problems ranging from housing affordability, traffic congestion, to global warming.

What is TOD?

TOD as a concept is not new. Historically, cities have grown rapidly along transportation networks, may it be railways or roads and internal networks within the cities. Before the arrival of automobiles, cities were compact and had mixed-land uses. Most of the development was around the transit routes because it provided better accessibility. In the Indian scenario, Mumbai is a good case in point as the city expanded in a linear fashion along the railway lines, that is, along the central and western railway routes. This is one of the major reasons why the local trains are crucial to the survival of Mumbai city. Similarly, the city of Jaipur, though planned in a gridiron pattern, uses a compact mix-use development along the major roads and streets. Therefore, TOD in many ways is just another name for traditional urban development.

Why TOD?

In the past, life in towns moved at a slow pace and was socially more satisfying. Today the situation has changed. Urban cities are facing severe problems, such as traffic congestion, air pollution, and the uncertainties of climate change conditions. In addition to this, large-scale migration to the cities has intensified the existing problem. Living in highly segregated urban neighbourhoods causes changes in lifestyle and within the social fabric as well. Given a chance, migrants may like to live in a mixed land use environment where people-to-people contact is easy, thereby enhancing social security and safety. Cities are also investing a lot in transit systems, such as metros, bus rapid transit (BRT) system, new rail roads or the extension of old ones. As TOD also propagates high-density mix-use development, TOD is modern-day version of a traditional, core city planning development.

National Policy on TOD

Taking into consideration the importance of TOD in the national context, the government has announced a policy, 'National Transit Oriented Development', dedicated to this. The Ministry of Housing and Urban Affairs, Government of India, has announced a framework to promote development near mass urban transit corridors for addressing urbanization challenges. It seeks to promote TOD which enables people to live within walking or cycling distance from metros, monorail, and BRT corridors, etc. This policy will help states and union territories to understand TOD as a sustainable and affordable solution to many of the challenges, such as excessive urban growth, rapidly rising private vehicles on roads, pollution, housing choices, etc. A community with a strong and dependable transit system and streetscaping elements can discourage vehicle dependence and congestion.

In the new metro policy drafted by the government, TOD has been made mandatory and prioritized for receiving central assistance. Doing so will promote integration of land use planning with transportation and infrastructure development to avoid long-distance travel in cities. TOD is, essentially, about compact development as against the present pattern of unplanned and haphazard urban growth. The union government's TOD policy will help the states in developing an in-depth understanding of the challenges currently faced by the cities.

TOD policy aims at inclusive development in the form of a range of housing choices, including affordable housing and ensuring spaces for street vendors. If properly executed, TOD could emerge as a means of financing mass transit projects for which the demand is growing.

Financial needs for TOD will be met by channelizing a part of property values resulting from investments in transit corridors through betterment levies and value-capture financing tools.

The central government has notified the TOD policy in 2015, but there was no clarity on the process for the management of open spaces, various sanctions, parking space, water requirement, etc.

TOD in Delhi

The TOD policy proposed by Delhi Master Plan will mark a paradigm shift in the way neighbourhoods and cities, in general, are planned thus heralding a new way of

linking urban systems with day-to-day living such that people can spend more quality time socially and in pursuing recreational activities rather than getting stuck in traffic jams, a major concern on roads toady.

Taking the master plan directive forward, the TOD policy designates a maximum, up to 500 m-wide, belt (i.e., approximately 5-minute walking distance) on both sides of the centre line of the mass rapid transit system (MRTS) corridor as the 'TOD Zone', with the exception of areas falling under low-density residential areas (LDRA). TOD zone is a new land use category that allows flexibility in a mix of various possible uses, with the exception of polluting and potentially hazardous uses.

The goal of the TOD Zone is to promote low-carbon high-density sustainable development in the city. The policy has the following major aspects:

- Allow flexibility of uses within the overall ambit of the zonal development plan.
- Mixed use of provisions to reduce travel demand and reduce pressure on road-based travel.
- Optimum floor area ratio (FAR) and density norms to facilitate people to live, work, and seek entertainment within walking distance from stations. These will also seek to balance/ redistribute densities over the city along the MRTS corridors.
- Creation of finer road networks within neighbourhoods/ development areas for safer and easy movement of non-motorized transport (NMT) and pedestrians.

A mix in income arising due to greater community integration. The more people share public spaces, greens, recreational facilities, and amenities, the more the economy will improve.

- Increase in public safety, especially for women and children using public transportation or walking at night. These changes can be brought about by revising the key development code and including aspects, such as revised setback norms, dispensing with boundary walls, having built-to-edge buildings with active frontages which provide 'eyes on the street'.
- Strict planning and regulation of on-street parking shall be undertaken to reduce use of private vehicles.
- Approval of projects shall be given through a single-window

Figure 1: An artist's vision of TOD project at Karkardooma, East Delhi

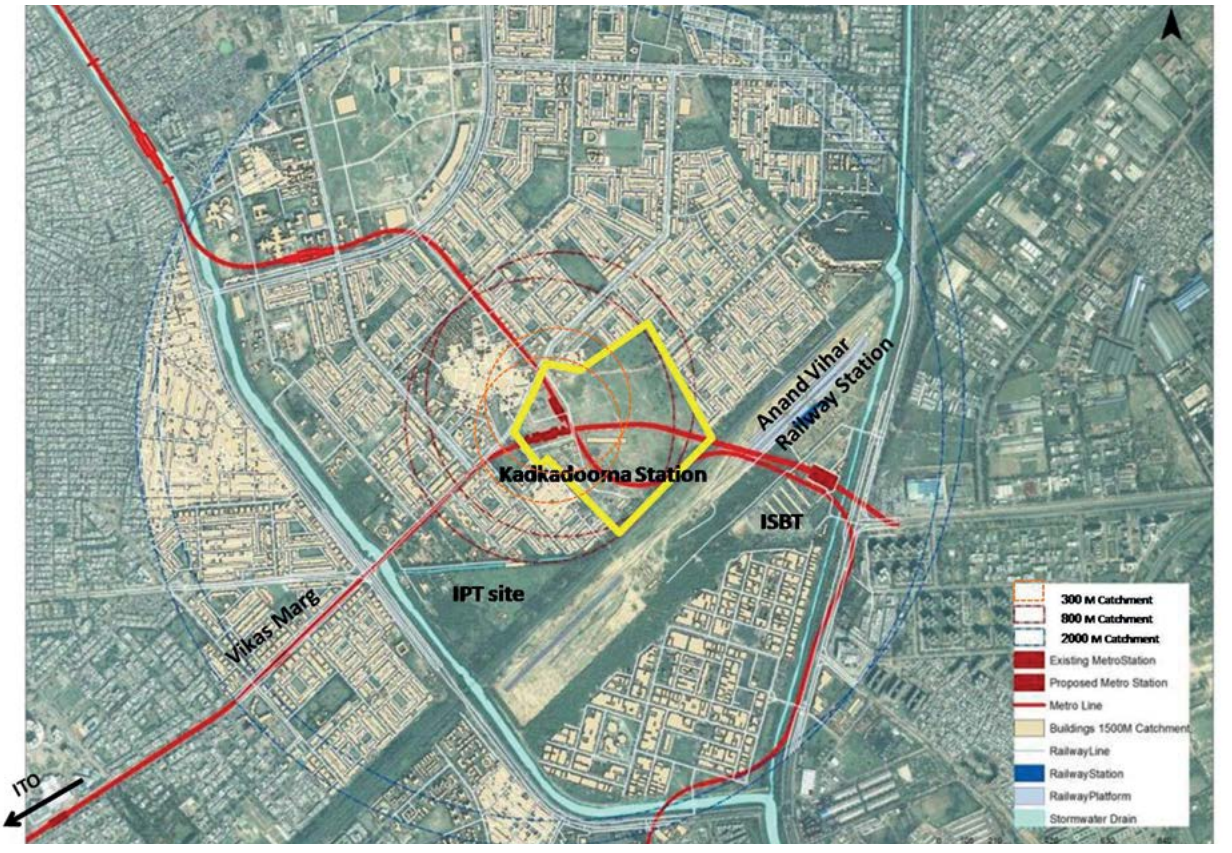


Figure 2: Location of the East-Delhi hub

software-based system to reduce processing time, thereby enabling a fast-paced (re) development to take place.

East-Delhi Hub: The Karkardooma Project

The Delhi Development Authority proposes to develop a green field TOD project on 30 ha of land near Karkardooma area. Two major metro lines pass through the proposed site. It is strategically located near Anand Vihar ISBT and the railway station. The entire complex will act as an integrated passenger terminal for the entire East Delhi area and the NCR. The entire project is proposed to be developed on the TOD principle as stipulated in Chapter 12, 'Transportation', of the Delhi Master Plan. It is named as an 'East Delhi hub'. It will be developed as an integrated commercial/offices/ residential complex.

Energy Conservation Strategy

Building blocks are oriented in such a way that every block gets at least two hours sunlight even on the shortest of winter days, the winter solstice. Planning and design based on TOD principles

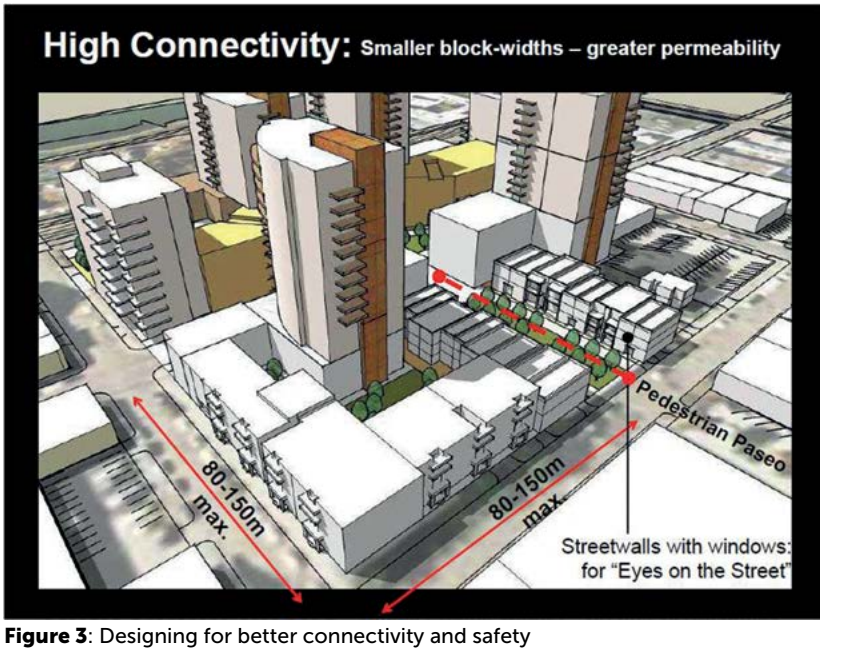


Figure 3: Designing for better connectivity and safety

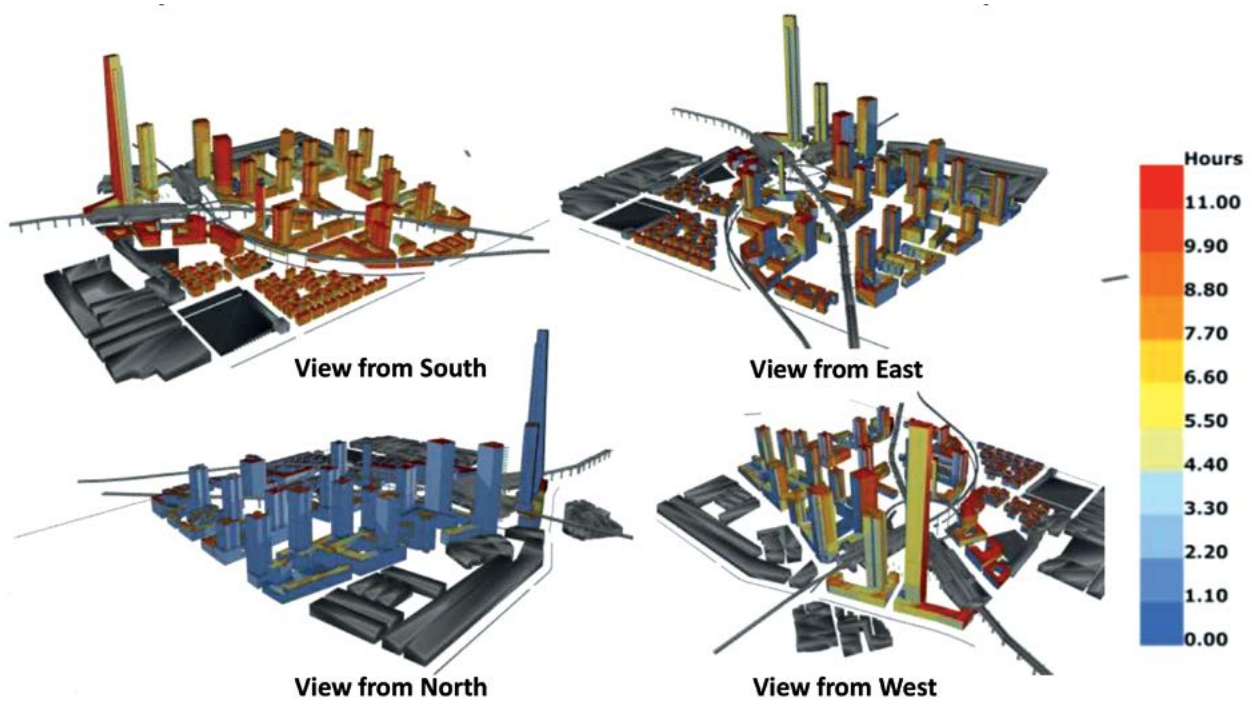


Figure 4: Views showing the number of hours of daily direct solar insolation on all façades on December 21

provides an opportunity to create energy-efficient buildings.

Conclusion

Residential and commercial buildings and vehicular transportation are the biggest contributors of pollutants in cities. Construction of tall concrete buildings with huge glass façades and reduction in open spaces have resulted in the absence of optimum, diffused natural light and ventilation. In case of most of the modern buildings, about 70% is utilized for lighting and air conditioning. Similarly, in the transportation sector, old buses must be replaced with electric and hybrid buses to control the polluting emissions occurring due to outdated machinery. Introduction of the BRT system in cities supported by TOD development in the surrounding areas will increase commuters in public transport.

Urban sprawl is always associated with large carbon footprint, planning tools, such as rezoning and provision of efficient MRTS to encourage TOD in the surrounding areas can discourage an urban sprawl-like development.

TOD has the capacity and capability to herald urban development/redevelopment and regeneration of the urban areas. Central city areas which are congested and lack in community/ open spaces are most suitable areas for TOD-based planning and redevelopment. Participation of local residents and stakeholders is crucial for the success of the project and to make TOD-based planning sustainable and affordable.

Acknowledgements
The author would like to acknowledge the following two sources in writing the article: Master Plan Delhi 2021- Chapter 12 Transportation, Delhi Development Authority 2007 and Delhi an Emerging Megacity Region, by P S Uttarwar, Copal Publishing Group 2016.

> "Global warming is no longer a philosophical threat, no longer a future threat, no longer a threat at all. It's our reality."
> — Bill McKibben

Ministry of Power
Government of India

UJALA
Unnat Jyoti by Affordable LEDs for All

EESL ENERGY EFFICIENCY SERVICES LIMITED

SWITCH KARO, SAVE KARO

PEOPLE HAVE LED THE WAY TO A BRIGHTER & SMARTER INDIA!

FREE REPLACEMENT FOR 3 YRS

Available Only for ₹220

FREE REPLACEMENT FOR 3 YEARS

Available only for ₹ 70

TECHNICAL WARRANTY OF 2.5 YEARS

5 - star rated fans only for ₹1110

Switch to Energy Efficient Appliances! Make India more energy efficient by joining a nationwide movement that has already resulted in the distribution of over 27 crore LED Bulbs, more than 43 lakh LED Tubelights and over 14 lakh BEE 5-star rated Energy Efficient Fans. Take advantage of the UJALA scheme by Government of India, which is a special offer for your home. Tell others you have switched to a smarter lighting solution and say **#ILEDtheWay!**

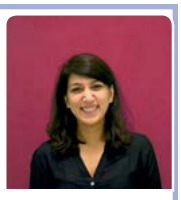
UJALA appliances are available at all DISCOM offices/ billing counters/Post offices/CSC counters and selected Petrol Pumps in your city. Please contact helpline number: **1800 180 3580** or mail us on **helpline@eesl.co.in**

For more information on the UJALA Scheme, visit www.ujala.gov.in and www.iledtheway.in

Passive Façade Design for Energy-Efficient and Cost-Effective Envelope

It is now a well-established fact that our resources are limited; however, our demands are not. The architectural industry, one of the biggest contributors towards GHG emissions and waste, is taking adequate steps to face the challenge and is deploying passive strategies to address these issues. In this article, **Sonali Rastogi**, **Isha Anand**, and **Aarushi Juneja** discuss the ways in which sustainability and affordability issues are closely linked vis-à-vis issues, such as identity and liveability parameters.

Sonali Rastogi, founder–partner at Morphogenesis, has written extensively in diverse areas, ranging from architecture to urban design, landscape, and interior design. She can be reached at: media@morphogenesis.org



Isha Anand, associate at Morphogenesis, has 11 years of experience with specialization in sustainability and environmental design.

Aarushi Juneja, architect at Morphogenesis, has a master degree in sustainable environmental design.

Hamdard, a research-based health and wellness charitable trust, commissioned the design of their 4,000-sq. m administrative and R&D office in New Delhi, India. This was to imbibe their vision and values of innovation, progression, and humility. The budgetary constraints were imposed by the charitable nature of the company where most of the company's earnings are diverted towards humanitarian activities. Therefore, every penny invested in the creation of this project had to be justified. Morphogenesis set out to achieve a cost- and energy-efficient envelope through an integrated design approach, illustrated through the design of this administrative office, set in a composite climate.

The Integrated Design Approach

The matrix of SAIL (sustainability, affordability, identity, and liveability) governs the philosophy of an integrated design approach.

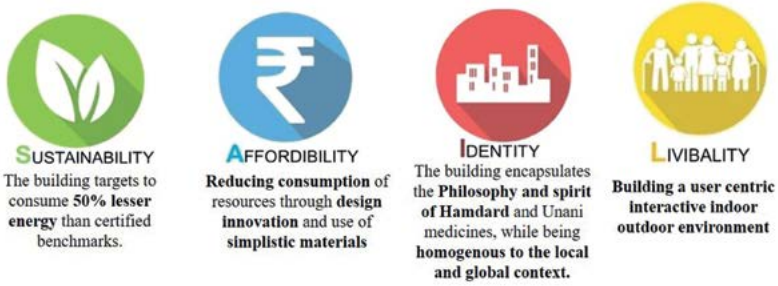


Figure 1: Key parameters for an integrated design approach (SAIL)

Sustainability

The approach of 'No is More', that is, imagining one has no resources at one's disposal, becomes an inspiration for creating truly optimized built-spaces responding to present-day issues of stress on resources.

The implementation of passive strategies at the site level (thermal banking and evaporative cooling) and at building level (thermal mass, glazing optimization, and façade shading), as guided by historical precedents, combined with modern-day techniques, strongly influenced the optimization of the built form making it sustainable.

The overall site comprising 15,000sq. m area for the administrative office and an existing factory in New Delhi explored the potential of being net-zero in terms of water consumption and energy.

The carrying capacity calculation for the site suggested a potential of rainwater collection at 4,695 cu.m/year. This, along with recycling of grey water through a bio-digester was sufficient to meet the water demand for the entire office comprising 200 people. The annual energy of this building has been targeted at an EPI of 45 kWh/m^2/year (HVAC, lighting and equipment load). As compared to a conventional building, passive methods are known to result in reducing the electricity demand. Further, the integration of renewable resources to offset the energy demand, presented a requirement of a 2,100 m^2 solar farm to be net-zero on energy.

Affordability

Affordability in terms of capital investment was a key component of the brief that led to the use of simplistic materials (brick and concrete), along with locally skilled labour to ensure cost control. Site optimization by working with the existing site levels into the built form led to material reduction. Passive design methods and resource optimization led to cost optimization of both construction and operation cost, thereby further enabling an economized investment in renewable resources.

Identity

Historical precedents in the region suggest that the architecture itself was a response to the harsh climate and a lack of availability of resources. Delhi and the immediate site context continue to inspire designs since precedents suggest that the architecture itself was a response to the harsh climate and a lack of resource availability.

- *Baoli* (stepped well)

A dipped site filled with trees presented the possibility and potential of using sunken courts for creating spill-out spaces for the office. An N-S oriented rectangular volume was formulated to minimize the exposed surface area which was raised above the ground making use of the existing excavated area to create an underbelly. This is banked with earth on all four sides and shaded by the building above thus creating a microclimate

Section the building with a series of stepped sunken courts.

Plan of the Building showing the workspace punctured with courtyards.

Figure 2: As compared to a conventional building, passive methods are known to result in reducing the electricity demand in courtyard planning

with reduced perceivable temperature inspired by Agrasen's baoli. Further, the use of water bodies explore the potential of evaporative cooling in the hot and dry summer months to enhance outdoor comfort, and double up as an amphitheatre when these are to be drained out (warm–humid monsoon months).

Courtyard plan has been a predominant and prevalent microclimate control feature of the historic Mughal architecture in hot–dry regions of the country which in turn influences the architectural planning of the office. The central courtyard concept has been taken to the next level to create a pixelated plan format with greens and workspaces.

The two-storeyed main office block with a 71 × 31 m footprint has been broken down resulting in creating alternating solids and voids. The solids become work halls while the voids provide visual breaks which allow for daylight and air penetration. This also helps in generating a healthy working environment for users in terms of daylight and indoor air quality, thus increasing their productivity. The series of courts have been optimally punctured into the work hall with a span of not more than 6 m from the work space and with no work desk more than 10 m away from an accessible court with operable windows. The end result is that the entire floor plate is 90% naturally lit. The office has been planned in an open format with collaborative zones to encourage team interaction. It has been designed for a modular efficiency using a 7.5 × 10.5 m structural grid that not only accommodates the multiple workstation modules and departmental organization while being adaptable to future changes, but also optimally fits the car parking bay below the main office block, thereby ensuring minimal wastage in a resource-intensive yet relatively non-contributory area. The internal self-shading courts with a resultant modified microclimate act as an extended workspace, thus reducing the need for enclosed areas.

- *Jaali*

The jaali or the *musharabiya*, a perforated skin inherent to Mughal architecture, is used to moderate the incoming natural light, which could be harsh most of the time, allowing proper ventilation. Thereby it becomes a second skin which acts as a thermal buffer between the building and its surroundings.

Liveability

Building a user-centric environment is extremely critical in making a design successful. As discussed above, the precedents so interpreted in the project along with modern-day techniques link to the liveability and well-being of employees.

Fresh air, daylight, minimal noise, and a steady temperature are the four main factors for a productive work environment,[1] and yet many people spend their working week sitting in sealed up, stuffy offices that are dim and dingy thus severely affecting their productivity and increasing the absenteeism rate. The design aims to develop a strong indoor–outdoor connect which is deeply rooted in the Indian social psyche, but often does not find expression in the workplace. Nowadays, with blurred boundaries between our work and private lives, the aspect of making our workplace more liveable gains utmost importance.

Façade Strategy

Value engineering is a harsh reality, particularly in the context of emerging economies such as India where projects are highly cost-sensitive and can manifest at any stage of a project. Bearing this in mind, the façade treatments are integrated as an extension of the structure of the building. This integrated façade design approach ensures that the vision of the architect is followed through till the completion of the project.

Energy Efficiency

The application of passive strategies through façade design targets the reduction of solar heat gain by the envelope whilst providing a 90% day-lit workspace and reducing its operational cost for lighting and air conditioning. An optimum balance between solar control and daylight has been achieved to design a user-efficient built environment.

Shading, glazing area (WWR, i.e., window-to-wall ratio), and building materials determine the performance of the façade. These three elements are analysed and optimized to determine the best solution for the project. For shading the external façade, the vertical fins and horizontal overhangs need to be optimally spaced as per the various orientations. A solar analysis determined the optimal width to depth ratio (1:1) of shading devices for maximum solar control during the hottest period for all the four orientations.

As per ECBC,[2] the WWR should preferably be ≤ 40% for this climate. The cumulative heat gain from the envelope was calculated to assess its thermal efficiency with a 40% and 30% WWR and

1 Henley J. 2014. *The Secret to Healthy, Productive Workplaces, Human Spaces-Spaces Designed with the Human Mind.*

2 Energy Conservation Building Code-2007. 2008. Bureau of Energy Efficiency (BEE), New Delhi.

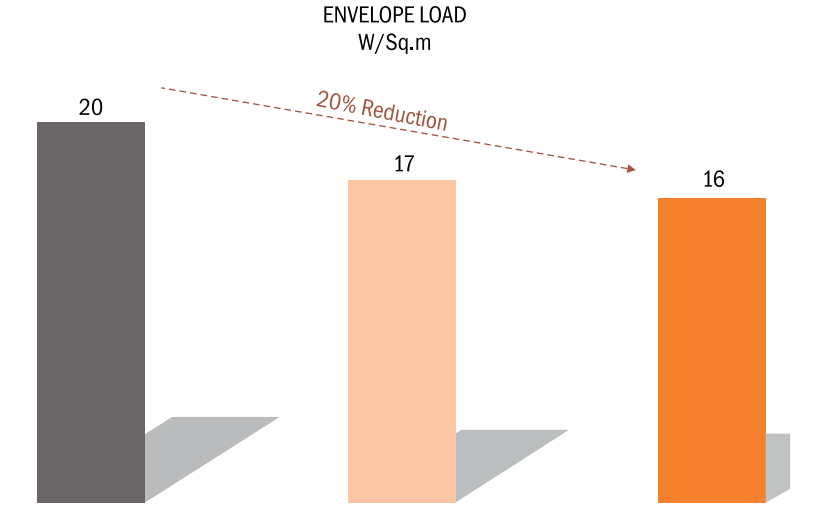


Figure 3: Thermal efficiency of façade

façade shading parameters at an indoor operative temperature of 24 °C. The solar heat gain from the envelope was seen to drop by 4W/sq. m by the dual strategies of reduction in the glazing area and façade shading.

The humble brick is expressed in a cavity wall format to provide insulation as well as internal and external thermal mass.

Cost Optimization

- Wall and glazing

Cost constraint being an extremely critical criterion, the potential of cheap, local, and easily accessible materials and strategies, were explored to achieve the desired performance. The high thermal mass façade was achieved by using a double-exposed brick cavity wall which is economical and low on maintenance. Additionally, it absorbs ambient heat during the day while radiating lesser amounts of heat overnight. An exposed cavity wall with insulation is only about 10% higher in cost as compared to a regular 230 mm-thick brick wall with external plaster and paint.

The 30% WWR has been distributed as long vertical strip windows punctured into the façade, optimized as per the orientation on the outer perimeter, and maximized around the internal courts as they receive diffused sunlight. High-performance glazing can add significant cost to a building, especially when required in larger spans. Therefore, to reduce cost, the panel has been divided optimally in alignment with the interior arrangement of desk height and within standard available spans.

- Shading devices

The jaali, as highlighted above, has been used as a façade strategy to reduce direct heat gain through fenestrations, yet allowing diffused daylight. Brick as a material for jaali proves to be economical with low maintenance and has flexibility to be arranged in various patterns as per the required perforations.

Jaali along with the exaggerated concrete roofs are the primary shading devices. Use of these simplistic and climate-responsive strategies and building materials enable envelope optimization

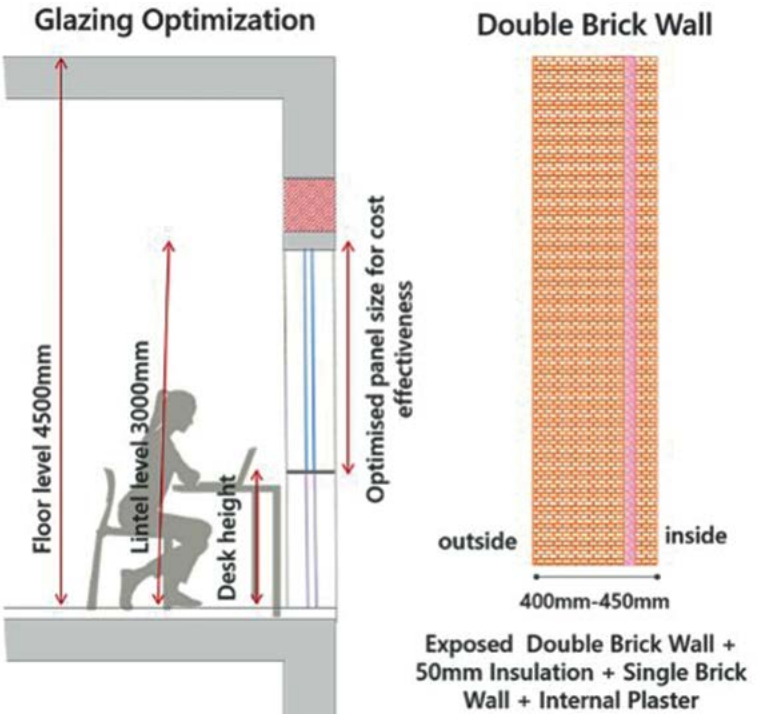


Figure 4: Wall and glazing section

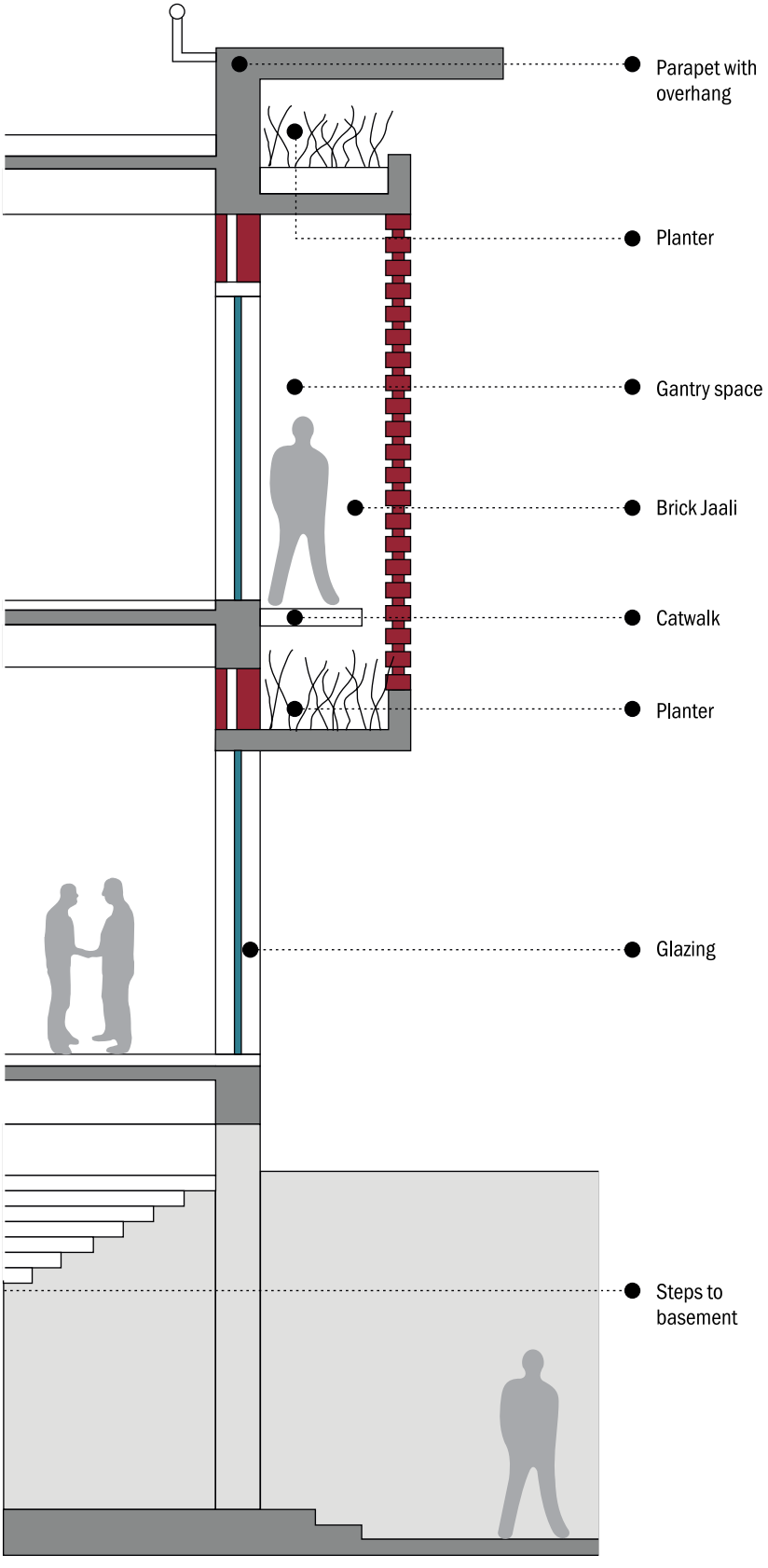


Figure 5: Typical wall section

not only in terms of energy but also in terms of construction cost (260 €/sq. m).

Overall Energy Performance

The built form and façade optimization together help in reducing the energy demand of the building. According to the GRIHA baseline, the EPI (energy performance index) for an air-conditioned building of this typology is 90 kWh/m²/yr.[3] Passive strategies, explore the potential of reducing the demand load and, therefore, lowering the EPI to 45 kWh/m²/yr., that is 50% better than the GRIHA baseline leading to a significant reduction in the cooling demand of the building.

A comparative analysis between the energy demand of the building and the area required for PV panel installation, highlights that the reduction in energy demand also reduces the space required for installing PV panels, thus reducing further investment as land is an expensive resource too. With an EPI of 45 kWh/m²/yr., the annual energy demand of the building is about 270,000 kWh, which needs a PV system over 2,100 sq. m. of 210 kWp. The south-facing existing factory terrace has been explored to plant this system. The analysis done by the solar energy consultants also clearly stated that 23% of the investment cost could be recovered within the first year of installation of the system and the total investment could be recovered in less than 6 years.[4]

3 Application. 2010. *Green Rating for Integrated Habitat Assessment (GRIHA) Manual, Volume-3*. New Delhi: The Energy and Resources Institute.

4 Solar Feasibility and Savings Report for Hamdard Administrative office. 2017. Sunfund Renewable LLP.

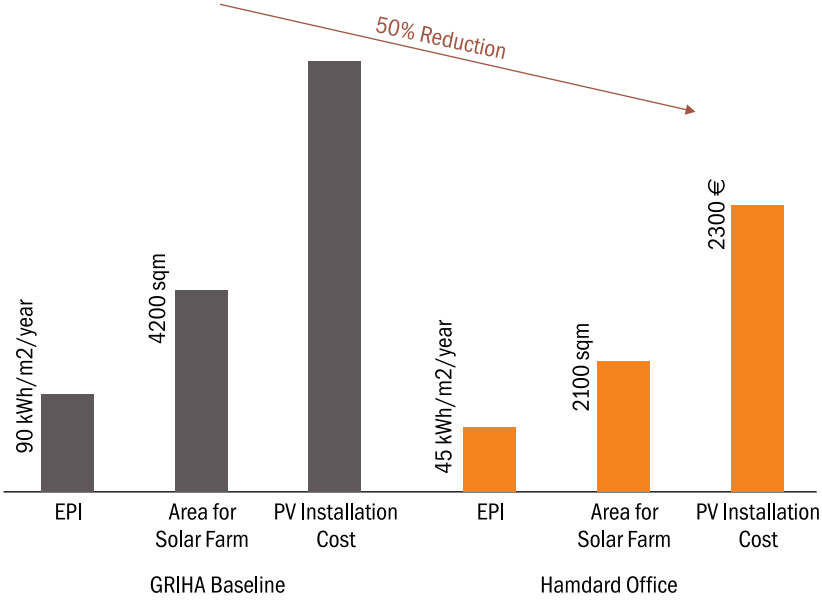


Figure 6: Comparative graph between the GRIHA baseline and Hamdard office targets

Conclusion

This comprehensive design process concluded with an overall cost of construction (civil and façade) at 260€/sq. m. As they say, 'necessity is the mother of all invention', the limitations set by the client in the design brief were used as an opportunity to create a design with an integrated approach of SAIL.

Acknowledgements
The authors would like to thank Ms Rashmi Mandal, Mr Sajid Ahmed, and Mr Shamshad Ali from Hamdard for their support.

Figure 7: A visual of the Hamdard administration office

> "Access to food, clean water, sanitation, education, technology and healthcare are all underpinned by affordable and clean energy."
> — Fuso Nerini

WE ARE THE PERFECT CANVAS FOR EVERY ARCHITECT'S IMAGINATION

At USG Boral we stretch, we bend, we think differently to always Focus on innovation inspired by you.
Our range of products are ushering a new era of lighter, faster, greener, buildings with great aesthetics.

Durock® Exterior Façade Solutions
(With Durock® Brand Next Gen e+ Cement Board)

• Lighter • Faster • Energy Efficient

Plasterboard Interiors
(Drywalls & Gypsum Ceilings)

• Light Weight • Fast Track • Great Aesthetics

Acoustic Ceiling Systems

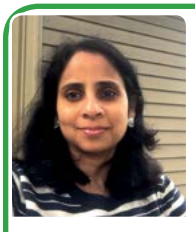
• Variety • Noise Absorption • Light Reflectance

USG BORAL™
INNOVATION INSPIRED BY YOU.™

www.usgboral.com

Providing Sustainable and Affordable Food in Cities

Sustainable living is our target and we are all exploring ways to live and work in a manner that helps us to be in synchrony with nature and coexist with the environment without disturbing it. In this article, **Mukta Rai Saxena** focusses on the issue of fresh food and how we can make its production and consumption more sustainable and affordable in a city.



Mukta Rai Saxena, a freelance architect and landscape designer, has 19 years of experience. After a decade-long stint at Design Cell, a leading landscape consultancy firm, she has been on the GRIHA panel of evaluators since 2012. She can be reached at: Mukta.rai@gmail.com.

The Problem

In today's urban context, the vast amounts of fresh vegetables that are consumed in each urban household, or organization, have their origin at very distant places. As the cities expand, they further push away the agricultural lands that produce the fresh vegetables. As a result, the vegetable produce, more fragile than grains, rapidly lose palatability and nutrition. Large, wholesale markets have been set up at a few distinct corners of the city from where the fruits and vegetables are purchased and transported all across the city through tempo, auto, minivan, and small trucks. By the time these items are purchased and ready to cook, they are already two to three days old and have lost their nutritional value to a large extent. The city vegetables have a greater 'food mileage', the distance travelled by the food to reach the consumer. It is an indication of the impact on the economic, social and, ecological system. Every added food mile means an increase in transportation cost, preservation cost, increase in wastage, and the reduction in nutritional value. It also means that the customer pays much more for the same nutritional value of the item. Vegetables with less mileage are fresh, preserve their original taste, retain nutrients, and are more palatable. They are also much cheaper.

There has been considerable concern in recent years regarding the efficiency of marketing of fruits and vegetables in India. The poor linkages in the marketing channels and poor marketing infrastructure have led to escalating and variable consumer prices, and a fraction of the money reaches the farmers. There is also substantial wastage, deterioration in quality, and frequent mismatch between demand and supply.[1]

According to the report on fruits and vegetables supply chain in India by the Ministry of Agriculture and the Indian Institute of Foreign Trade, 'about 60% of the food is lost in the supply chain from the farm to the consumer.

The traditional supply chain is inefficient and is being taken over by the retail supply chains which are providing better and cheaper services, albeit unsustainable and still very expensive.

Today, we have created large cities that do not generate any food within. How could we be so inconsiderate towards our basic needs? As a result, each city

1 Gandhi V P and Namboodri V N. 2002. Fruit and Vegetable Marketing and Its Efficiency in India: A Study of Wholesale Markets in the Ahmedabad Area; available at: https://ideas.repec.org/p/iim/iimawp/wp00056.html#biblio; last accessed on November 17, 2017.

dweller is forced to eat costly, yet low-nutritional vegetables that are loaded with pesticides, wax, and are poor in taste or genetically modified to last longer. The transportation of food by trucks further pollutes our environment, adds to the cost of produce, and compromises our heath.

The Solution: Growing Food Locally, Sustainably, and Affordably

The solution, though simple, needs awareness. We need to look for opportunities to grow and harvest vegetables locally; also, people should realize the importance and the efforts of growing fruits and vegetables, thereby reducing wastage. Given the favourable climatic conditions in India, where different species of vegetables can be grown round-the-year, the predominant concern in this regard should be cost and maintenance. Apart from the low vegetable costs, there are various other intangible benefits that can be achieved by society, which are as follows:

- Ready availability of fresh produce
- Increased sense of teamwork in a community garden
- Reduced food wastage because the people value the effort in growing it
- Health benefits due to fresh, pesticide-free, and wax-free vegetables
- Health benefits to those who actually choose to work in community gardens
- Better team spirit and sensitivity towards the environment
- Promotion of composting household waste in cities
- Rainwater harvesting on wasteland
- Enhanced sense of ownership and productivity
- Ecological and environmental ethics are learnt
- Vacant lands get transformed
- Reduced heat island effect due to terrace gardening
- Increased food security
- Better mental health

The food can be locally grown in an urban setting through the following means:

Community Gardens

There are various countries in the West that are growing fruits and vegetables locally through the means of 'community gardens'. This idea has tremendous development potential vis-à-vis our cities as well. The Indian cities already have something called 'urban agriculture' that, predominantly, involves individuals growing for their own needs. Even though these are not on a community-level scale, they do help out the urban poor and the

Photograph 1: Community Garden at Midland MI

migrant populations in providing them with food. There is lot of potential to establish community gardens in India.

- *Through Government Incentives*: Some cities have a lot of open waste government lands—ones that eventually turn into garbage dumps. The government should take measures to promote the community gardens for the well-being of the citizens and also for promoting sustainability and food security. The economically weaker sections can be given alternate employment opportunities to work in government parks or empty land parcels in urban areas to grow vegetables. The compost from their own kitchens could serve as the manure. These government lands could be leased out to groups of interested citizens. Neighbours could be recruited to take ownership and help protect the investment. These local advocates serve as the eyes and ears of the neighbourhood. They have the potential to benefit most directly from such a project. The neighbourhood gardeners, master gardeners, agricultural extension offices, and the local botanical garden experts in the area could provide expertise, donate materials, or donate labour. Sponsors and the others, those who can provide political support along with the operating capital, should come together. These projects may include: businesses that contribute to community beautification and highway adoption projects.
- *Through Resident Welfare Associations*: The concept can also be introduced as an option for the group housing residents who could use the common area for such activities. Organized by the resident welfare associations, all residents can get to enjoy nature and its bounties.
- *Through Neighbourhood Schools*: Local schools can take the initiative to set up community gardening areas, thereby letting children learn the procedures first hand. Doing so will also let them understand the efforts involved while enjoying themselves. Children can really benefit from such group activities as connecting with nature at an early age can instil a deeper understanding of various environmental issues; they can also begin appreciating various ecosystems that coexist with farming and help in the sustainable development of cities. Even a global concern such as child obesity can be tackled in a healthy way.
- *Through Cooperative Set-Ups and Other Organizations*: Amul, a cooperative milk industry, along with a few similar cooperatives have been very successful in India. Community

Photograph 2: Container garden
Source: http://balconygardenweb.com; last accessed on November 17, 2017

Photograph 3: Hydroponic vegetable garden
Source: http://www.hamarikrishi.com; last accessed on November 17, 2017

gardens can be established along these lines where like-minded people can come together to work. Newspaper reports showcase achievements in this direction with community gardens coming up all over cities, of which places, such as Rajarhat, Bengaluru, Nagpur, and Puducherry are the most prominent.

Container Gardens, Vertical Gardens, and Terrace Gardens

The cities have space constraints and alternatives need to be explored. In many cities, residents are taking initiative to grow vegetables in container gardens and vertical gardens since the cost of vegetables is sky rocketing in cities. Such motivated people must be given assistance by the community to teach and promote such means. Vegetables, such as tomatoes, radishes, peas, spinach, broccoli, and turnips, can be very easily grown in containers.

Hydroponics Gardens

Hydroponics is an alternate technology that enables growing of vegetables in the minimal soil. Hydroponics technology is a green technology that makes use of the natural plant growth phenomena in obtaining better results from plants. Developed in Latin America, it can be easily adapted in urban areas in the following ways:

- The production system has minimum soil usage and hence is easy to adopt. Planting is done at a convenient height where soil pollution has no impact.
- Plants are grown in various containers or in low-cost natural substrates (sand, rice husk, pumice, etc.). With this system, it is possible to grow a vast range of vegetables, for example, lettuce, tomatoes, carrots, celery, watercress, eggplants, beans, parsley, wild radish, leeks, strawberries, melons, aromatic, and medicinal plants.
- Another advantage is the use of urban spaces which until now had not been considered adequate for growing food (patios, small gardens, party walls, balconies, and rooftops). The water usage is very efficient; water is recycled and does not pollute the environment.
- Pest, disease and weed control can be done by natural herbal methods.
- This provides higher yields in shorter duration. Hence, the total output is greater than the case of conventional soil systems.[1]

Nowadays boutique restaurants also prefer fresh and home-grown produce over stale produce from the market. There are many small home delivery vendors which have already begun providing services in this direction. However, for any concrete results, this trend needs to spread to more individuals and organizations.

Implementation

An idea is as good as its implementation. The architect and urban planners play an important role in improving the local vegetable production. Sustainability can only be ensured if we integrate the areas of food generation in our design approach. This can be addressed in the following ways:

- Projects aiming for sustainability can allocate a percentage of green area to be used for vegetable gardening. The target would be to achieve at least 20% of the requirement on site.
- Green rating systems should emphasize the procurement of food from local venues, thus promoting sustainable and affordable practice by allocating points for the same.
- Projects with a small site area can allocate a designated space where vegetables can be grown using the hydroponics method.
- Group housing societies should create community gardens to promote resident involvement.
- Designated parks could host community gardens for people who do not have any land for this activity.
- Terrace gardens, container gardens, and hanging gardens, all need to be promoted. The need of the hour is to sensitize the people to start growing their own vegetables. The landscape need not be just ornamental, but also productive.
- Schools and institutes should have their own vegetable plots maintained by the students. This could be done by introducing it as a part of the curriculum. The intangible benefits of such an involvement are numerous along with the cost benefits.
- Government-operated shops should promote the techniques and sell heirloom seeds at reduced prices.
- Workshops and volunteering should be done to educate the people about food growing.

Conclusion

We need to focus on growing our food more sustainably, locally, and affordably. Such vegetables and fruits could help us fight the growing food crisis, cost escalations, and give better food security and health along with reduced environmental pollution.

1 Gerieke E W. 2009. 'Your Terrace Could Be Your Farm too'. *Planet Earth*, May: 30–3.

Environmental Impact of Solar Photovoltaic Installations on Urban Heat Island Effect

Energy, in the form of fossil fuels, is the driving force of human life; therefore renewable energy sources such as solar energy are seen as the answer to the energy crisis. However, these are relatively new technologies and might effect the environment negatively. In this article, **Khushal Matai** discusses the possible negative effects of SPV installations, which need further research.

Khushal Matai is an architect with an M.Arch in sustainable architecture. Currently, he is pursuing a PhD from the School of Planning and Architecture, New Delhi. He can be reached at: arkhushal@live.com

Climate Change and Renewable Energy

Climate change has become a highly critical issue as the repercussions have started manifesting all around the world with melting glaciers, fluctuating weather conditions, crop deterioration, etc. A major transformation is required to address these challenges and to avoid catastrophic future consequences. Large-scale conversion to clean, perpetual, and reliable energy at low cost can be a solution to such problems as well as the energy crisis.

A move towards cleaner and greener renewable energies, such as solar, wind, geothermal, etc. has been initiated with an understanding of these issues. It has been predicted that the share of renewable energy in global primary energy sources could increase from the current 17% to between 30%–75%, and in some regions exceed 90% by 2050.[1]

Solar Power

Solar energy has been at the forefront due to its abundance and various technical advancements.

Recent estimates of achievable solar power in the world ranges from 400–8,800 TW given: the current system performance; topographic limitations; and environmental and land use constraints.[2] In 2010, the average global power consumption was about 17.5 TW,[3] so harvesting a few percent of the achievable solar power should be able to provide enough energy for all. It is also one of the few renewable energy sources that can be implemented on a large scale within cities itself. If compared with solar farms, individual rooftop solar panels are a convenient and

1 Turney D and Fthenakis V. 2011. *Environmental Impacts from the Installation and Operation of Largescale Solar Power Plants, Renewable and Sustainable Energy Reviews* 15: 32613270.

2 Oleson K W, Bonan G B, Feddema J, and Jackson T. 2010b. *An Examination of Urban Heat Island Characteristics in a Global Climate Model*, Int. J. Clim., 31, 1848-1865, doi:10.1002/joc.2201 2010b.

3 Oleson K W *et al.* 2010a. *Technical description of version 4.0 of the Community Land Model (CLM)*, NCAR Technical Note NCAR/TN-478+STR.

Table 1: Impacts on climate change from solar power, relative to traditional US power generation[7]*

Impact category	Effective relative to traditional power	Beneficial or detrimental	Priority	Comments
Global climate				
CO_2 emissions	Reduces CO_2 emissions	Beneficial	High	Strong benefit
Other GHG emissions	Reduces GHG emissions	Beneficial	High	Strong benefit
Change in surface albedo	Lower albedo	Neutral	Low	The magnitude of the effect to low
Local climate				
Change in surface albedo	Lower albedo	Unknown	Moderate	Need research and observation
Other surface energy flows	Unknown	Unknown	Low	Need research and observation

cost-effective means of increasing renewable energy generation and decreasing GHG emissions.[4]

Solar Power and India

On a worldwide level, awareness about the renewable energy wave is resulting in huge investments in this field. India itself has ambitious targets for harnessing solar energy.

India's solar market, especially solar photovoltaic, has seen significant growth after the launch of the Jawaharlal Nehru National Solar Mission in 2010, with installed capacity of over 3 GW in just 4 years.[5] According to the Ministry of New and Renewable Energy (MNRE), India has an ambitious target of 100,000 MW by 2022, out of which 40,000 MW shall be rooftop. MNRE has also announced the Rooftop PV and Small Solar Power Generation Programme (RPSSGP) under phase I of the solar mission to encourage grid connected projects.

Driven by various national schemes and the rising energy crisis, solar panels have now started becoming an integral part of rooftops in the urban areas. Solar panels absorb solar energy to produce energy, either in the form of heat (in case of solar thermal panels) or as electricity. Thus, they modify the energy balance of the urban surface in contact with the atmosphere and thus possibly influence the urban microclimate. They also change the radiation received by the roof and influence the overall heat fluxes (radiative and convective) to the atmosphere.

Urban Heat Island Effect and SPV

Rapid urbanization and industrialization have resulted in warmer cities. The urban heat island effect (UHIE) is defined as the rise in temperature within man-made areas.[6] The UHIE intensity is an indicator of urban heating, which is the maximum difference between urban and rural air. It varies between 5 °C to 14 °C within climate zones. Increased temperatures have a negative effect on the health and microclimate , such as increased air temperature, decreased humidity, changed wind patterns, formation of ground-level ozone, heat-related mortality, etc.

In this solar rush, the possible adverse effects of solar PV installations are being overlooked. One of such negative impact is the effect on the temperature in the urban areas due to SPV installations.

Few studies looking into the relation of SPV and heat island effect in deserts as well as urban areas have produced a mixed bag of results. Turney and Fthenakis investigated 32 impacts from the life stages of solar farms which are broadly divided into five sections: land use, human health and well-being, wildlife and habitat, geo-hydrological resources, and climate and GHG emissions. The impacts have been categorized as either beneficial or neutral, with the exception of the 'local climate' effects for which they concluded that research and observation are needed.

PV panels have low reflectivity and conversion efficiency variation between 13%–20% which results in conversion of most of the incident solar radiation, that is 80% into heat which can alter the air flow and temperature profiles near the panels. Such changes may,

4 Arnette A N. 2013. *Integrating Rooftop Solar into a Multi-source Energy Planning Optimization Model*. Appl. Energ. 111, 456–467. Doi: 10.1016/j.apenergy.2013.s 05.003.3

5 TERI, MNRE, and Shakti Foundation. 2014. *Reaching the Sun with Rooftop Solar*, p. 62. Delhi: The Energy and Resources Institute.

6 Oke T R. 1982. 'The Energetic Basis of the Urban Heat Island'. Royal Meteorologica Society 108 (455): 1–24.5

7 Refer to footnote 1

subsequently, affect the thermal environment of nearby living organisms.[8]

In Tokyo, the effect of large-scale rooftop PV installations on heat island effect was investigated and was found to be negligible, provided PV systems are installed on black roofs.[10] However, black roofs are a significant factor/assumption in this study, and if white roofs are considered, then the result could be different altogether. Another study shows that the annual average of air temperatures in the centre of a PV field can reach up to 1.9 °C above the ambient temperature, and that this thermal energy completely dissipates at a height of 5–18 m. Analysis of 18 months of detailed data showed that in most days, the solar array was completely cooled at night, thus it is unlikely that a heat island effect could occur.[11] Although daytime effects will also have some impact on the microclimate of the areas, these cannot be ignored.

Aixue Hu, a climate change research scientist at the National Centre for Atmospheric Research, conducted a study attempting to predict the climatic effects of solar arrays.[12] He assumed a future scenario by 2100 wherein

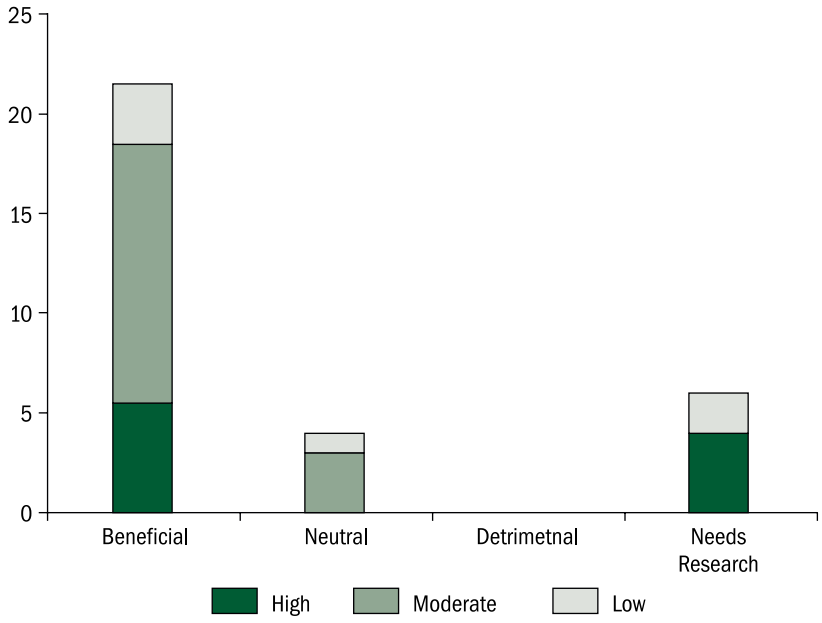


Figure 1: Summary of the aggregate impact of solar power in forested environments compared to traditional US power generation[9]

around 40% of the urban and desert regions will be covered with equally distributed solar panels in the sunny regions all over the world. Their results suggest that idealized, massive-scale installations of solar panels redistribute the incoming solar radiation and change the local radiation balance, resulting in changes in atmospheric circulation, thus affecting regional and global climate. Overall, regardless of its capacity (as large as 800 TW or a more realistic projection of 45 TW), the potential global mean climate changes induced by the use of solar panels are small in comparison to the expected climate change owing to fossil fuel consumption, which, relative to pre-industrial climate, could raise the global mean temperature by a few degrees by 2100. However, some of the regional climate changes induced by solar panels could be much greater than the global mean. For example, India and the West coast of North America warm up by 1 °C. The warming in India is associated with a precipitation feedback on land.[13]

SPV and Their Effects on Buildings Energy Consumption

A scenario of large but realistic deployment of solar panels on the Paris metropolitan area has shown that solar panels, by shading the roofs, slightly increase the need for domestic heating by 3%.[14] In summer, however, the solar panels reduce the energy needed for air-conditioning (by 12%). The air temperature of the study area also reduces by 0.2 K during day and up to 0.3 K at night. In this study, the solar panels affect the indoor temperature by shading and decreasing the energy consumption of cooling/heating. According to Masson *et al.*, the

8 Refer to footnote 1.
9 Refer to footnote 1.
10 Genchi Y, Ishisaki M, Ohashi Y, Takahashi H, and Inaba A. 2003. *Impacts of Large-Scale Photovoltaic Panel Installation on the Heat Island Effect in Tokyo,* in the Fifth Conference on the Urban Climate.
11 Fthenakis Vasilis and Yu Yuanhao. Date. *Analysis of the Potential for a Heat Island Effect in Large Solar Farms*. Center for Life Cycle Analysis, Department of Earth and Environmental Engineering, Columbia University, New York, NY. PV Environmental Research Center, Brookhaven National Laboratory, Upton, NY.
12 Hu A, Levis S, Meehl A Gerald, Han Weiqing, Washington M Warren, Oleson W Keith, van Rujiven J Bas, He Mingqiong, and Strand G Warren. 2015. *'Impact of Solar Panels on Global Climate'*. Nature Climate Change; published online on November 2, 2015. DOI: 10.1038/NCLIMATE 2843.
13 Refer to footnote 12.
14 Masson V, Bonhomme M, Salagnac Jean-Luc, Briottet X, and Lemonsu A D. *Solar panels reduce both global warming and urban heat island*. French Center for Aerospatial Research, France; available at: https://www.researchgate.net/publication/271435900_Analysis_of_the_potential_for_a_heat_island_effect_in_large_solar_farms; last accessed on November 17, 2017.

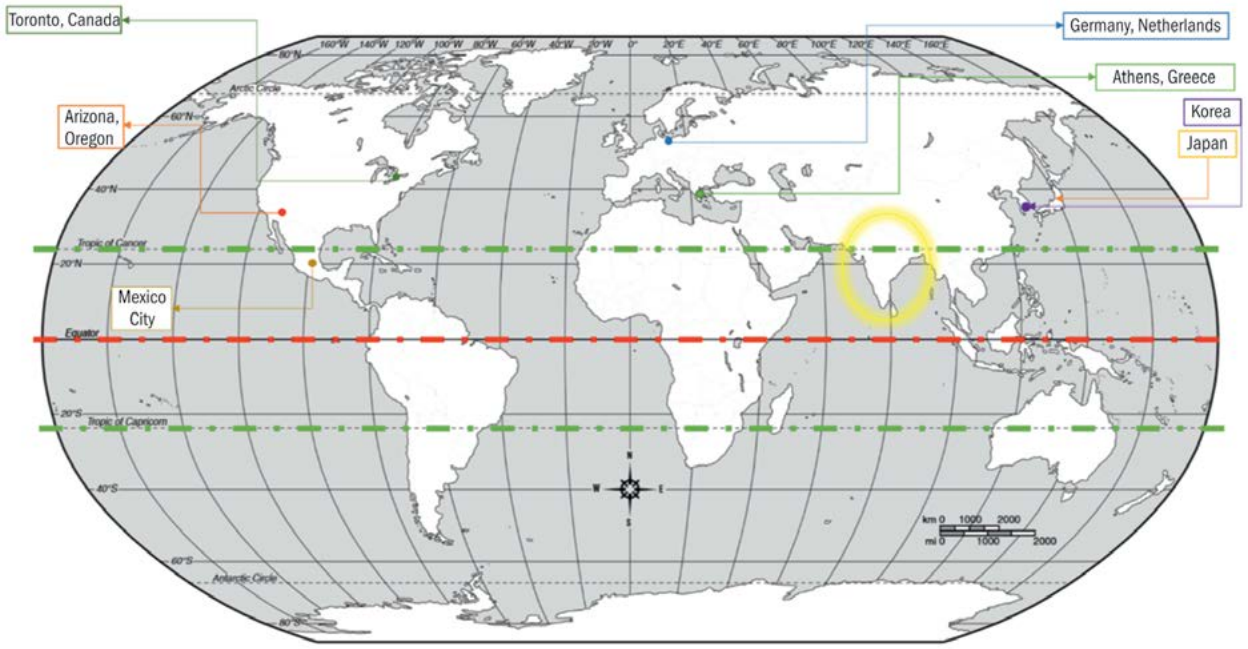


Figure 2: A broad representation of research done all over the world

deployment of solar panels is good both globally, to produce renewable energy (and hence to limit the warming of the climate), and locally, to decrease the UHI, especially in summer when it can constitute a health threat. [15]

Researchers at UC, San Diego, determined that during the day, a building with rooftop solar installations had a ceiling temperature 2.5 °C cooler than that of a roof exposed to sunlight. At night, the panels helped retain the heat absorbed by the roof material, thereby reducing heating costs in winters. For the building, the researchers analysed that the panels reduced the amount of heat reaching the roof by about 38%.[16]

All these studies shed light on the absence of such a study in the highly diverse Indian conditions. With MNRE's ambitious targets, the relation of SPV installations

and UHI has become significant so that the move to control GHG emissions does not trigger another climatic cataclysm. It has become critical to analyse whether the two objectives of mitigating climate change and global warming, that is, solar panel installation for cleaner energy and attenuating UHIE, are compatible.

According to a few research projects mentioned above, installation of SPV on buildings impacts the temperature of the urban areas to some extent. Mostly, all such studies have been done in colder climates (refer to Figure 2), which shows the necessity of conducting such research in tropical countries such as India. The move towards renewable energy is inevitable due to the shortage of non-renewable resources and GHG emissions. Such a large number of solar panels redistribute the incoming solar radiation and change the local radiation balance, resulting in changes in atmospheric circulation, thereby affecting regional and global climate. So it is of utmost importance to understand how SPV installations impact the urban climate of Indian cities.

15 Refer to footnote 14.

16 Earthsky, Surprise Benefits of Solar Panels, viewed 15.12.2015 from http://earthsky.org/human-world/surprise-benefits-of-solar-panels; last accessed on November 7, 2017.

35 years
Delivering Customer Satisfaction. Globally.

BAANI™
real estate & beyond

Delivering Quality with Opulence

With a legacy of 35 years, Baani Group has created a niche for itself in the real estate industry. With an excellent eye for detail, the Group has been successful in delivering optimum luxury and class through all its projects.

Creating Milestones with 15 Projects
Over 2 Million Sq. Ft.
& 1.5 Million Sq. Ft. is Under Development

Baani has surpassed client's expectations across all asset class, including IT Sector, Commercial, Mixed Use Developments, Hospitality, Facility and Asset Management. The group further aspires to create more milestones though its innovation and inventiveness.

Current projects from Baani Group

BAANI CITY CENTER
RETAIL.LIVING.WORKSPACE

ADDRESS 1
1 GOLF COURSE ROAD

Center Point
Add Style To Your Life

info@baani.com

Call: +91 9999599445 | +91-124 - 4222264

www.baani.com

In Conversation with

Peter Head

Peter Head, a civil and structural engineer and an expert in advanced composite technology and sustainable development in cities and regions, has won many awards for his work including the Award of Merit of IABSE, a silver medal in the Royal Academy of Engineering, and the Prince Philip Award for Polymers in the Service of Mankind. He joined Arup in 2004 and established the Ecological Sequestration Trust in 2011.

You have worked on many eco-city planning projects. How is it different from conventional planning practices? Is affordability a relevant factor?

When I joined Arup in 2004 to lead their global effort in integrated planning, we had the opportunity to work on master planning of an eco-city called Dongtan on Chongming Island Shanghai. The eco-city was a new concept then linked to the Chinese government's desire to move to the 'Ecological Civilization' in which pollution, including carbon emissions, were reduced and resource consumption was cut to bring the economy within the planetary boundaries. We went on to work on other eco-cities in Tianjin, Huzhou, Wuxi, Langfang, and Caofeidian.

The main change we had to make in the planning process was to model all the resource flows and pollution created through life in the new city using an input–output life cycle model. We could then try out different mixes of uses and land-use density to match our client's commercial needs and optimize them to meet those performance requirements. We found very quickly that solutions involved running the city entirely on renewable energy, restricting car use, having a network of walking–cycling routes, good public transport, low-energy buildings, recycling

and storing water, and growing food inside the city.

One huge advantage to residents in an eco-city, apart from living in a clean, green, and healthy place, is the low living costs. Locally grown food, low energy and water bills, and the ability to walk and cycle around the city makes life much cheaper. The construction cost was more but the long-term benefits were huge.

Can an existing city become an eco-city? If yes, what would be challenges one might come across?

In 2008, I presented the Institution of Civil Engineers Brunel Lecture around the world and in this I analysed how all the cities could move to this ecological age through retrofit and new construction. I found that the existing cities could be retrofitted using public–private partnership investment. Private investment in reducing the energy demand in buildings and installing solar energy generation on rooftops and storage batteries could get a return and centralized coal-fired power stations could be phased out with reduced grid costs. Water recycling and storage could provide water to communities more cheaply as aquifers were depleted, food grown on rooftops and in vertical farms had lower transport costs and was fresher, and electric cars linked to 'pedestrianization' used much less energy and reduced carbon emissions and the resulting cleaner air reduced healthcare costs. The investments will also be instrumental in creating many jobs and will help lift the economy. The problem was that many cities did not have the tools and knowledge to embark on such a radical journey.

Do you think eco-cities can become a reality in fast-developing countries, such as India, considering the fact that problems here are quite unique? If yes, how?

As the economy moves from an industrial to a service one, rapidly urbanizing countries like India can move straight to this ecological age model. This, with retrofit and eco-city design being combined, is a major advantage vis-à-vis economic opportunity. However, new tools and training are urgently needed to enable urban planners, engineers, and architects to work together to deliver these outcomes. The Indian Institute for Human Settlements has embarked on the training needed for both students with a master degree, municipal governments, and the private-sector employees. It is also vitally important that modelling tools are available so that data can be used to support planning and design to deliver the improved overall performance outcomes; moreover, human and the ecological system resource flows and the overall economics need to be included.

Tell us about the Ecological Sequestration Trust.

I set up the Ecological Sequestration Trust TEST UK Charity in 2011 to try to help this transition by providing the integrated design, planning, and decision-making tools for cities, developing and testing them in demonstration regions, and then making them available for free for the whole world to use. The idea was to research and create a feedback-oriented, knowledge-based journey. I thought that unless someone did this, by bringing together the best-possible leading skills from the public and private sectors and academia, the world would continue to struggle to move quickly enough in the right direction. Gandhi said, 'There is no point in running fast unless you are running in the right direction'. We set out to develop a resilience compass to guide the rapid urbanization processes towards a more inclusive, sustainable path, a compass that could be used collaboratively by all the stakeholders in a city and to develop and restore and connect the hinterland.

Do you think the principles of the Trust can be applied to any work in the field of built environment?

The vision and ambition of the

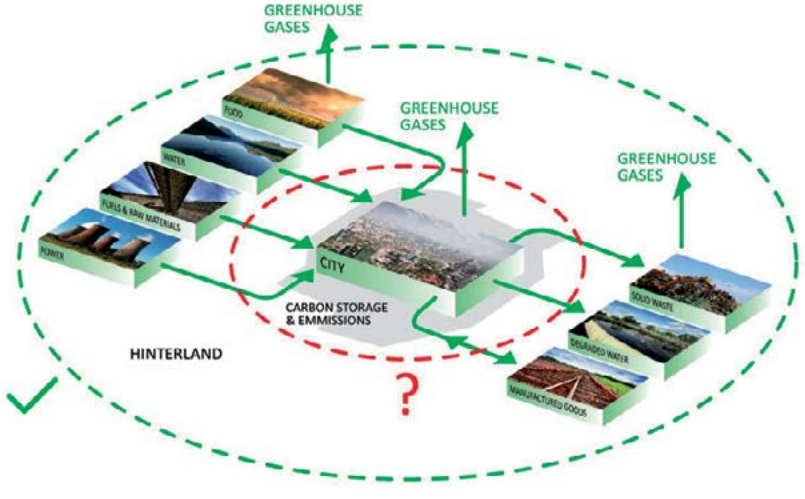


Figure 1: Dependence of a city on its regional hinterland

Trust was huge in that we wanted every region of the world to be able to use the platform, load in free GEO data, combine this with locally sourced demographic and land use data, and be able to take advantage of integrated planning and risk-assessed investment for all sectors of human endeavour.

Who or what do you draw your inspiration from?

My brilliant planning and engineering teams in Arup were my principle source of inspiration and learning. However, I may not have set up the charity without demonstrations of profound change already completed in China and Africa by John D Liu and the UN. They restored vast areas of desert caused by deforestation and brought back agriculture and running water within 10 years and with many new jobs and improvements in lives. These projects greatly increased carbon storage and I chose The Ecological Sequestration Trust name as a reflection of this inspiration and influence, which could also be achieved inside the city, through green infrastructure which slows water run-off, absorbs carbon, cleans the air, and cools the streets so that energy use is lower during summers.

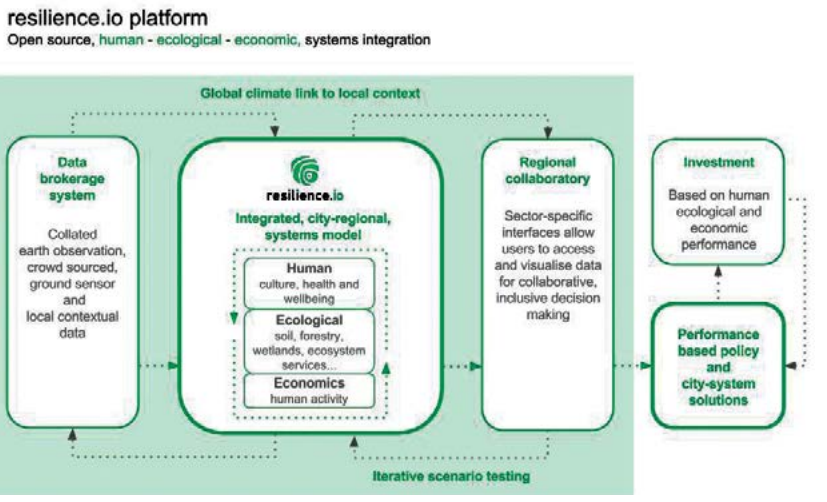


Figure 2: Resillience.io: an analysis and design support tool to model resources flows

Please elaborate on some of your projects on resilience planning in cities and regions.

In 2012 and 2013, we worked hard to try to set up a demonstration region in India in the city of Surat. The Chamber of Commerce was very interested and we held a successful workshop with many city stakeholders to try to move forward, but, in the end, I think it was a little early.

I visited the then Chief Minister of Gujarat Shri Narendra Modi and discussed the idea with him, and he was interested in the potential social benefits. Thanks to the UK government's Department of International Development funding, we built a prototype of the software platform called resilience.io in 2015/16 to enable the stakeholders in greater metropolitan area of Accra GAMA, Ghana, to solve a chosen problem. They decided to use the platform to develop an integrated investment plan to meet SDG 6

Figure 3: Global Resilience: An approach to planning, investment and implementation

by providing safe drinking water and sanitation to all 4 million people by 2030.There were 15 separately governed districts in GAMA and they had not been able to work together to solve these serious problems. The resilience.io platform enabled this to happen and we now plan to go back and roll out the platform to all 216 districts of Ghana at the request of the National Planning and Development Commission. We are also working in Sichuan Province, China, to use resilience.io to help establish a landslide/debris flow-warning system for the valleys in the mountains near Dechang, and China is interested in a wider use of the platform. The platform is also being used in Scotland as a tool to monitor the safety of canal infrastructure and the risks to adjacent populations.

Why do you think it is important for the public and private sectors to adopt sustainable development principles? What would be the way forward in this regard?

Most of the world's national governments have signed up to meet the 17 Sustainable Development Goal targets by 2030. The signing in September 2015, followed by the agreement to adopt the New Urban Agenda at Habitat III in Quito, firmly established the intention to take an integrated planning approach to cities and bring forward project investments which drive these SDG outcomes through public–private partnerships. Eliminating extreme poverty, moving to renewable energy, living within planetary boundaries, protecting cultural heritage, and inclusive green growth are all part of the transition. The good news is that there is enough capital for this to happen by 2030, but it would need at least 60% of the capital to come from the private sector. The way forward is to use tools, such as resilience.io, and take projects forward in an integrated approach, which in turn has been shown to reduce investment costs by up to 40%. This would mean that global investment costs, estimated to be $4 trillion per year, could be reduced by $1 trillion and the savings used to provide better social services.

Do you think there is a role of technology and innovation towards adoption of sustainability in all practices? If yes, what would be the role?

The transition I have described will be made easier by continued development and lowering of cost of renewable energy and energy- or water-efficient technology, hydroponics for urban farming, etc. We intend to enable technology companies to put apps on the 'resilience.io' platform so that the latest technologies can be scenario tested in cities and then purchased, if they meet the local needs. This will provide revenue to keep resilience.io maintained as an open-source, free-to-use planning platform. Smart cities are being talked about a lot. For me, a smart city is one where all the people with their many skills and needs are using their skills and steering their consumption and lifestyles towards a more sustainable and resilient outcome. Technology can facilitate this, but in the end it is about how people live and what choices they have and make that determines success. Insurance and cash management are other important facilitators that also need to have smart dimensions using technology.

How do you see the government policies in regard to sustainable development—a hindrance, an opportunity, or both?

What is needed is a smart partnership between national and municipal governments, working with the private sector and academia, to enable the transition I described to happen. With a platform like resilience.io, decision making, locally, can be better steered, and it should mean that national government intervention around SDG delivery could be less interventionist over time. The approach is set out in detail in Roadmap 2030. We will explore the role of government policy with our 'Resilience Broker 200 demonstration city region programme', proposed to be set up all over the world in the next 5 years. This will be a great learning opportunity and we intend to share the findings through a research and feedback process. We want to quickly set up an Indian demonstration region within this programme.

How do you feel about being cited by *Time* magazine as one of 30 global eco-heroes and what future plans do you have towards this endeavour?

When I was cited by *Time* magazine in 2005 as one of 30 global eco-heroes, I felt a great sense of responsibility was placed upon me and that was partly why I set up the Ecological Sequestration Trust in 2011. Now that we have demonstrated the resilience.io platform, we plan to develop it fully and scale its use to the whole world by 2030, starting with the 200 regions, hopefully one in every country. By 2030, we would like to reach 10,000 city regions and all 5 billion people living in urban areas, and through this, to try to help them all live happier, more resilient, and fulfilling lives.

Higher performing façades

thanks to dynamic solar shading

Somfy believes in smarter buildings with happier and productive occupants. We are committed to significantly improving the performance of façades by automating solar shading with intelligent controls and motors. Because each building is unique and needs to adapt to occupants' requirements during its lifetime, Somfy provides flexible and scalable solutions for all solar shadings and building types.

As your project partner, Somfy supports you from the specification stage through to project completion. Intelligent building controls through our animeo product range, market leading motors and a service offering tailored to your needs make Somfy your ideal partner for projects.
Let's talk about it and plan your project together !

To know more:
www.somfy.co.in/projects
india@somfy.co.in
+91 11 46111500
+91 99 71356622

somfy® Building happiness

Affordability of Sustainable Supply of Potable Water in Urban India

India inhabits 17% of the global population and 15% of the livestock. Broad estimates show that about 80% of India's surface water is polluted, thereby resulting in losses over $6 billion, annually, to water-borne diseases.[1]

According to a recent UN report, India is projected to add 300 million new urban residents by 2050.[2] In this article, **Dr Arvind Kumar** discusses the various facets of the formidable water crisis.

Dr Arvind Kumar is a renowned water activist and environmentalist. He has provided new impetus to the water and environmental movements in India. He specializes in an ecosystem-based adaptation, water-energy-food nexus, and community-based integrated water resources management approaches. He can be reached at: drarvind@indiawaterfoundation.org

The Looming Water Crisis

Water is a finite resource which is already becoming scarce in the wake of burgeoning population, urbanization, and industrialization coupled with the rapid depletion of groundwater, melting and shrinking of Himalayan glaciers, and the pollution of surface water resources. According to broad estimates, the annual availability of freshwater in India from rainfall, snowfall, and glacier melting in terms of volume works amounts to 4,000 billion cubic metres (bcm). A sizeable part of this is lost through evaporation and evapo-transpiration and runoff, thereby reducing the availability of freshwater to about 1,953 bcm and usable water to 1,123 bcm. Lamentably, only less than 20% of the rainwater is used effectively and a substantial part enters the oceans via rivers. Of the 1,123 bcm usable water, 728 bcm is derived from surface water and the remaining is contributed by groundwater.[3]

Currently, agriculture is the biggest consumer of water followed by industry and domestic use. There has been a phenomenal growth in water demand followed by a corresponding decline in the availability of per capita water over the years. In 2006, water consumption stood at 829 bcm which is likely to increase to

1 Bose P and Srivastava P. 2017. *Water Supply for Urban Poor in India*, New Delhi: Water-Aid India.

2 UN Habitat. 2016. *World Cities report 2016: Urbanization and Development-Emerging Futures,* Nairobi, Kenya: UN Habitat, available at: https://unhabitat.org/wp-content/uploads/2014/03/WCR-%20Full-Report-2016.pdf; last accessed on October 27, 2017.

3 Government of India. 2009. *Background Note for Consultation Meeting with Policy Makers on Review of National Water Policy,* New Delhi: Ministry of Water Resources; available at: http://wrmin.nic.in/writereaddata/NationalWaterPolicy/background_note_NWP2002717577543.pdf; last accessed on October 30, 2017.

1,093 bcm in 2025. The availability of per capita water, which stood at 5,177 million cubic metres (mcm) in 1951, witnessed a drastic reduction in 2001 when it stood at 1,820 mcm per year, and by 2025, the per capita water availability is likely to be further reduced to 1,341 mcm and to 1,140 mcm by 2050.[4]

Dr Hegde opines that in a scenario where water is needed extensively for multiple purposes, the situation is regarded as a water-stress condition, that is, when the per capita water availability ranges from 1,000 to 1,700 mcm per year, and in the eventuality of reduction in the availability, that is 1,000 mcm or below, is considered as water scarcity. In India, water availability is contingent on wide variations in rainfall, groundwater reserves, and the proximity to river basins. This carries the potential threat of rendering most states hard pressed for water or reaching the critical water-stress condition by 2020–25.[5] Water scarcity coupled with the uncertainties of climate change will vastly affect water security along with food security and energy security and impact the industrial and economic growth, especially in the urban areas in a considerable way.

Issues in Urban Water Supply

In recent years, there has been substantial improvement in making water accessible to the people in the urban areas. The access to improved water sources, which stood at 72% in 1990, increased to 88% in 2008 and, as of 2015, the access to

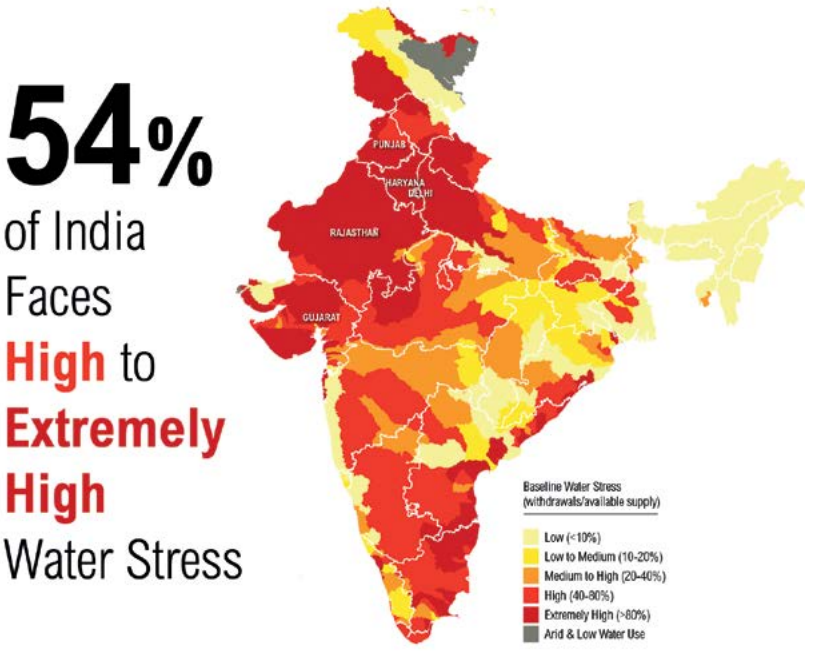


Figure 1: A major part of India (54%) faces high to extremely high water stress

clean potable water became almost universal.[6] Despite the improved accessibility to water sources, water supply in urban India is confronted with challenges, such as inadequate infrastructure, pollution of surface and groundwater resources, inadequate mechanism of recycling wastewater for reuse, lack of convergence and synergy between different departments/ ministries dealing with water, and a lack of investment.

The growth of water infrastructure in India has fallen out of step with the rapid expansion of urbanization. Poor maintenance, leaky distribution networks, and theft culminate in large amounts of 'unaccounted water'. In one of its 2013 audit reports, the Indian Comptroller and Auditor General of India pointed out that New Delhi was losing 60% of its water supply owing to these reasons. Concurrently, local government institutions in charge of administering and maintaining the infrastructure are falling short of fiscal resources to carry out their functions. According to one opinion, low prices are often cited as contributing to this problem, as they make it difficult for local government bodies to fund repairs and expand water infrastructure.[7]

The lack of synergy between various ministries/departments at the centre and state levels dealing with the water sector is also cited as an important factor impeding urban water supply. Undoubtedly, the water policy model framed by the centre is expected to serve as the cornerstone for state governments to develop their respective state-level water policies, but such policy frameworks often fall short of the kind of synergy needed, thereby resulting in duplication of work, squandering away of

4 Hedge N G. 2012. *Water Scarcity and Security in India*, available at: http://www.indiawaterportal.org/sites/indiawaterportal.org/files/waterscarcityandsecurityinindia_nghegde_baif_isc_2012.pdf; last accessed on October 30, 2017.

5 Refer to footnote 4 .

6 Piesse, M. 2015. *Water Security in Urban India: Water Supply and Human Health*, Australia, available at: http://futuredirections.org.au/wp-content/uploads/2015/09/Water_Security_in_Urban_India_Water_Supply_and_Human_Health.pdf; last accessed on October 30, 2017.

7 Refer to footnote 6.

fiscal resources, and emphasis on wrong priorities.

Pollution of surface and groundwater resources, especially due to the discharge of untreated sewage is another issue facing the urban water supply. According to a 2007 report by the Central Pollution Control Board (CPCB), there exists a big gap between the generation and treatment of domestic wastewater in the country and the problem is not merely confined to a lack of sufficient treatment capacity, but also that the existing treatment plants either seldom operate or are poorly maintained.[8] It is further pointed out in the report that the bulk of government-owned treatment plants remain closed most of the time owing to improper design or poor maintenance or lack of reliable power supply or poor management. In such an eventuality, the wastewater thus gets accumulated in the urban areas, thereby causing unhygienic conditions and releasing pollutants that leach into surface and groundwater.

Towards Sustainability

Sustainable supply of potable water in urban areas calls for conservation and judicious use of water, recycling wastewater for reuse, rainwater harvesting, and enhancing intersectoral synergy. In order to augment the sustainable supply of water in urban areas, it is essential to build the capacity of all stakeholders by sensitizing them to the importance of water conservation, thereby encouraging them to make discerning use of water resources and keep these resources free from pollution. This programme—of capacity building of the stakeholders—can be better facilitated with increased involvement of civil society organizations.

Water is a finite source and an increasing demand for water in different sectors has to be met through available resources. Recycling wastewater for reuse in agriculture and industry—two major consumers of water—can help reduce dependence on freshwater resources. 'As of 2003, it estimated that only 27% of India's wastewater was being treated, with the remainder flowing into rivers, canals, groundwater, or the sea'.[9] The existing scenario of water

8 CPCB (Central Pollution Control Board). 2007. *Evaluation of Operation and Maintenance of Sewage Treatment Plants in India-2007.* New Delhi: Ministry of Environment & Forests, available at: http://www.cpcb.nic.in/upload/NewItems/NewItem_99_NewItem_99_5.pdf; last accessed on October 30, 2017.

9 Wikipedia. 'Water Supply and Sanitation in India', available at: https://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_India; last accessed on October 30, 2017.

pollution calls for urgent steps in bridging the gap between sewage generated in the country and its treatment capacity of sewage per day. New technologies in sewage treatment should be deployed.

According to one estimate, major cities of India generate 38,354 million litres per day (MLD) of sewage, but the urban sewage treatment capacity is only 11,786 MLD,[10] and a bulk of this untreated sewage is discharged in numerous rivers, thereby severely polluting river water. Undoubtedly, the CPCB has established a National Water Quality Monitoring Network to monitor water quality round the year and take adequate steps to maintain the water quality; however, there remains a need for investing more fiscal resources to upgrade and maintain the existing wastewater treatment plants and encourage reuse of recycled water, especially in agriculture and industrial sectors. There is also need for framing industrial water policy on which the India Water Foundation (IWF) has been emphasizing since 2011.

Parallel attention needs to be focussed on envisaging inter-sectoral convergence to avoid duplication of work, bring inter-departmental coordination and cooperation in water-related issues, and save wastage of fiscal and human resources by synergizing efforts in tackling water-related issues in a sustainable manner. The IWF has been espousing since 2009 for establishing a National Water Nodal Agency to streamline water-related issues under a single window and such a step could lead to better interstate, centrestate, and intersectoral synergy in water and other related sectors.

The Way Forward

In order to ensure affordability and sustainability of water supply in the country, some innovative approaches have been tested in India in recent years and these, inter alia, include: demand-driven approaches in rural water supply, and a public–private partnership to improve the continuity of urban water supply in Karnataka. Microcredits is another approach which is typically used to finance household water, sewage connections, bathrooms, toilets, pit latrines, rainwater harvesting tanks, or water purifiers.[11]

It becomes discernible from a World Bank study carried out in 10 Indian states that *Swajaldhara* results in lower capital costs, lower administrative costs, and better service quality compared to the supply-driven approach. It is also revealed from this study that the average full cost of supply-driven schemes is ₹38 per cubic metre, while it is only ₹26 per cubic metre for demand-driven schemes.[12] The costs incurred in this approach, inter alia, include: capital, operation and maintenance costs, administrative costs, and coping costs incurred by users of malfunctioning systems.

Undoubtedly, a World Bank study amply demonstrates that demand-driven approach to water supply is more affordable as compared to a supply-driven approach because the latter is fraught with many hassles; nevertheless, as of 2008, only about 10% of rural water schemes built in India used a demand-driven approach. 'Since water users have to pay lower or no tariffs under the supply-driven approach, this discourages them to opt for a demand-driven approach, even if the likelihood of the systems operating on a sustainable basis is higher under a demand-driven approach.'

In order to enhance the affordability of water supply in urban areas, water and sewer tariffs have been kept low and are subsidized by the government; however, a majority of the beneficiaries of these subsidies are often not the poor. The World Bank has lamented that access to reliable, sustainable, and affordable water supply and sanitation (WSS) service is lagging behind in India. Asserting that no Indian city receives piped water 24 hours a day, 7 days a week, the World Bank notes that water supply services are not environmentally sustainable as a result of which most households are forced to cope with poor water quality and supply. Referring to urban India being at the bottom of most international measures of performance, the World Bank observes that poor managerial and financial autonomy, limited accountability, weak cost recovery, perverse incentives, and limited capacity have led to poor services to customers across the country[13] and this needs serious attention.

10 Kaur R, Wani S P, Singh A K,and Lal K. *Wastewater Production, treatment and uses in India*, New York: UN Water, available at: http://www.ais.unwater.org/ais/pluginfile.php/356/mod_page/content/111/CountryReport_India.pdf; last accessed on October 30, 2017.

11 Refer to footnote 9

12 World Bank. 2008. *Inefficiency of Rural Water Supply Schemes in India.* Washington D C: World Bank.

13 Wikipedia. 'Water Supply and Sanitation in India', available at: https://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_India; last accessed on October 30, 2017.

COOLROOF®

Heat Reflective Paint

Approved by

GRIHA

Listed on GRIHA Product Catalogue

- HIGH SOLAR REFLECTIVE INDEX (SRI) - 122
- REDUCES TEMPERATURE UPTO 20°C
- SAVE AIR CONDITIONING COST UPTO 35%
- EXTREMELY LOW VOC - 1.34 gm/ltr.

ECO FRIENDLY

GREEN BUILDING INITIATIVE

Independently Tested Green Certified Product

Indian Insulation & Engineering

Indian Insulation & Engineering

Head Office : SCF 37, Phase IX, Mohali, Punjab
Phone : 0172-5093735 Mobile : 099150 80488, 098784 66444
E-mail : indianenggs@gmail.com, Website : www.coolroofpaint.com

Water Affordability of Construction Materials

When there is a mention of water conservation in buildings, we, generally, tend to ignore the water content that goes into the production, processing, and manufacturing of the building materials; this, incidentally, turns out to be important. In this article, **Prashansa** discusses how water is an important aspect of the construction industry and how it can be minimized using various techniques and technology.

Prashansa, Assistant Professor, Sushant School of Art and Architecture, has been widely published and has many years of professional experience in teaching, project management, modern building technologies, and building integration and modelling services. She can be reached at: prashansa@ansaluniversity.edu.in

Construction Materials and Embodied Water

Water is utilized throughout the construction life cycle, from the extraction of raw materials, through the various manufacturing stages, construction stage, and in the operation and maintenance stage at homes, offices, schools, hospitals, shops, hotels, etc. Water is also used at the demolition stage. Water in the operation and maintenance stage is generally regulated and monitored for optimization.

Originally, the concept of embodied water was proposed by Allan in 1993, and refers to the cumulative quantity of water used to manufacture a product through the supply chain, that is, the total quantity of water entering a product system.[1]

There are two prominent methods of calculations of embodied water. The footprint network method (FPN) for calculating virtual water is the method used for most of the agricultural products. This concept was developed by Hoekstra and Hung (2002). It can be calculated for a product, person, company, or nation. It is the total volume of water needed for the production of products and services consumed for inhabitants.[2]

The life cycle analysis (LCA) is a common method nowadays. The idea of LCA is to add the material and energy use at every step of product life cycle, from raw mineral extraction to the waste treatment for recycling. LCA is often used to compare different product systems.[3]

The footprint network method is like the whole-to-part analysis, whereas the life cycle analysis is like the part-to-whole analysis of the method. For embodied water calculations, the results in both methods vary, the results from the LCA methods are widely accepted with an advantage of being able to look into the breakdown of the life cycle of the construction material.

While consumptive use of water is defined as: 'Uses or activities where water is not returned to the immediate environment from whence it came because it is evaporated, transpired, incorporated into products or consumed by humans or livestock';

1 Allan J A, 1993. Fortunately, There Are Substitutes for Water: Otherwise Our Hydro Political Futures Would Be Impossible. ODA, Priorities for Water Resources Allocation and Management: London.

2 Wärmark K. 2015. 'Assessment of Water Footprint for Civil Construction Projects'. UPPSALA University.

3 June 2015, Assessment of water footprint for civil construction projects, UPPSALA University. Katarina Wärmark.

non-consumptive use of water is defined as: 'Uses or activities where water is returned to the source from which it was drawn.'[4] The primary source of water for manufacturing the construction materials is also drawn from the main water supply line. A direct extraction is the secondary source from the ground. Other important back up sources of water can be harvested rainwater collected from rainwater run off collected at the sites. Recycled water in manufacturing can be the reused water from one process to the second process. The use of water by the manufacturers of the construction products can be 'consumptive water'.[5]

Limited research and data in this field is available in India. The methods of calculations of the virtual water may vary from the source of the data. Table 1 reflects the most commonly used construction materials in the Indian construction industry and the embodied water quantity.

Embodied Water in Building

- **Case study:** 4 m long, × 8 m wide, and × 3m high single-floor building, the material specification, and the detailing of the material used. The study is done with the purpose of understanding the overall embodied water. The travelling distance of the construction material from the source has not been taken into account.
- **Scenario 1**: Framed structure with RCC footings, 115 mm-thick clay-burnt brick infill wall, vitrified tiles for flooring,

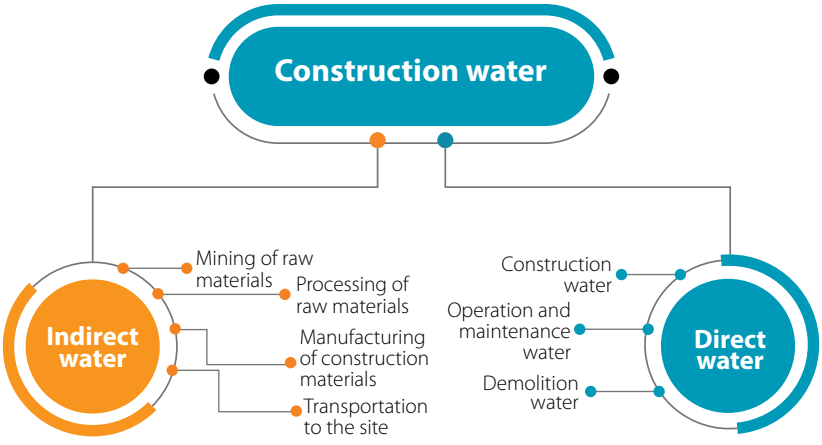


Figure 1: Embodied water vested in construction

Table 1: Classification of building units into different materials and their virtual water consumption*

Building Units	Materials	Virtual Water
Structural system	Concrete structural system (including cement, sand, and steel)	19.8 kl/m^3
	Steel structural system	200 kl/metric tonne
	Load-bearing clay-burnt brick structural system	0.71 kl/m^3
Infill members	Clay-burnt bricks	0.71 kl/m^3
	AAC blocks	0.6 kl/m^3
	Concrete blocks	1.05 kl/m^3
	Dry particle board partition	1.10 kl/m^3
	Sun-dried bricks	0.1 kl/m^3
	Cement plaster	1.05 kl/m^3
	Lime plaster	1.1 kl/m^3
Doors/ windows	Timber	8.530 kl/m^3
	Aluminium	0.88 kl/ Kg
	PVC	1.18 kl/m^3
	Steel frames	200 kl/metric tonne
	Glass	3.42 kl/m^2
Finishes	Paint	1.7 kl/m^2
	Vitrified tiles	1.8 kl/m^2
	Ceramic tiles	1.1 kl/m^2
	Stone cladding	1.08 kl/m^3
	Synthetic stone	8.40 kl/m^3

*Sources:
(a) Meing J and Tang . 2014. 'Virtual Water Accounting for Building: Case Study for E-Town Beijing. *Journal of Cleaner Production.*
(b) Roy Choudhuri I. 2015. 'Computing the Pre-operational Embodied Water of a Multi-storey Residential Complex in Gurugram'. *International Journal of Engineering Research* 4(10): 566–8.
(c) Bardhan S. 2011. 'Ecosystems and Sustainable Development VIII, Assessment of Water Resource Consumption in Building Construction in India; available at https://www.witpress.com/Secure/elibrary/papers/ECO11/ECO11008FU1.pdf; last accessed on November 7, 2017.
(d) Bardhan S and Roy Choudhuri I. 2016. 'Studies on Virtual Water Content in Urban Buildings in India'. *Indian Journal of Science and Technology*; available at http://www.indiawaterportal.org/sites/indiawaterportal.org/files/87671-160525-2-pb.pdf; last accessed on November 8, 2017.
(e) Prashansa. 2017. 'Embodied Water in Buildings: Changing Perspectives to Relearn E'. ARCASIA Forum Jaipur.

4 http://www.constructionproducts.org.uk/media/87904/water_efficiency_report.pdf; last accessed on November 7, 2017.
5 UPPSALA University available at http://www.diva-portal.org/smash/get/diva2:833652/FULLTEXT01.pdf; last accessed on November 7, 2017.

Scenario 1						
S. No.	Item	Numbers	Quantity	Unit	Embodied Water Value	Total Embodied Water (Kl)
1	RCC footing 0.250 m x 1 m x 1 m	6	1.5	m^3		
2	Depth of foundation 2.25 m x 0.3 x 0.3	6	1.215	m^3		
3	Plinth beam 0.3 x 0.3 x 4	7	2.52	m^3		
4	Columns 0.3 x 0.3 x 3	6	1.62	m^3		
5	Beams 0.3 x 0.3 x 4	7	2.52	m^3		
6	Slab 0.1m thick 4 m x 8 m spam	1	3.2	m^3		
	Total RCC		12.575	m^3	19.8 kl/ m^3	248.99
7	Brick work 0.115 m x 4 m x 3 m	7	9.66	m^3		
8	Doors and windows - 2 nos door (2 m x 1m)+ 2nos window (1 m x 1 m)		0.69	m^3		
	Total brick work		8.97	m^3	0.71 kl/m^3	6.37
9	Flooring vitrified tiles 4 m x 8 m	1	32	m^2	1.8 kl/m^2	57.60
10	Synthetic stone outer cladding 8 m x 4 m x 3 m	1	96	m^2	8.40 kl/m^2	806.40
11	Doors and windows steel frame (50 x 50 x 12) angle section		0.0099	m^3	200 kl/m^3	1.98
	Total embodied water					1,121.33

Scenario 2						
S. No.	Item	Numbers	Quantity	Unit	Embodied Water Value	Total Embodied Water (kl)
1	Masonry stepped foundation 4 m × 0.45 m × 1.5 m	7	18.9	m^3		
2	Walls 0.230 × 3 × 4	7	19.32	m^3		
3	Deduct for doors and windows 2 nos door (2 m × 1 m)+ 2 nos window (1 m × 1 m)		1.38	m^3		
	Total bricks		36.84		0.71 kl/m^3	26.16
3	Wooden joists for roof 0.125 m × 0.75 m × 4 m at 1m C/C	9	3.375	m^3	8.5 kl/m^3	28.69
4	Stone roof 60 mm thick (0.06 m × 4 × 8)	1	1.92	m^3	1.08 kl/m^3	2.07
5	Flooring ceramic tiles 4 m × 8 m	1	32	m^2	1.1 kl/m^2	35.20
6	Stone outer cladding 8 m × 4 m × 3 m	1	96	m^2	1.08 kl/m^3	103.68
7	Doors and windows 2 nos door (2 m × 1 m)+ 2 nos window (1 m × 1 m) aluminium frame (1.08 kg/m)		6.48	kg	0.88 kl/kg	5.70
	Total embodied water					201.50

synthetic stone for outer cladding, steel-framed doors, and windows with glass panes. The quantity of the embodied water consumed is 1,121.33 kl.

- **Scenario 2**: Load-bearing structure with clay-burnt brick masonry foundation 1.5 m deep, 230 mm-thick clay-burnt brick, stone slab with wooden joists, ceramic tile flooring, stone cladding, and aluminium doors and windows.
  The quantity of embodied water consumed is 201.50 kl.

Inferences

- Scenario 1 is the general practice of construction typically used for buildings. The standard water consumption in this case is 1,121.33 kl.
- Scenario 2 is the practice of construction with some variations from the normal practice. The chosen method of construction is load bearing. The water consumption for this case is 201.50 kl.
- The water consumption in Scenario 1 is 5.5 times as compared to the water consumption in Scenario 2.
- The major quantity of embodied water is consumed during the construction of the building frame in RCC.
- The choice of materials plays an important role in the total embodied water of the building.
- A conscious decision on the choice of materials and structural system can drastically bring down the embodied water level.
- The difference between the quantities of water consumption of Scenarios 1 and 2 is 919.84 kl. This quantity of water can suffice for 6,813 people for a day considering each individual consumes 135 l of water per day.
- Most of the buildings in and around us are 2–3 floors high. The structural system adopted nowadays are mostly RCC which along with the choice of materials should reduce the embodied water content of the buildings and help conserve our natural resource.

The New Heat Barrier For OLD and NEW Buildings

SINICON PP

Heat Proofing Plaster

Roof · Wall · Ceiling

In use since 1991

Architect | Design FREEDOM

- **No design constrains**
  Any design can be made suitable for tropical climate.
- **Goodbye to trussed roof**
  No need of truss structure and roof tiles/sheet for heat proofing.
- **Aesthetic Friendly**
  Roof tiles, if required, can be mounted on Sinicon PP plastered slope roof or may be designed to suit the environmental compulsions.
- **Design Flexibility**
  Enormous design flexibilities to suit Architect's imagination
- **Light weight**
  Additional floors, structures, fire walls etc. can be constructed using Sinicon PP.

Builder | Execution SAFE & EASY

- **Protects Quality**
  Direct replacement for good quality river sand in plastering.
- **Protects Brand**
  Protects structure from developing cracks due to extreme heat.
- **Save Labour & Time**
  Better labour output, better surface-finish and speedy completion of project.
- **Easy Transportation & Storage**
  Packed and light weight makes handling easy.
- **Save Maintenance Cost**
  Reduce maintenance requirements substantially.

Sinicon PP, a climate control plastering aggregate used like sand in the internal and external plastering (Roof, Wall & Ceiling) of a building. Sinicon PP ensures cool interior in summer and warm interior in winter making it a perfect material for a future compatible building.

User | Life COMFORT

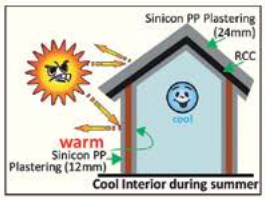
- Cool Interior during summer
- Warm Interior during winter
- Double the life of a building
- No more plaster cracks/spalling due to extreme heat
- Exceptional thermal insulation
- Energy saving "green" product
- Completely fire proof
- Better acoustics - Good for high traffic area
- Vermine and Termite resistant
- Durable & easy to apply
- Ultra light weight reduces high rise structural building costs
- Application same as like sand, no special skill required
- Permanent solution

Roof (RCC Flat or Slope)

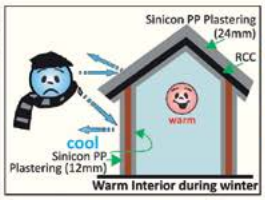
Sinicon PP plaster thickness - Minimum 24mm or as required to suit the climatic condition at the location.
Mix Ratio 3 : 1 (Sinicon PP : Cement)

Internal/External Wall & Ceiling

Sinicon PP plaster thickness - Minimum 12mm or as required to suit the climatic condition at the location.
Mix Ratio 4.5 : 1 (Sinicon PP : Cement)



Cool Interior during summer



Warm Interior during winter

Sinicon PP
~~Sand~~ + Cement + Water = Plaster

SINICON®

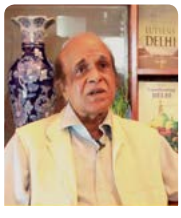
Sinicon Controls (P) Limited

Mobile: +91 94 95 22 11 22 marketing@sinicon.net www.sinicon.net

• INDIA • PAKISTAN • BANGLADESH • SRI LANKA • NEPAL • SAUDI ARABIA • U.A.E. • QATAR • BAHRAIN • KUWAIT • OMAN •

Planning Climate and Disaster-Resilient Habitat

The importance of the Sustainable Development Goals (SDGs) have never been more acutely felt. Designed to improve climatic conditions and our way of life, SDG 11, especially aims at striking the much-needed balance between the economy, environment, and various human needs. In this article, **A K Jain** talks about centrality of habits that are sustainable and inclusive.



A K Jain, as Commissioner for planning with the Delhi Development Authority, has been central in formulating the Master Plan for Delhi 2021. He has received many awards for his contribution in the field of urban planning and architecture. He can be reached at: ak.jain6@gmail.com

Climate change has become an imminent reality with a rise in global temperature, changes in rainfall, floods, droughts, and intense heat waves. A drastic increase in atmospheric concentrations of water vapours, carbon dioxide, methane and nitrous oxide, and other greenhouse gases (GHGs) help trap heat near the Earth's surface.

Given these conditions, the population's health and productivity will inevitably be affected by these erratic changes. In such circumstances, action to reduce the climate change effect must become a priority.

Sustainable Development Goal (SDG) 11 aims to make cities and human settlements inclusive, safe, resilient, and sustainable. Inclusive and sustainable habitat implies decoupling natural resource use and environmental impacts from economic growth. Low-carbon habitat can mitigate GHG emissions and also adapt to the impact of climate change. Mitigation of and adaptation to climate change imply new ways of habitat planning and applications of new technologies and systems for energy, construction, infrastructure development, and transport.

The Quest for Sustainable and Inclusive Habitat

The pursuit of sustainable development requires striking a balance between economic goals, human needs (social, cultural, liveability, and health),

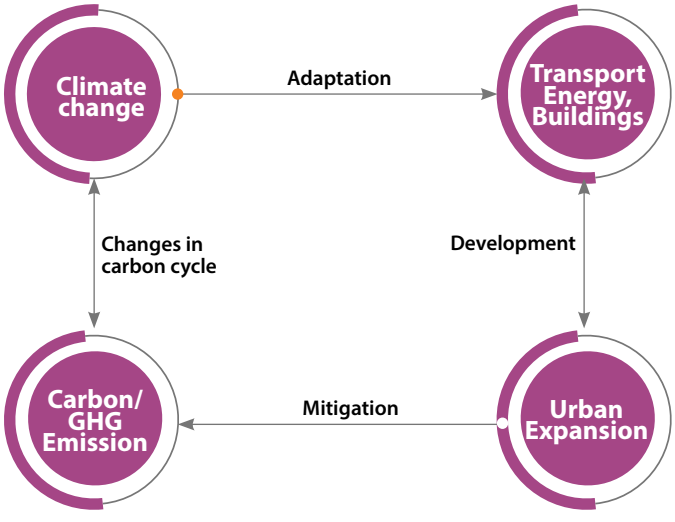


Figure 1: Vicious cycle of climate change
Source: UN Habitat

and environmental integrity. This involves a process of effective citizen participation in decision making. An economic system that is self-reliant and securing ecological basis for development are the prerequisites of sustainable development.

Sustainable development basically means development and human interventions in natural system to the extent of carrying capacity of an area which is the population or level of activity that can be sustained for a given length of time without the depletion of resources or breakdown of biological, natural systems.

Sustainability is a subject which concerns everyone and cuts across various activities, disciplines, and levels. It is thus an all-embracing and complex agenda to plan for. Although disaggregated for analytical purpose, the ecology, landscape, and cultural processes need to be tackled in an integrated manner by sustainable planning and development.

The physical context, that is, the geography, geology, hydrology, vegetation, and climate form the foundation of land use and intensity of activity in a particular site. The urban process—that includes consumption, food production, and energy and waste management—should embody the principle of circular metabolism and recycling which in turn ensures the integrity of the five elements of nature.

Land suitability to be identified for the existing areas or new development should be based on preserving the green areas, conserve fertile land, and protect groundwater recharge areas.

There is an interdependence between natural and built environment, this has been shown in Figure 2.

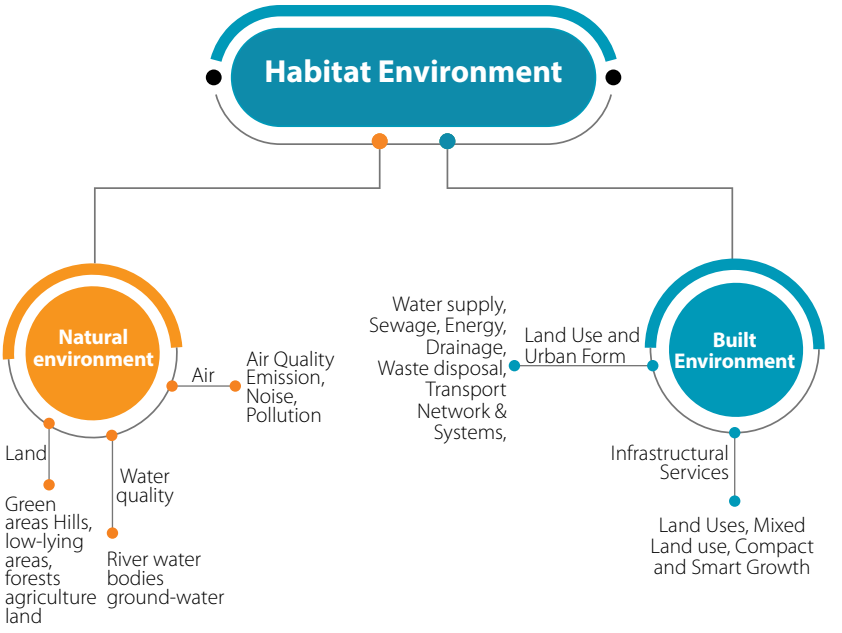


Figure 2: Components of urban environment

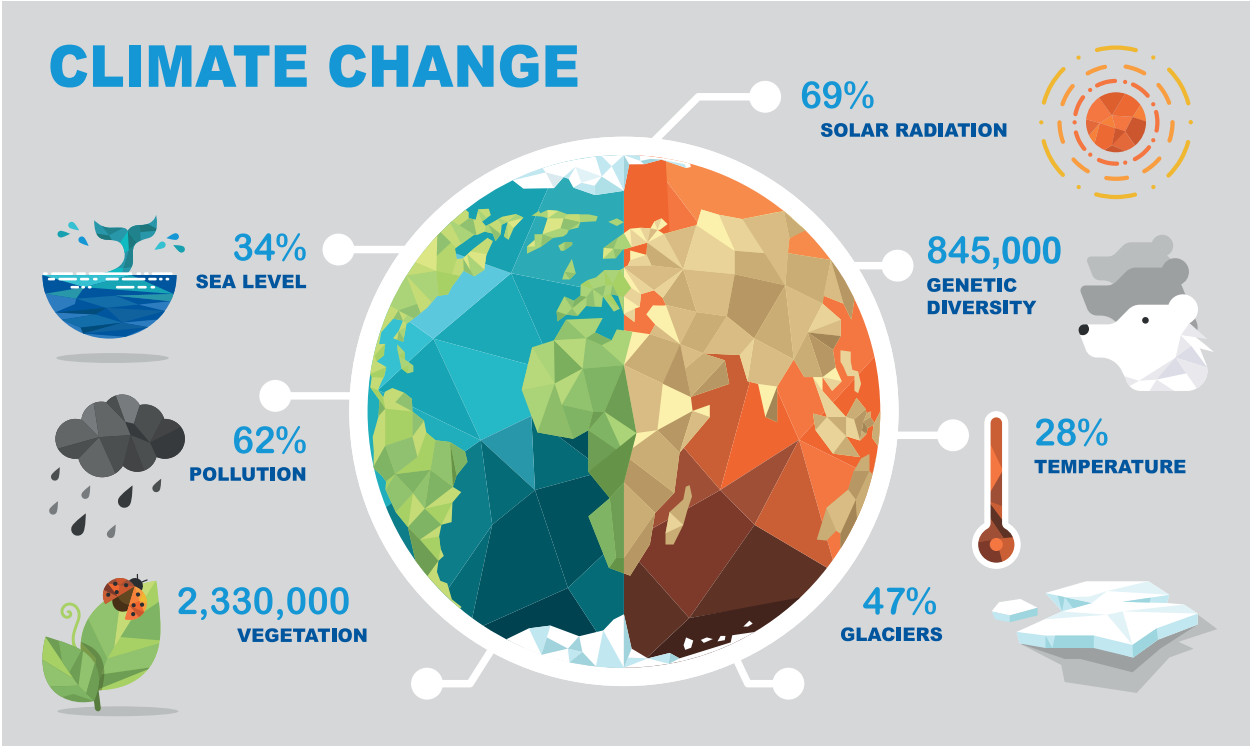
Habitat Design Code

Recognizing the fact that human life, the built form, climate and environment are inextricably interlinked, a habitat design code, comprising the following can be evolved:

- **Spatio-Gravitational Context:** City structures should be commensurate with the dynamics of growth, decentralization of activities, economy of scale, and better quality of life. A higher level of mixed land use, density, and compact urban form based on environmental performance criteria will enable better context setting. A coherent urban form, place making, controlled streetscape, enveloping of inner city areas, landmarks, nodes, pedestrian precincts, and *chowks* (an open market area) and squares are a few methods that enable a wider proliferation and blending of socio-cultural activities and the relationship between commercial and public activities with public transportation. The city context is not complete without built forms that are consistent with historical, socio-cultural context, and the particular potential of an area/region.
- **Local Economic Promotion and Poverty Reduction:** In order to address the needs of the majority of the people, that is, the poor, a major focus area has to be local economic promotion and poverty reduction. A large number of the unemployed are forced to take on informal, illegal, or uncertain jobs, and entrepreneurial potential and developmental opportunities lie untapped. The economic development stagnates, while the vicious cycle of poverty perpetuates. There is an urgent need to focus on the local and regional economy of the city, facilitating micro and small businesses and attracting investments that provide jobs and reduce poverty. At least 10% of commercial area/shops can be reserved for the informal sector (street vendors, food, fruit and vegetable stalls, etc.).

Photograph 1: Internal courtyards can be used to establish natural ventilation

- **Energy:** The concept of energy efficiency, renewable energy and zero-fossil energy development (ZED) can reduce the level of energy demand and slow down the rate at which resources are depleted. Energy efficiency involves a synergy of the various levels of planning, design, construction, and maintenance, leading to a sustainable and energy-efficient regime.
- **Climate Responsive Design:** Water, shade, and channelling of cooling breeze as prime elements for a comfortable microclimate; minimum exterior surface to maximum internal volume and correct orientation; atriums and internal courtyard to reduce glare and dissipate heat, compact grouping and clustering of buildings to minimize exposure of wall surface, and the use of open spaces, platforms, chowks, porch, and squares.
- **Sustainable Transport:** Transport in cities may contribute to nearly two-thirds of the total suspended particulate matter and 18% of carbon emissions posing a serious threat to the environment and health of the people. The objective should be to provide access to people and places by 'green' modes of urban transport. These include walking, bicycling, intermediate public transport modes, bus ways, dedicated bike tracks, CNG-powered vehicles, trains, etc. Inherent in this is the aim to curtail the need for commuting and to shorten the distances by various strategies, such as decentralization of work centres, compact urban form,



by telecommunications, electronic mail, mixed land-use zoning, etc. An important element of policy should aim to shift private vehicle users to public transport. The concepts of walking to work, transit-oriented development, travel demand management and smart growth, promoting non-motorized transport, multi-modal integration, last-mile connectivity, and e-governance are pillars of sustainable urban mobility.

- **Decentralized, Smart Services and Recycling:** Drinking water, sanitation, solid waste treatment, and drainage, are important aspects of our environment. The performance of the existing sanitation system needs to be reassessed with reference to environment, hygiene, and their accessibility. Various alternative technologies based on decentralized services, such as extended aeration technique, biogas production, bubble diffusion process, flotation, anaerobic reactors, etc. which are already in vogue, should be explored for urban sanitation. Widespread method of land filling for solid waste disposal is an environmental disaster. Decentralized systems based on recycling, energy generation, and organic decomposing should be explored for solid and liquid waste treatment. Bioreactor composting and vessel system, vermicomposting, etc. are new-generation technologies for treatment of wastes.
- **Conservation of Surface Water Source:** The rivers and water bodies in urban areas usually have a high level of pollution, which is mainly from untreated sewers and waste from adjacent industrial/urban areas. Besides, the enforcement of the Water Pollution Act, an environment-based strategy as given below, is essential for their improvement:
  - » Linking of the natural water body and river with the population by access and landscape development.
  - » Control of water pollution from various industries, drainage, sewerage, flyash, garbage, and waste dumping.
  - » A drainage and flood control strategy linked with water supply.
  - » Control of land uses which are incongruous with the environment such as coal-based thermal power plants.
- **Watershed Planning**: Revival of the concept of watershed development, harvesting, and conservation of rainwater and groundwater can substantively resolve the urban water crisis. Several technologies, such as decentralized and compact water treatment units, solar/aerobic/oxidation, and root zone cleaning systems, can be employed to purify potable water from natural sources.

- **Vegetation and Organic Life:** In a city, about 10 sq. m of recreational area per capita should be reserved as open space. A system of landscaped linkages connecting various parts of the city, neighbourhoods, and important monuments should be planned. Private and community gardens should provide a sense of oasis and shelter from oppressive climate. Peripheral green belts can be utilized as wind breakers, dust storm filters, and as transition zones.
- **Greenways for Drainage**: The development of greenways along natural drainage corridors and harvesting of rainwater in balancing lakes and ponds has been a new frontier in water management. Instead of resorting to conventional drainage, the concept of 'zero run off' may be adopted by using a series of retention ponds. Such ponds, reservoirs, and sediment traps can be located in the catchment zones on low-lying ground, earmarked for greenery. This system offers distinct advantages over the conventional drainage system, such as replenishment and enrichment of underground water table and augmentation of water reserve, availability of rolling greens, and improving the microclimate.

There is no need for elaborate gardening of the greenways, their wild simplicity should suffice. These act as air filters and bring neighbourhoods together.

- **Sound pollution:** Noise is emerging as a major pollutant and irritant in the Indian cities, causing a number of health hazards. Faulty and leaking silencers, overuse of motor horns, screeching tyres, and the din of rattling vehicles plying on rough roads accentuate the noise level on streets. Besides the noise from commercial and industrial activities in residential zones, unabated use of sound amplifiers, generator sets, and fire crackers often act as impediments to peace in urban areas.

The urban form, land use planning, landscape, and green/noise buffers can help in reducing the noise levels. By proper land use planning, mixed land use, location of public/semi-public and commercial activities along major transport arteries, a buffer can be created for residential zones. The green buffer with thin-leaved trees, land formations, mounds, embankments, etc., can provide effective noise transmission barriers.

- **Climate and Disaster Resilience:** The planning for climate change involves the convergence of various sectors into a strategy and establishes a link between climate change and GHG/CO_2 emissions. The spatial area can be delineated as natural conservation zones based on its vulnerability (coastal areas, cyclone, earthquake, landslide, droughts, etc.). Accordingly, a series of geographically linked and disaggregated regional-district-local-sectoral plans, all telescopically connected, can be developed. However, the focus is on the local action plan which is connected either way, up and down in a geographical scale and also on its sides with various sectoral plans. (Land, water, air, infrastructure services, shelter, public health and hygiene, transport, energy, greenery/forest, tourism, etc.)
- **Gender, Equity, and Safety:** The cities in India have become insecure, crime and danger prone, particularly for the vulnerable sections of the society—the poor, women, elderly, children, and disabled. A study finds that two out of three women have faced incidents of sexual harassment more than once during a year, mostly in public spaces, along roadsides, and while using public transportation. Various initiatives include the setting of rescue and rehabilitation centres, re-integration of victims of trafficking, the setting up of 'one-stop crisis centres', provision of shelters, police desks, legal, medical, and counselling services, and 24x7 helplines. This also needs incremental actions, such as enhancement of street lighting, establishment of 'multi-utility zones' (MUZs), pedestrian safety, safer roads, and the provision of public toilets for women, especially in slums and streets and safer public transport with CCTV and alarm system.

The planning of a city can contribute in crime prevention by gender-sensitive designs of shared, lively, and defensible spaces, mixed land use, and adequate shelter/ tenements for the poor, together with spaces for vending and informal trades that promote livelihood and community surveillance.

It is a fact well known that a habitat impacts the environment and vice versa. It is necessary to readdress the urban process by taking a dynamic and holistic approach, wherein the human element, physical environment, and built form synthesize into a workable equation. The old paradigm of development needs to be reformed within the larger goals of inclusion, equity, environmental sustainability, and climate and disaster resilience.

Learn more at lighting.philips.com

PHILIPS

Advanced Concrete Design: Sustainable and Affordable

Essentially, the purpose of sustainable structural engineering is to conserve energy and resources. With regard to buildings, this can be carried out by the judicious use of materials. In this article, **Saibal Saha**, with the help of examples and scenarios, discusses the ways in which this can be realized.

Saibal Saha, a civil engineering graduate from Jadavpur University, Kolkata, has more than 24 years of experience in building engineering. He can be reached at: saibalsaha2@gmail.com

The term 'sustainability', principally, refers to reduction of carbon emission and after COP 21, almost all the large-emitting nations have pledged to reduce 50% of the current emission by 2050.

There is no doubt that the construction sector is one of the principal contributors of GHG emissions. The Government of India has developed a stringent building energy code, ECBC: 2017, the nationwide implementation of which could help in reducing a substantial amount of GHG emissions. Next in line is the transportation sector for which also the Government of India is deliberately pushing electric vehicles. However, the industrial sector remains the largest emitting sector. We live in an age that relies heavily on industries for various reasons. At the same time, if we do not keep the emissions in check, we cannot possibly reach the desired decrease by 2050.

From the above chart it is clear that the production of five materials contribute to more than 55% of emissions and the top two are steel and cement with 44%

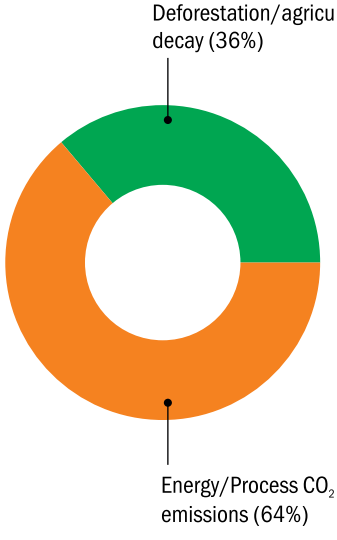


Figure 1: Global GHG emissions

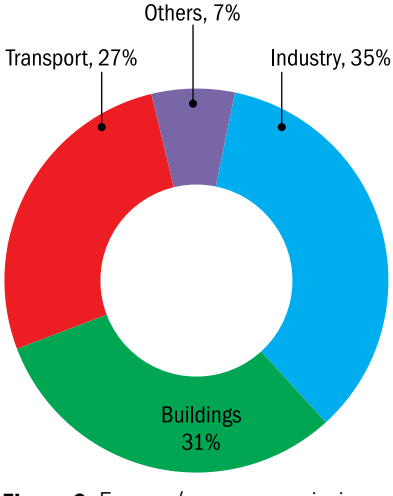


Figure 2: Energy/process emissions

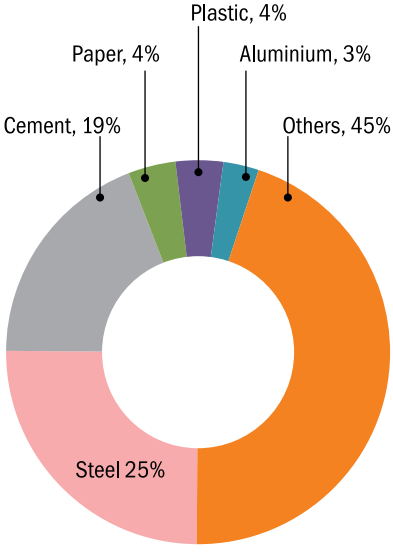


Figure 3: Industrial carbon emissions (10 GtCO2)

contributions. Additionally, out of the mentioned materials, such as steel sheet and bars, these figures are just for the development of basic products. The 'other 45%' is attributed to the manufacturing of the final products (pipes, steel sections, reinforcement bars, car bodies, machineries, wires, ropes, cables, packaging box, cans, etc. for steel and aluminium; ready-mix concrete, and mortar for cement). So the five materials; steel, cement, paper, plastic, and aluminium, are solely responsible for the majority of global emissions either during the manufacturing of the base products or their final derivatives. Table 1 shows the energy intensity and carbon intensity of the said materials.

It has been found that more than 50% of the steel produced globally is being used in construction sector, Table 2 shows the break up.

To reduce GHG emissions, if we disregard the debatable CCS (carbon capture and sequestration) process, the available options are two fold:

- By enhancing the energy efficiency of the production systems, from mining of ores to showcasing the finished goods.
- By reducing the use of material without compromising the strength and stiffness and vis-à-vis the safety, stability, and durability of the system or structure.

It has been researched and concluded that the global manufacturing sectors for steel, cement, and aluminium are already equipped with the best efficiency standards and a further reduction of energy uses or CO_2 emissions would not be helpful in solving 50% reduction by 2050.

However, by reducing the demand and production of materials that consume copious amounts, steel and cement, the energy usage can be monitored and reduced.

Table 1: Energy-intensity and carbon-intensity of the materials

Material	Global Annual Production (Mt)	Energy Intensity (GJ/t)	Carbon Intensity (t Co_2/t)
Cement	2,800	5	1
Steel	1,400	35	3
Plastic	230	80	3
Paper	390	20	1
Aluminium	70	170	10

Table 2: Global use of steel in the construction sector

Infrastructure, 150 Mt (14%)		Buildings, 433 Mt (42%)			
Roads and rail, 107 Mt (18%)	Utilities (fuel, water, power), 43 Mt (7%)	Commercial, 129 Mt (22%)	Industrial, 145 Mt (25%)	Residential, 90 Mt (16%)	Other, 69 Mt (12%)

The following two case studies show the quantity of materials that can be saved with an advanced concrete design systems: the Post-tensioned slab system and PT-voided Bi-axial slab system.

Case I: Post-tensioned slab system vs RC slab system in a commercial building[1]

A few basic design principles are as follows:

- Being a flat surface, a slab must withstand bending.
- Though concrete is a universal construction material able to take any shape, it is weak in tension but much stronger in compression, hence cannot withstand bending stress alone.
- Reinforcement bars (commonly termed as rebar) are placed within the concrete to take the bending in conventional RC design.
- In PT (post-tensioned) slab system, a high-strength (more than three times that of the available rebar) low-relaxation strands/wires are placed within the concrete slab at an appropriate profile. After casting when the concrete gains a stipulated strength, the strands are pulled through

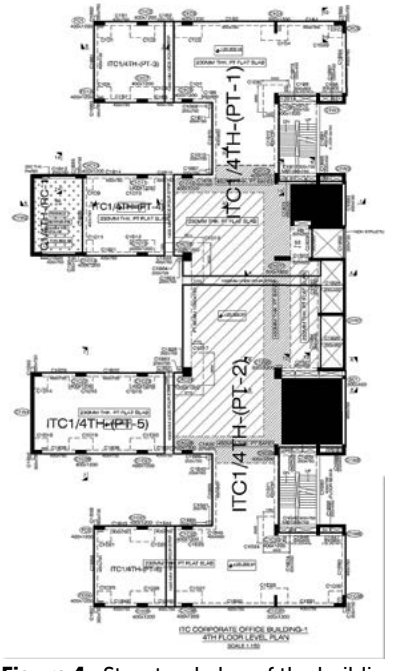


Figure 4: Structural plan of the building

1 The 4th floor of an office building (2-B+G+7 storied) at mixed-use development, an ongoing project of the ITC (Indian Tobacco Company) at New Town, Rajarhat, Kolkata. Usha Martin Ltd. is the PT vendor.

Table 3: Comparison of the slab systems

Structural Systems	Area of the Slab (sq. m)	Concrete Volume (Cum/sq. m)	Rebar Qty. (Kg/sq. m)	PT Strand Qty. (Kg/sq. m)	Extra Cost for PT Slab (₹/sq. m)	Total Cost (₹/ sq. m)
PT Slab System	1,200	0.323	15.00	4.50	180.00	3,258.00
RC Slab System (if designed)	Same	0.363	38.00	Nil	Nil	4,268.00

a hydraulic jack creating a huge compression within the concrete along its section, thus providing an upward force which, when undergoes designed live load, becomes neutralized.

- This way the tension in the concrete section becomes minimal and compression increases two folds, but as concrete is stronger in compression, it withstands the extra compression and reduces the use of rebar substantially.
- The following are the considerations though which the costing for both has been derived:
- Loads: S.D.L. = 4.00 kN/sq. m and L.L. = 4.50 KN/sq. m
- Grade of Concrete = M40; Cost of Concrete @ ₹6,000.00 per Cum.
- Grade of rebar = Fe500; Cost of finished rebar **in situ** @ ₹55,000.00 per tonne.
- Cost of PT strand after fabrication @ ₹70,000.00 per tonne.
- Extra cost for PT slab @ ₹ 40,000.00 per tonne comes from cost of anchorage, sheathing, hiring charges of jacks, pumps, etc.
- The design exercises have been made with the help of a Finite Element Analysis software, ADAPT Builder: 2016.

Sustainability quotients of the PT slab are as follows

- 9.00 kg of less cement per square metre is used corresponding with the reduced use of energy and reduced CO_2 emissions.
- Approximately, 15 kg of rebar per square metre is consumed less resulting in reduced emissions; given that the equivalent of the embodied energy of strand is higher than rebar due to some added metal in the alloy and extra processing power requirements are less consumed vis-à-vis the reduction in emission values.
- Due to the addition of a strong compression transverse to the section of the slab and use of higher grade of concrete for ,early stressing and stripping (a four-day de-shuttering is allowable with an M45 grade concrete), a PT slab becomes crack free (the maximum permissible crack-width being 0.3 mm in Type-III structure and no crack in Type-II is permissible). It enhances the durability as well as the life span of the structure as embedded rebars could not be corroded due to moisture absorption and corresponding oxidation.
- The longevity of structures is of paramount importance in the sustainability quotient to ensure less usage of virgin materials.
- The following is a more concrete value proposition derived from the 'Inventory of Carbon and Energy (ICE) : Version 2.0' instead of some abstract figures:

Affordability quotient of the PT slab is as follows:

A possibility of a whopping 23.66% savings which ultimately resulted in at least 15% exists.

Table 4: Embodied energy and embodied carbon of slab systems

Structural Systems	Embodied Energy (MJ/sq. m)				Embodied Carbon ($kGCO_2$/ sq. m)			
	From Concrete	From Rebar	From Wire	Total	From Concrete	From Rebar	From Wire	Total
RC Conventional Slab System	775.368	820.8	0	1,596.168	1,282.752	70.68	0	1,353.432
PT Slab System	689.928	324	180	1,193.928	1,054.272	27.9	15.795	1,097.967
Percentage Reduction				25.20%	Percentage Reduction			18.88%

Case II: Voided bi-axial PT slab system vs. RC slab system in a residential project[2]

The following is a description of Photograph 1:

- The project is for central government employees' welfare housing organization (under the Ministry of Urban Employment and Poverty Alleviation). The execution status is unknown.
- A typical floor has 10 apartments with 2 principal service blocks (stair + lift) and another 2 lifts for catering to the traffic as per the NBC 2005. The entire floor is accessible through a central corridor. Grid-size columns, 5.00–6.00 m, have been placed for placing parking locations at stilt. Car parking size as per the NBC 2005 is 2.50 × 5.00 (m × m).
- It has been modelled as a 210 mm-thick complete flat slab system without any beams except the staircase and lift shafts.
- The intermediate square blocks are bending zone of the slab and designed as voided system. The rest of the slabs are solid and filled with M40 grade of concrete. All the inside partition walls are 100 mm-lightweight AAC blocks.
- The brown rectangular portions are modelled as cut-outs either for staircase lifts, stairwell, or for ventilation shafts.
- The FEM model and analysis + design has been made with an ADAPT Floor Pro:2016.

The following is a discussion of the principles of a voided PT slab system:

- As explained in our previous case, pre-stressing strands (in combinations is called tendon or cable) reduce the deflection of the slab while the voided system reduces the weight of the structure.
- By embedding the bubbles (∅ 140 mm) within the bending zone of a 210 mm thick RC slab, leaving 19 mm clear cover over the rebars, the stiffness is compromised by 7% while the weight is reduced by 20%. This reduction plays a great role in minimizing the requirement of rebar which is provided to withstand the stress that arises due to the self-weight of the structure. This is to note that in case of residential building, self-weight is almost equal to the load it has to withstand in its lifetime, inclusive of the lateral loads.
- When some voids are left embedded within the structure, it is supposed to be losing some of its monolithic nature; hence, the solid parts of Figure 5 have been developed. These would additionally take the punching shear stress developed around the slab-column junctions as well as allow the PT tendons to compress the entire structure from both the directions.

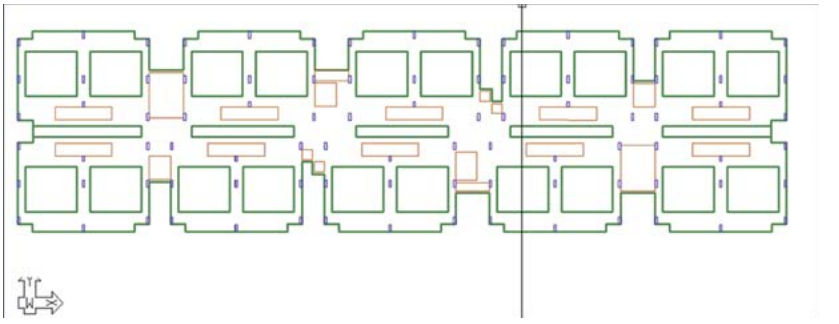


Figure 5: Structural plan of a typical floor of the government housing project, Chennai

Photograph 1: Pictoral elaboration of slab-beam conventional systems and a flat plate voided slab system

We can easily conclude the advantages of the voided PT slab system as follows:

- Increased number of floors within the same height as the depth of beams are eliminated; this is true for the general PT slab system.
- Large span and greater architectural freedom.
- Reduction in the number of columns and foundation structure as the overall load of the structure is being reduced by more than 15%.

2 Typical floor model of a 'Stilt + 10 storied' government housing project in Chennai.

Table 5: The following table shows the cost comparison and derivation of the sustainability quotient of voided PT slab system

Structural Systems	Area of the slab (sq. m)	Cost of Concrete @₹6,000/Cum (₹)	Cost of Rebar @₹550 /ton (₹)	Cost of Extended Polystyrene Bubble @₹10/ Piece (₹)	Cost of Strand @ ₹1,20,000 / tonne (₹)	Total Cost (₹/sq. m)
Slab-beam system	1,007.42	201.50 Cum × 6,000 = 1,208,904.00	40.28 ton × 55,000 = 2,215,400.00	Nil	Nil	3,399.00
Voided PT slab system	1,007.42	190 Cum × 6,000 = 1,140,000.00	15.11 ton × 55,000 = 831,121.00	10,000×10 = 100,000.00	0.35 ton × 120,000 = 42,000.00	2,113.12

Table 6: The following table shows the comparison between the embodied energy and embodied carbon of two different structural systems

Structural Systems	Embodied Energy (MJ/s.qm)					Embodied Carbon ($kGCO_2$/s.qm)				
	From Concrete	From Rebar	From Wire	From Polysty-rene Bubbles	Total	From Concrete	From Rebar	From Wire	From Polysty-rene Bubbles	Total
RC conventional slab system	427.23	863.64	0	0	1,290.874	652.85	74.37	0		727.22
Voided PT slab system	402.85	323.97	13.90	38.0	778.7131	615.59	27.90	1.22	1.41	646.12
Percentage reduction					39.68%	Percentage reduction				11.15%

- Increased acoustic behaviour.
- Decreased U value without putting insulation materials; hence greater thermal efficiency is expected.
- Increased shuttering efficiency vis-à-vis enhanced construction speed.

Sustainability quotients of voided PT slab

- Almost 11.00 Cum of concrete would be replaced by bubbles made of extended polystyrene (a byproduct of crude) and will result in lesser use of cement and other virgin resources, such as chips and sand.
- Rebar consumption comes down from 40 kg/sq. m to 15 kg/sq. m by reducing self-weight of the slab and putting some compressive forces along the column strip.
- Lower U-value means better insulation and energy efficiency throughout the building life.
- Other advantages are same as plain PT slabs.

The PT slab system is commonplace in commercial buildings today, but the voided slab is still not explored in our country. Though it is a globally proven technology, some big companies (e.g., Bubbledeck in UK and Cobiax in Germany) in Europe are doing fantastic projects worldwide. However, there is a huge potential in mass housing technology, if the system is thought of during the architectural planning of the project.

Affordability quotient

There is a possibility of an astronomical 37.83% savings while, in reality, after wastage, etc., it could settle to 30% overall.

The structural consultants are often sceptical regarding the following two issues:

- Post-tensioning creates further stiffness of the structure and that is thought of as an impediment to lateral forces and reversal of stress during earthquake.
- The skill set for designing and execution is not frequently available like the RC structure.

However, when the overall weight of the structure reduces, the base shear (V_B) also reduces and the related stress is a result of it. Moreover, when the solid concrete and rebars are placed along columns, strips are left without voids to take stresses while undergoing lateral forces.

Secondly, the workmanship required is not very different from that of the bar-bending works and is not difficult at a well-managed working site. Whatever may be the current scenario, our target should be creating maximum job opportunities for skilled manpower.

BOLIX®

Since 1760 Lewis Berger Paint your imagination

ADVANCED ETICS SYSTEMS

100 mln m² of insulation

www.bolix.pl

External Thermal Insulation & Composite Systems (ETICS) in India by Berger Paints under Technical Collaboration with Bolis S.A. Poland

GRIHA

Sustainable vs Affordable

A Dichotomy That Never Was

What does it mean to be 'modern' and, given our so-called need for products, how far have we strayed from our roots? In this article, **Sheily Shrivastav** identifies the nuances of how most of what we use is either excessive or unnecessary. Emphasizing that sustainable is affordable, the article examines the architectural industry and how it can deploy affordable means to provide sustainable housing solutions.

Sheily Shrivastav is an Associate Professor at Vastukala Academy College of Architecture, New Delhi. An expert consultant, editor, and course writer for IGNOU, she has 32 years of experience as an architect and interior designer. She can be reached at: asaxena@rics.org

Sustainable is affordable. Has there even been a counterargument? The very fact that the validity of this has to be discussed shows that somewhere in the race of becoming 'modern' and 'developed', we have lost our bearings and have gone astray. Essentially, to be sustainable is to last or to carry on for long, to last long would mean the absence of frequent replacement, and if recurring expenditures on replacements are saved, then sustainability will be a naturally affordable phenomenon. Given these factors, why do we need to keep emphasizing this? Perhaps, because market forces have made it appear so.

In the market today, there are numerous products claiming to be sustainable or 'green'. If one were to go by the product marketers' advice, it would appear that in order to live a sustainable life, one would have to live many lives only to earn the kind of money required to live a sustainable life! Be it what you eat, what you wear, how you travel, or how you build, there is always a multitude of agencies selling a range of 'green' items at 'red' prices. Thus in the name of sustainability, as a world citizen, one feels a moral responsibility and is enticed into spending unreasonable amounts, all in the name of consuming organic foods, wear natural fibre clothing, building using green materials, etc.

A topical discourse on this issue is a signal that things are bound to change and already people are aware and eager to embrace affordable sustainability. This by no means is a new concept. Traditionally, we in India have always had naturally sustainable lifestyles. Frugality, or in other words an absence of excess, has been a way of life for us. Even our scriptures are testimony to that. Our ancestors were brought up not to waste—neither food nor clothing and certainly not space. If we look back even one or two generations, we can identify incidents of recycling all kinds of daily-use products, ranging from old clothes being recycled to be used as dusters, empty water bottles used to store water in refrigerators, small cans being used as pen stands, the large ones

Photograph 1: An example of value being derived from the Last Morsel

being used as pots for gardening purposes, etc.

With the growth of the design industry and the ensuing manufacturing boom, buying new, stylish, and specialized products have become a trend, thereby resulting in a peculiar dilemma of (a) using the latest products and (b) an excess of discarded products. This has become a catch-22 situation of sorts. While on the one hand there are millions who are ill fed, bare bodied, and homeless, on the other and, there are unmanageably tall heaps of waste, constituting 'out-of-fashion', discarded products which we can barely salvage.

Given this, what is the way out? The answer to this, of course, is no rocket science! All we have to do is look back and adopt the same means that our ancestors did to live a sustainable life. We have to revert to respecting our traditional wisdom of recycling waste. Waste has none or a marginal cost and is easily affordable. A situation of minimal wastage not only improves an economy, it also promotes culture and social behaviour and eases the burden on the environment. What we truly need first is a mindset that is committed towards ushering in the change.

A cursory look around will bring to our notice a whole lot of construction waste. Discarded building material, outdated fittings and fixtures from old buildings but otherwise functional along with surplus construction materials lying around comprise a typical construction site. If we devise a systematic means of salvaging waste from these two sources along, we can embark upon a most viable method of providing affordable buildings in the form of housing, public toilets, temporary shelters, etc. for the downtrodden. Much of the renovation for the up-market population results in discarding building material, such as door window frames and toilet fittings and fixtures; these are changes that are often prompted by the need to display the latest in building infrastructure and not for any utility-related purposes. There are other categories of fresh building material, such as various types of wooden boards, wiring, pipelines, tiles, stones, bricks, plaster materials, and so on which are surplus and are left lying around after the completion of a project. All this taken together will add up to suffice for a basic shelter for a number of economically weaker sections of society.

Waste As a Useful Resource

Recycling of waste affects all aspects of sustainable development—social, environmental, cultural, and economical. Some of the innumerable benefits of waste recycling are as follows:

- Waste has no cost and is, therefore, universally affordable
- Waste in landfills takes up land space that could be used for other functional necessities
- Constructive utilization of waste reduces burden on the manufacturing industry
- Controlled or need-based manufacturing will reduce the burden on natural resources
- Less manufacturing will reduce the energy requirement, thereby leading to the conservation of the various energy sources
- Environmental pollution will be reduced

Photograph 2: Construction waste has potential as affordable building material

- Large-scale employability can and will be extended to both the uneducated and educated youth, irrespective of their gender, caste, or background
- Taking the above-mentioned steps can directly contribute to the government's exchequer as direct revenue. Additionally, these steps can also provide entrepreneurs with opportunities to express their creativity and a successful model can be benchmarked for replicating throughout the country

That the Government of India also puts emphasis on such a strategy is evident from the following: The Municipal Solid Wastes (Management and Handling) Rules, 2000, published vide notification number S.O. 908(E), dated September 25, 2000, by the Government of India in the erstwhile Ministry of Environment and Forests, provided a regulatory framework for management of municipal solid waste generated in the urban area of the country. The central government reviewed the existing rules to make these rules more effective and to improve the collection, segregation, recycling, treatment, and disposal of solid waste in an environmentally sound manner considering necessary to revise the existing rules and has notified the new rules with an emphasis on the roles and accountability of waste generators and various stakeholders, give thrust to segregation, recovery, reuse, recycle at source, address in detail the management of construction and demolition waste (*The Gazette of India, Part-II, Section-3, Sub-section [ii],) Ministry of Environment, Forest and Climate Change*). This notification clearly defines the role of waste generators, service providers, their contractors, and the local authorities. Their responsibilities in handling the waste besides establishing criteria for storage, processing, or recycling facilities for the construction and demolition of waste and its subsequent application are considered in the notification. The notification for this initiative also defines the role of various state and central government administrative and pollution-control organizations.

Given the commitment of our government towards the cause, it is a great opportunity to provide institutional support to the idea of constructive utilization of

Photograph 3: House made with LEGO-like construction method

Photograph 4: An old rail coach converted into house

construction waste and making affordable sustainability a reality rather than just associating the whole idea of sustainable construction with only the installation of active, energy-saving devices. If the stakeholders are involved in the process and awareness about the various initiatives is spread, the problem of reallocating the waste and superfluous materials will not arise. However, as things are, building shelters for the homeless has been a long-standing priority and anything that contributes towards its fulfilment can and should be encouraged. Some

Photograph 5: Old container converted into habitable spaces

instances of the desired utilization of construction and other wastes will further illuminate this discussion.

The Colombian company Conceptos Plásticos has successfully demonstrated how waste plastic can be processed and converted to LEGO-like building blocks that can be used by homeless families to easily construct their own homes without any professional help.

An additive in the plastic makes the blocks fire resistant and with the blocks being plastic, the houses made by them are also earthquake resistant. Not only this, being a LEGO-like construction method, a house for a family of four can be easily constructed in four to five days.

While the plastic used for building the houses (refer to Photograph 3) may take 500 years or more to degrade, the house built with it will provide shelter to some homeless and, most admirably, at a drastically reduced cost. The house shown in Photograph 3 cost the makers $5,200 or approximately, ₹3.4 lakh. This is far below the norm for EWS housing in India which is ₹5 lakh.[1]

Used containers that have lived their life on the sea are available in every city and range between ₹ 65,000 to ₹1,25,000 depending upon their condition and size, which, typically, may work out to approximately ₹300 per sq. ft of usable, liveable, and ready-to-move-in space. Add to this things, such as cost of sanitary fittings, electrical fit-outs, painting, and flooring, this can be a solution well within ₹800 per sq.ft, thus making it a 200 sq. ft liveable house well under ₹2 lakh.

Whether to say sustainable is affordable or the other way around, that is, affordable is sustainable is all a matter of perspective. The idea is to implement a need-based worldview of sustainability and see how it best serves the needs of the marginalized. Once we deploy this perspective, wastage and superfluity will automatically get curtailed.

1 Read more about it on http://conceptosplasticos.com/ or http://inhabitat.com; last accessed on October 24, 2017.

Acknowledgements
The author would like to acknowledge Anupam Saxena, associate professor, School of Real Estate, RICS SBE, for contributing papers on construction waste management and affordable housing.

A glimpse of three-day training programme for Evaluators & Certified Professionals at Noida, Uttar Pradesh from May 31 – June 2, 2017.

Haveli at Koteshwar

mistry associates architects

"amrakunj farm" at prahladnagar
junction,s.g.highway,ahmedabad-380051.
ph:+91-79-26936017M:+91-9727709935
e-mail: jmistry1938@gmail.com, studio3.jm@gmail.com

Founded in Year 1968, Mistry Associates & Studio 3 Architects Pvt. Ltd. provides complete professional services in the fields of Architecture, Master Planning & Interior Designing.

The firm is headed by Mr. Jitendra Mistry, Architect & Mrs. Mamta Mistry, Interior Designer, who brought many years of wide experience in the field from India and abroad.

Mr. Jitendra Mistry, a soul behind the total development, is an architect having taken his degree from USA. He worked under the guidance and direction of world famous architect **Dr. Walter Groupis** at the **Architects Collaborative Inc.,** Cambridge, USA.He was associated with complete Architectural Planning and Construction of New **Baghdad University, Iraq** campus for 12,000 students as well **Mosul University, Iraq.** He was also associated with design work of **State Park Recreation Center, West Virginia, USA** and **Hotel Project in Greece.**

In India he has designed several projects for Educational Institutes, **Hotels,** Commercial Buildings, Industrial Estates and Private residential houses.

In Conversation with

Rolf Disch

Rolf Disch, solar energy pioneer and environmental activist, has contributed greatly to the advancement and efficiency of solar architecture internationally. In addition to his responsibilities as the head of his own architectural firm, Disch has lead Germany as the solar pioneer with respect to residential, retail, and commercial building and design.

What is solar architecture? How is it different from conventional architecture?

Fossil and nuclear fuels are limited resources. Energy from combustion is harmful for the climate. We have already seen two total meltdowns of nuclear power plants, and there is no solution in sight for the storage of nuclear wastes over tens of thousands of years. The sun, on the other hand, gives us an abundance of energy, and so do other renewable sources. Here, unlike with conventional energy conversion technology, the primary energy sources are for free: You do not have to mine wind or sun rays, so you do not have double costs for raw materials and technology, but for technology only. Since the building sector accounts for 40% of our energy consumption, more than the industry or the traffic, architects must play a major role in the fight against climate change. So why not see the sun as our ally in this fight?

Traditional architecture has always 'cooperated' with the sun, be it by using its energy for room heating, be it by avoiding overheating in hot climates and make use of the shadows. Visit any Maharaja palace or any little farmer's house or hut in any of the diverse Indian climates and you can easily verify that. And read Jun'ichirō Tanizaki's *In Praise of Shadows* (1993) to know how beautifully this can be done. Visit any modern office building or hotel in Srinagar or in Bangalore, with their very different climates, and you will see that they look alike in both cities and that architects (and investors) have forgotten all about their 'solar ally'.

So what is the difference between solar and conventional architecture? Solar architecture avoids up to 90% of room conditioning demands (heating and/or cooling), like traditional architecture in the pre-airconditioning era always tried to do, only that we can get to higher thermal comfort levels than in the old days. And, on top

of the energy efficiency issue, solar architecture can provide the remaining energy demands, hot water, electricity, and whatever remains of room conditioning necessities, largely or even completely, from renewable sources. The 'solar' in 'solar architecture' can be solar thermal or photovoltaic but stands *pars pro toto* for all the renewable energies that you can use.

Do you think the concept of solar architecture can be applied to any existing built form?

Solar architecture principles can be applied to projects for all kinds of purposes, from homes to hotels, from hut to high rise, office, retail, industry, hospitals, schools, data centres.... In that sense, yes, it can be applied universally. Yet, there are 'built forms' and constructional and architectural conventions that are less favourable than others. Solar architecture is not about designing just any kind of building and then applying some photovoltaic panels. This is not sustainable, but 'green washing'. Solar architecture starts with the very first design stages. You have to exactly consider the climate, even the micro climate at the given spot, and adapt your designs to it.

Do you think solar architecture will work in fast-developing countries like India?

India has a lot more sun than Germany. So you have a higher potential for reducing cooling demands (and costs) and a higher energy harvest from photovoltaic panels or solar thermal collectors, which makes all solar architecture measures economically rather viable than they are in Germany. The pioneering days are over; and the technologies needed are already mass produced with their prices decreasing rapidly. This has happened with PV in the last 15 years and is now happening with electricity-storage devices. India has been and is educating lots of clever engineers, the whole world envies you for that, who can easily make use of the building construction and energy-generation technologies that are at hand and apply them or adapt them, wherever this may be found necessary. And you have brilliant young architects from first-class architecture schools such as Chandigarh.

You would not believe how often we have heard variations of the argument: 'These things can be done in Germany, certainly not in India.' Or Brazil. Or Nigeria. On a conference in Houston, the engineers and architects said, 'Certainly not in Texas.' And sometimes visitors from northern Germany tell us, 'You can do it in Southern Germany, certainly not in Hamburg, up in the north.' When we designed

Photograph 1: Sun Ship: A community that runs entirely by solar energy in Freiburg, Germany.

the first plusenergy buildings, the banks, the building developers, the politicians, and all those experts said, 'Cannot be done, for technical, economic, social reasons.' Eventually it comes down to the old joke: 'Everyone was saying it was impossible. Until there was this guy who did not know that and just did it.' If only half of the mental energy wasted for finding reasons why things cannot be done would be invested into innovation, the world would be a better place. I am not saying it can be done easily. It is always a challenge to do something new. But it is so much fun to prove all the skeptics wrong.

There are two ways of actually doing it: Start with the simple things. Or start with the difficult ones. A very simple thing would be, for example, to provide simple solar thermal kits for villagers or simple PV kits with some basic gadgets (light bulbs, a fridge, a TV set, a basic tablet computer, etc.) even for first-time electrification in remote rural areas. This is happening all over the planet in developing countries, for example, by means of microfinancing which has been invented in India. Or start with a spectacular, iconic, big-scale project. Somewhere in between lies the mass housing sector for growing cities. Now, the State of Mexico has recently come up with a fascinating and massive 'Eco Housing' programme for exactly that segment: small and cheap workers homes, of which hundreds of thousands get built every year in different forms and sizes, for the different climates of Mexico, at different levels of energy-efficiency. If they can do it Mexico, then why should it be impossible in India?

Tell us something about 'Heliotrope', your home and the experiment you hold very dear.

The Heliotrope was the first building in the world to produce more energy than it consumes. The energy consumption is emission-free, CO_2-neutral, and 100% regenerative. And the electricity surplus is shared with the public grid. The name comes from biology: Heliotropic plants, like the sunflower, turn themselves with the rotation of the sun. That is what the Heliotrope does. It has a completely glazed side that follows the sun in winter so that the sun heats up the building. And it has a heavily insulated side with only small windows that follows the sun in summers so as to avoid overheating. On the roof you will find a large, mounted photovoltaic tracker that also follows the sun independently and which always finds the ideal angle to maximize electricity output. The heat for hot water and for the little room heating needed on a few winter days comes from solar thermal vacuum tube collectors on the balcony railings. Thus, the building generates 4 to 5 times the energy it needs.

We built the Heliotrope as early as 1994. It was an experiment. What we learnt from this project, we then applied in all other projects ever since. The Heliotrope is a very special architectural design, a lighthouse project, which is certainly not suitable for a mass market. So the next step was to take everything we learnt from the Heliotrope and apply it in a project of a less 'spectacular' design with a higher potential for replication anywhere in Germany. So after the Heliotrope, we designed the 'Solar Settlement' in Freiburg with 61 residential units in terraced houses and an office and retail building, the 'Sun Ship', with all buildings generating an energy surplus.

Photograph 2: Heliotrope: An environmentally friendly house in Freiburg, Germany

How do you relate affordability with renewable energy generation considering the fact that the initial investments are higher in such cases?

The classic argument is: It is indeed an extra *investment*, not extra costs, because it will save you costs or even, in case you can feed in and sell PV electricity,

Photograph 3: Solar Settlement at Schlierberg is a 59 PlusEnergy housing community in Freiburg, Germany

generate an income, while the long-term trend is that prices for energy from fossil fuels are going up. However, the guy from the controlling department of any big shot building development company or real estate fund will probably give you a smile and say that he does not accept a payback period of more than three years. Can your PV roof do that? No? Sorry, end of discussion, business as usual. This is the same all over the planet, and real estate business in India is tending rather more to the speculative side than in Germany. There is nothing much that an architect can do here, except for appealing to the moral sense and the necessities of climate change, etc., which would probably just get you yet another smile from the controlling guy.

This is a political issue. Higher efficiency standards and renewable energy generation must be flanked by a legislative framework, by defining minimum standards, and by a certain degree of incentives because our controlling guy is no idealist and cannot possibly be an idealist. In the long run, with rising prices of fossil fuels, exploding energy demands, and unstable electricity grids, the government must take such steps in order to keep the side costs of housing affordable (or else subsidizing them to a degree that will exhaust state budgets, especially of developing countries). But mentioning grid stability, which is a big issue in India, here we already have an argument for our controlling guy, which might make him think twice: Your kilowatt-hour from the PV on the roof is certainly cheaper than the backup system, usually an inefficient and dirty diesel generator. And, if you add a battery, it is more reliable than the public grid.

But again, renewable energy generation is only the second issue to consider. Start with energy efficiency. Get the consumption down. The measures are comparatively simple and cheap. It might not yet be the case for lower-income housing, but Indian middle classes already want high thermal comfort. If you do not give it to them, they will sooner or later buy and install the cheapest and least-efficient air conditioner. This is exactly what has happened in China. Look at the rapidly developed housing estates from the 1990s onwards all over that vast country and see all the ugly electricity-devouring boxes that have been added to the façades only a few years after people had moved in. India should not repeat China's mistakes here. So, you would better install energy-saving façades and windows in the first place and an efficient cooling system. It does not cost you a fortune, but it saves you a fortune in the long run.

Having done this, you can then even downsize your PV instalment, because you need less PV after getting the consumption down, which again saves you a lot. If we are talking not only about a single house but a larger development, you can upsize your energy-distribution infrastructure and make it more intelligent, which, in turn, makes the system cheaper and more efficient. A central cooling device or a central storage system for your PV electricity servicing 100 flats might well be a lot cheaper and a lot more efficient than 100 individual technical units for each flat. Use intelligent modes of distribution and electronic management, and again you can downsize the energy-generation side.

The most affordable energy is that which you do not need, and the lower your demand, the lower the cost of your renewable energy system.

Is there any specific person whose work you admire?

Hermann Scheer, MoP, was the politician who invented the national feed-in tariff for renewable energies, and who managed to get the legislation through the parliament. He also founded the European Association for Renewable Energy 'Eurosolar' and the International Renewable Energy Agency (IRENA). He consulted many governments worldwide, so that in almost 100 countries the German model was adopted. He was a visionary, one of the fathers of the global transition towards renewable energies.

KANSAL

AAC BLOCKS

(ISO 9001: 2008, ISO14001:2004 Certified Company)

Indian Green Building Council MEMBER

GRIHA

DIMENSIONAL

Length(mm)	Height(mm)	Width(mm)
625(25 inch)	240(9.7inch)	100/125/150/200/230/250/300/(4inch,12 inch)

FEATURES

- Eco- Friendly
- Light Weight-1/3 Of Brick
- Earthquake Resistance
- Fire Resistance
- Load Reduction
- Pest & Termite Resistant
- Reduce Joints And Mortar
- Moisture Resistant/Effloresence
- Cost Saving/Easy To Use
- Fast Construction

अब घर बनाना और भी आसान.....

कम समय में, कम लागत में.....

Head Offece: Kansal House, 509/5, Govindpuri, Maa Anand Mai Marg Marg, New Delhi-110019

Tel.: (+91) 11-26212028/26466666, Mob.: +91-9818990444 / 9818990333

B.O. Dehradun.: 2, 1st Floor, Shiva Palace, 57/19, Rajpur Road, (Opp. Sachivalya) Uttrakhand-248001

E-mail: Info@kansalindia.in, Website: www.kansalindia.in

Plant: Unit-1: Kansal Building Solutions Pvt. Ltd. Village Aggewala, P.O. Jaminiwala Paonta Sahib- 173025 (H.P.)

Unit-2: UT Concrete Pvt.ltd. D-14, Road No.15, Upsidc Industrial Area, Kotwan Kosi Kalan, Distt. Mathura 281403 (U.P.)

Sustainable Housing is Affordable in India

There is no denying the fact that Earth's climate is rapidly changing. Not only have we depleted a considerable portion of our resources, we have also exploited our forests, water bodies, and land. In this article, **Deepak Bansal** and **Professor V K Minocha** discuss the centrality of building affordable houses and sustainable construction materials as a necessary step towards preserving our environment.

Deepak Bansal, Joint General Manager of projects, HUDCO (Housing and Urban Development Corporation Ltd.), has more than two decades of experience in several areas ranging from civil engineering to construction technologies. He can be reached at: dbansalindia@gmail.com

Professor Vijay K Minocha, principal, CBPGECJ, Jaffarpur (on diverted capacity), has more than 22 years of teaching and research experience. His area of specialization includes civil and environmental engineering.

We live on Earth—the only habitable planet in our solar system and, perhaps, the only one in our galaxy. We depend on it for our survival, but given the way things are shaping up, we are exploiting our resources in the name of development. Excessive felling of trees, mining, exploiting surface and groundwater, encroaching on wet lands, etc. are some of the few damaging blows we have dealt to our environment. This type of development has led to the extinction of many flora and fauna, depletion of natural resources, and now, when excessive damage has already been done, we are feeling the pinch. The Earth's temperature has been steadily rising from the pre-Industrialization times, that is, from the 1790s.1 This has resulted in climate/seasonal changes, melting of glaciers, and rising ocean water levels, thereby risking submerging of the island countries. Developing and underdeveloped countries are the worst affected by these disasters.

To counter the effect of this skewed development, many climate change workshops and conventions are being organized around the world and many restrictions are being imposed on countries and sectors to control greenhouse gas (GHG) emissions; the idea is to monitor that the temperature of the Earth does not rise beyond 2 °C than that in the year 1790.[2] Both India and China have much to cope with as these two countries are developing at a fast pace in this century and are feeling the heat of these restrictions on some of its sectors. The major sectors affected by these restrictions are industry, transportation, and construction. In India, housing construction is being taken up in a big way as many people are homeless. Also, migration to cities is on the rise along with increase in population thus resulting in a demand for rapid urban housing. Currently, the urban population of India is about 31%[3] which is expected to reach to about 40% by the year

1 IPCC. 2007. Mitigation Contribution of Working Group III to the Fourth Assessment Report of the IPCC [AR4].

2 Refer to footnote 1.

3 www.censusindia.gov.in; last accessed on October 3, 2012; Report of the Technical Group (11th Five year plan: 2007–12), on Estimation of Urban Housing Shortage in India, http://mhupa.gov.in/ministry/housing/HOUSING SHORTAGE-REPT.pdf; last accessed on April 5, 2013.

2030;[4] these are indicators of how sustainable and affordable housing in India is on the rise.

It is estimated that 30%–40% of primary energy (energy produced from fossil fuel) and 30% of potable water is annually used in the construction sector including operations of these facilities, and this sector is responsible for about 40% of GHG emissions, globally.[5] In the construction sector, buildings are the major contributor of GHGs as they have a big share vis-à-vis construction and use cement and steel extensively (both energy-intensive materials). It is estimated that 67%[6] of the total cement produced in India is consumed in the building sector alone and 1 tonne (MT) of cement emits about 1 tonne (MT) of CO_2 during production.[7] Buildings thus contribute towards the rising pollution crisis in big cities.

The air quality Index (AQI) in Delhi is rather poor and it is no wonder that serious health issues are rampant in the city; many a time-forced measures, such as car rationing and working from home are imposed to curb the crisis. But is the construction sector learning any lessons from this and are these measures a permanent solution? In India—where the green development or sustainable development is not cost effective and is marked by low affordability—such measures cannot be imposed on the general masses. It is believed that the poor in India cannot even afford food, clothes, and shelter; hence, priority should be given to providing them with houses at affordable costs and without considering its sustainability. In the Indian big cities, about 40% of the population is without shelter or is living in slums.[8] There is 96% shortage of houses in urban India as per the 2011 Census in EWS/LIG category[9] and the Government of India is trying to provide houses to all through the JnNURM/HFA/PMAY[10] by year 2022. But how to make it sustainable is a big challenge. There are standards in the US/Europe/Australia about sustainable houses and carbon mapping, but, unfortunately, there are no such standards or exercises in India. In the Indian context, by the year 2022, under the housing-for-all programme, the primary focus should be on providing safe and economic houses to all. However, the sustainability of these houses in terms of life cycle cost analysis or life cycle energy analysis has not been emphasized like it has been in developed countries. The only focus has been on energy-efficient lights, fans, ACs, washing machines, refrigerators, glass, etc. It is important to note that these are popular industrial products that already follow international standards as they are marketed by big industrial houses and are widely used in industrial, commercial, and institutional buildings. The Bureau of Energy Efficiency has issued star ratings for these appliances and this is very popular in India as, increasingly, people are becoming energy conscious because of rising energy prices. But the major housing shortage lies in the EWS/LIG sector and they are not probable consumers of these products.

The houses for the poor in India are traditionally made of basic building materials, such as fire clay brick/blocks, cement, steel, and aggregates (fine and coarse sand), and these should be optimized in terms of quantity as well as in energy and cost (through technological intervention). Now, pre-fabricated and pre-engineered houses are also being constructed/promoted in India, but as of now, its acceptability, availability, and vernacularity is in question as India is a very big country with diverse ethnic, religious, geographical, climatic, and hazard conditions (earthquakes, cyclones, floods, landslides, tsunamis, etc.). The social fabric and living habits of residents are also quite different. The construction industry also involves small-scale/cottage industries that manufacture building materials locally as per vernacular construction practices. Hence, house planning, design, and construction in India is a tricky subject. However, India has made significant progress in alternative building materials and construction technologies. Different building materials and construction technologies are prevalent in different parts of country, such as in J&K the *dhajji-diwari* system is prevalent, in Kerela/Tamil Nadu, the rat trap band with RCC filler slabs is prevalent, in Gujarat, the fly-ash blocks/concrete block-based construction, and in the North East, bamboo-based houses are modernized and many of these are accepted in the National Building Code of India by the Bureau of Indian Standards. The local materials and construction system are improvised to resist horizontal and vertical forces with scientific knowledge and are cost

4 Refer to footnote 3.

5 Asif M, Muneer T, and Kelley R. 2007. Life Cycle Assessment: A Case Study of a Dwelling Home in Scotland. *Building and Environment* 42: 1391–94.

6 http://www.investindia.gov.in/cement-sector/; last accessed on March 2, 2015.

7 Bhattacharjee B. 2010. Sustainability of Concrete Construction in Indian Context. *Institution of Engineers* I (July): 45–51.

8 Refer to footnote 3.

9 EWS: economically weaker section; LIG: low-income group; refer to footnote 3.

10 JnNURM: Jawaharlal Nehru National Urban renewal Mission; HFA: Housing for All; RAY: Rajiv Awas Yojna; PMAY: Pradhan Mantri Awas Yojana.

and energy efficient. These houses are sustainable, affordable, and climatic/disaster resilient. Locals can recreate them using their traditional knowledge along with improved techniques resulting in better skills, thereby resulting in an upgradation of sorts. It is estimated that these affordable, load-bearing, low-rise houses may have carbon footprint (embodied) of about 2 GJ/m^2 to 4 GJ/m^2 resulting in 11 kwh/m^2 /annum to 22 kwh/m^2 /annum (for a 50-year life cycle).[11] These values are quite less as, usually, they vary from 240 kwh/m^2 /annum to 380 kwh/m^2 /annum[12] in the developing countries as the houses consume a lot of insulating materials and energy-intensive building materials for construction. The operating energy requirement of affordable Indian houses is also low due to poor affordability as they generally have less than 1 kW energy connection and may have about 5 LED lights (12 W), 2 fans, and only 1 desert cooler. The low-rise construction do not have lifts and firefighting systems, hence the affordable houses with local building materials in low-rise construction are highly sustainable. The operation and maintenance of these houses is also less and requires much less cost and energy. Micro climate through solar passive design and landscaping further enhances the quality of life in these buildings.

The authors have been involved with the construction of houses under the JnNURM/RAY/HFA programme deploying different

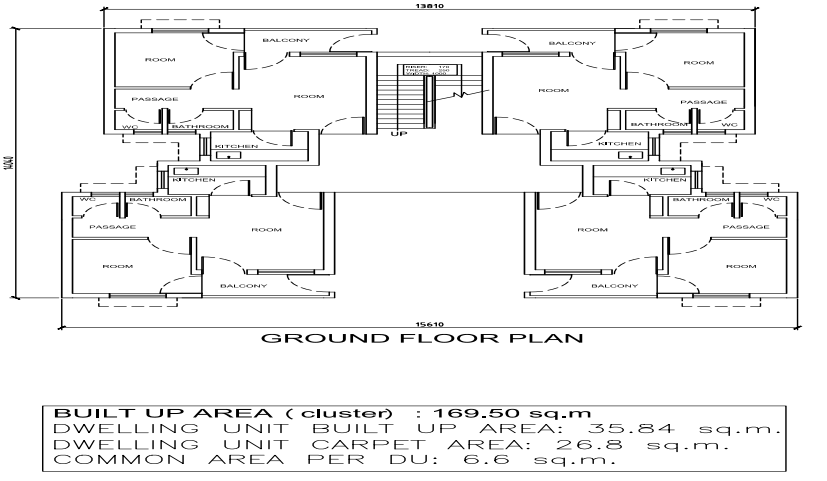


Figure 1: Drawing of typical affordable houses in India under the JnNURM programme

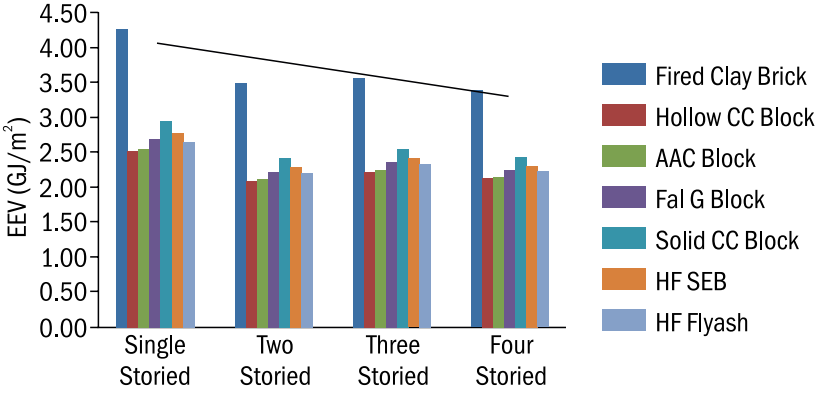


Figure 2: Embodied energy reduction through the intervention of alternative building materials

variations are given in Figures 2 and 3, respectively. Various Indian researchers have also reported reduction in cost and energy of building materials on a pan-India basis, and it has been found that the houses built with local alternative building material is acceptable and cost-/energy-efficient. It is estimated that energy consumption and cost of low-rise, load-bearing houses can be reduced by about 30% by local building materials and construction technologies[13] for a given typology of houses as per Figure 1, and the energy and cost houses with different building materials and prescribed some values.[14] It is also calculated that in high-rise construction of houses, circulation areas increase due to

11 Bansal D, Singh R, and Sawhney R L. 2014. Effect of Construction Materials on Embodied Energy and Cost of Buildings: A Case Study of Residential Houses in India up to 60 m2 of Plinth Area. *Energy and Buildings* 69: 260–6.

12 Ramesh T, Prakash R, and Shukla K K. 2012. Life Cycle Approach in Evaluating Energy Performance of Residential Buildings in Indian context. *Energy and Buildings* 54: 259–65; Ramesh Talakonukula R, Prakash R, and Kumar S K. 2013. Life Cycle Energy Analysis of a Multifamily Residential House: A Case Study in Indian Context. *Open Journal of Energy Efficiency* 2: 34–41.

13 Refer to footnote 11

14 Shukla A, Tiwari G N, and Sodha M S. 2009. Embodied Energy Analysis of Adobe House. *Renewable Energy* 34: 755–61; Debnath A, Singh S V, and Singh Y P. 1995. Comparative Assessment of Energy Requirements for Different Types of Residential Buildings in India. *Energy and Buildings* 23: 141–46; Venkatarama Reddy B V and Jagadish K S. 2003. Embodied Energy of Common and Alternative Building Materials and Technologies. *Energy and Buildings* 35: 129–37.

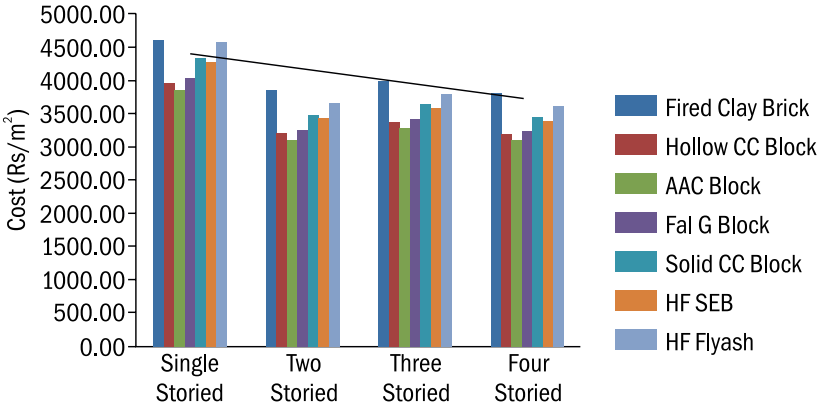


Figure 3: Cost reduction through the intervention of alternative building materials

requirements of more staircases, lifts, and fire terraces, but the floor–area ratio (FAR) remains the same. Hence usable carpet area decreases, resulting in less utilization of spaces and increased cost and energy, as consumption of steel and cement increases due to more gravity loads and more lateral loads on the buildings.

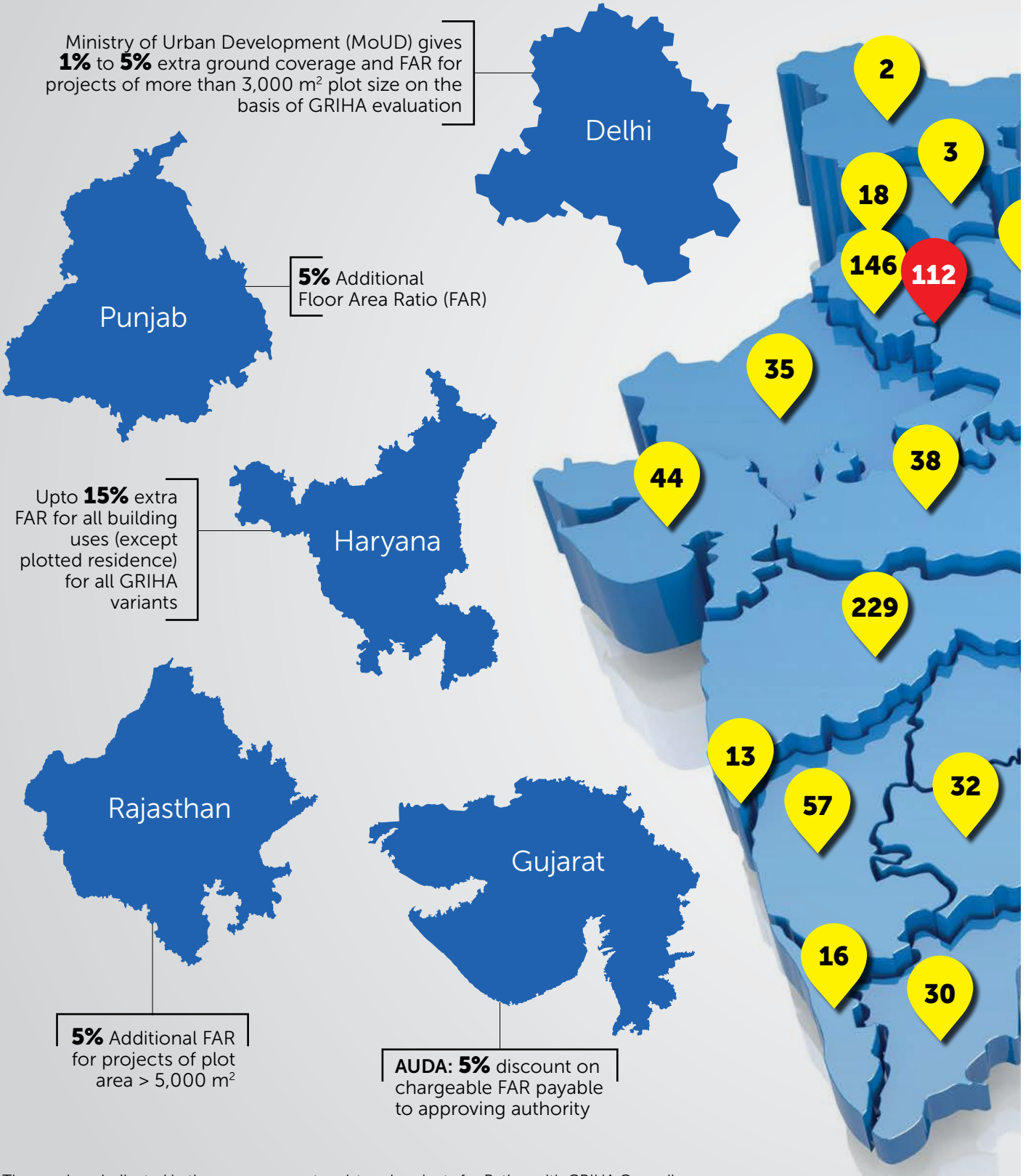
Operating energy requirement of high-rise buildings also increases due to requirements of lifts and pumping water and firefighting systems. Hence high-rise constructions are expensive and cost intensive compared to low-rise, load-bearing systems for the same FAR. However, in some cases, where the FAR is more, the same cannot be utilized in low-rise construction and, in that case, high-rise construction is the only solution in terms of the utilization of full land area.

There are many qualitative advantages of solar passive houses that cannot be quantified but provide pleasant indoor conditions without increasing the cost. However, these materials and design cannot be generalized as the availability/skill, geographical conditions, and typology of houses are quite different in different regions in India.

Hence, sustainable housing in India is quite affordable and represents a confluence of traditional and modern methods. Constructing such houses not only bolsters the safe housing programme but also improves skill and technical know-how.

A glimpse of three-day training programme for Evaluators and Certified Professionals at Lucknow, Uttar Pradesh from 27–29 September, 2017.

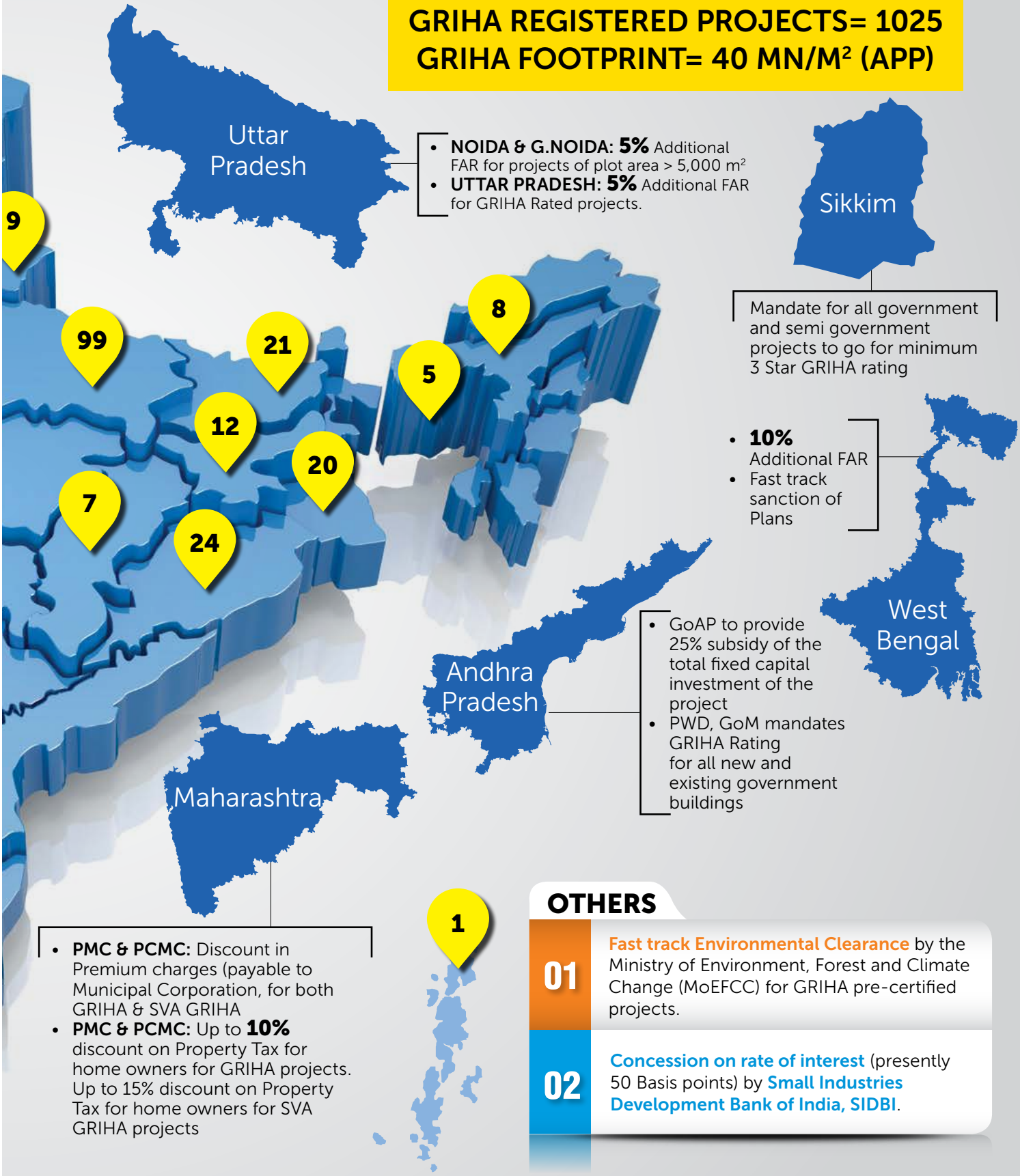
GRIHA PROJECTS' UPDA



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

TE & LINKED INCENTIVES

GRIHA REGISTERED PROJECTS= 1025
GRIHA FOOTPRINT= 40 MN/M² (APP)



- **NOIDA & G.NOIDA: 5%** Additional FAR for projects of plot area > 5,000 m²
- **UTTAR PRADESH: 5%** Additional FAR for GRIHA Rated projects.

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

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

- GoAP to provide 25% subsidy of the total fixed capital investment of the project
- PWD, GoM mandates GRIHA Rating for all new and existing government buildings

- **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 the Ministry of Environment, Forest and Climate Change (MoEFCC) for GRIHA pre-certified projects.

02 **Concession on rate of interest** (presently 50 Basis points) by **Small Industries Development Bank of India, SIDBI**.

Skilling for Green Construction

In the wake of mounting environmental concerns and climate change, green construction practices have gained momentum. Fortunately, these have also expanded beyond buildings/sites to incorporate the research and planning stages. In this article, **Dr Praveen Dhamija** mentions how green construction materials go a long way in curtailing pollution and managing costs, thus making the construction sector sustainable and energy-efficient. The article also sheds light on the role of the Skill Council for Green Jobs (SCGJ) in skill development for using the diverse building materials efficiently.

Dr Praveen Dhamija, currently working as an advisor in Skill Council for Green Jobs, Delhi, is involved in promoting skill development in various sectors of renewable energy and environment sustainability linked to afforestation, green construction, green transportation, solid waste, water and waste management, etc. She can reached at: pdhamija.greenjobs@gmail.com

Under the IPCC's high-growth scenario, it is estimated that the total GHG emissions from the building sector will almost double to 15.6 billion metric tonnes CO_2-e by 2030.[1] The urban population growth trends estimate an increase in urban population in India to 590 million by 2030, thus creating a direct demand for new construction and infrastructure in the country.[2] The current scenario and growth forecast in population growth and relative demand for construction foresees a huge potential in the construction industry. Construction in India is poised to become the world's third-largest construction sector by 2018.[3]

Green construction has gained increasing attention as an important aspect of sustainability. A sustainable way of designing, constructing, operating, and maintaining the building infrastructure focuses on waste reduction, energy efficiency, water conservation, enhanced indoor environment quality, and environmentally preferable materials and ecofriendly transportation. Integrating green building materials into construction projects can help reduce the environmental impacts associated with extraction, transportation, processing, fabrication, installation, reuse, recycling, and disposal of construction materials.

Green construction provides opportunities for implementing new technologies and materials that are ecofriendly and promote conservation of dwindling non-renewable resources. However, there is a need for skill training in this sector so that a trained and skilled workforce is created for implementing green building programmes and projects. The SCGJ, set up in October 2015 under the National Skill Development Council, functioning under the Ministry of Skill Development and Entrepreneurship, has the mandate to interact with the industry and provide trained and certified manpower for 'green businesses', so as to contribute to the initiatives launched by India to combat the problems of climate change and GHG emissions.

According to the definition of sustainability of the Brundtland Report (2), 'Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs'. A material can be considered sustainable

1 http://www.greeningtheblue.org/sites/default/files/Buildings%20and%20climate%20change_0.pdf; last accessed on November 22, 2017.

2 http://www.teriin.org/projects/green/pdf/National-Buildings.pdf; last accessed on November 22, 2017.

3 http://www.devalt.org/images/L2_ProjectPdfs/MarketevaluationreportforrecoureefficiencyusingCDwaste.pdf; last accessed on November 22, 2017.

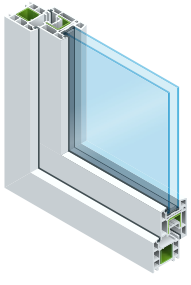
if its source has the capacity replenish/regenerate faster; also if it has the least adverse impact on the environment. A sustainable material usually is made from natural or recycled materials and its production requires a small amount of energy. It makes limited use of non-renewable sources and has a low environmental impact.

The usage of alternate building materials and products promote conservation of dwindling non-renewable resources. In addition, integrating green building materials into construction projects can help reduce the environmental impacts associated with extraction, transportation, processing, fabrication, installation, reuse, recycling, and disposal of construction industry source materials. The manufacturing of many of the materials used in buildings require consumption of large amounts of energy derived from fossil fuels and displacement of mega tonnes of earth during the course of mining.

Some of the green building materials are as follows:

- **Aerated autoclaved concrete blocks (AAC)** is made with fine aggregates, cement, and an expansion agent that causes the fresh mixture to rise like dough. In fact, this type of concrete contains 80% air.
- **Fly ash bricks (FAB)** are made of fly ash, lime, gypsum, and sand. These can be extensively used in all building constructional activities similar to that of common burnt clay bricks. The fly ash bricks are comparatively lighter in weight and stronger than common clay bricks. Since fly ash is being accumulated as waste material in large quantities near thermal power plants, thereby creating serious environmental pollution problems, its utilization as the main raw material in manufacturing of bricks will not only create ample opportunities for its proper and useful disposal but also help in environmental pollution control to a great extent in the areas surrounding the power plants.
- **Insulated glass unit (IGU)** combines multiple glass panes into a single-window system. Most IGUs are double glazed (two panes of glass) with three panes (triple glazing) or more becoming more common due to higher energy costs. The panes of glass in IGUs are separated by a spacer and a still layer of air or gas. Double-glazed windows are an ideal energy-efficient choice with the added benefit of minimizing noise; the sealed air gap between the two panes act as an added layer of insulation. This added thermal resistance reduces the amount of heat escaping in winters and maintains home temperatures at a comfortable level. Double glazing has the reverse effect in summers, it prevents unwanted heat from coming inside. This extra insulation lessens our reliance on artificial heaters and air conditioners and can ultimately reduce energy costs.
- **Glass wool** is a thermal insulation that consists of intertwined and flexible glass fibres which causes it to 'package' air, and, consequently, make good insulating materials. Glass wool can be used as fillers or insulators in buildings and for soundproofing as well.
- **Green-tinted glass** is a transparent float glass produced by adding an oxide of metals into raw materials in the float-glass process, the most technologically advanced method in the world. Being manufactured by this process, green-tinted glass can effectively absorb the heat while offering an aesthetically pleasing green tint. Green glass can not only absorb the heat but can also reflect the infrared up to approximately 40% which can lead to a dramatic reduction in energy costs. Its greenish colour can reduce the transmission that results in unwanted glare and discomfort. Green glass reduces the transmission of ultraviolet light and subsequently minimizes the fading of furniture and flooring.
- **High-albedo roof paints and reflective materials** are paints that act as insulation coating





Photograph 1: AAC blocks, fly ash bricks and insulated glass unit

Photograph 2: Glass wool insulation

whereby its ability to reflect or resist heat on all roof surfaces, such as RCC, concrete, metallic, asbestos, G I, galvalum sheets, pre-coated roof sheets, and poly-flex. These are ecofriendly, low-VOC products that reduce roof temperatures leading to low pressure on air conditioning, hence reducing the energy consumption of the building.

- **Ferro cement** is a composite material comprising rich cement which is highly reinforced with continuous and small-diameter steel rods and wires. It may be defined as a sophisticated design with well-proportioned cement-based compounds in which suitably sized steel sections are evenly dispersed for achieving remarkable homogeneity, ideal monolithic properties, excellent strength, and absolute impermeability.
- **Bagasse particle board** is the residual pulp from sugarcane after the juice has been extracted. A considerable amount of excess bagasse generated from sugar mills is left to rot or is burnt as fuel for boilers. This byproduct is now being used as a substitute for wood in particle boards that are light and low cost. Bagasse-based composites offer potential as the core material for laminated floors, replacing high-density and expensive wood fibreboard. As such, bagasse does not have enough strength and water resistance to be used on its own. However, if it is made into a laminated particle board with resin as a bonding agent and wax as dimensional stabilizer, then it can be used for laminated floor and furniture applications.
- **Bamboo** has long been used as a traditional building material and is achieving increasing popularity due to its potential for environmental sustainability. Bamboo in disaster-prone areas, come from the lightness and flexibility of the material which gives it resilience to withstand strong winds.
- **Abaca** is a banana tree-like plant that is, typically, found in tropical countries. It is one of the many species of banana native to the Philippines and is extensively grown in Borneo and Sumatra. This material can be used in houses in the form of woven cloth, place mats, and curtains to small furniture, such as centre and side tables.
- **Coconut** is grown in tropical and subtropical countries and its

Photograph 3: Bagasse Particle Boards

products are considered to be amongst the best ecofriendly products. The remarkable thing about this plant is the fact that almost every part of it can be used, ranging from the leaves to its roots. It can be used to create household items, such as curtains and wall decors. The coconut coir fibres are a great source for making door mats, carpets, and rugs.

- **Corn** is one such product that can be used after being discarded. The discarded corn husks can be used as home décor furniture. They are equally brilliant and elegant as bamboo, sea grass, and other natural materials. A company known as Corn Board Manufacturing, Inc., has developed a proprietary corn-based composite boards that can be used instead of particle boards, plywood, or fibreboard for furniture and house construction.
- **Jute** is one of the most consumed and frequently produced vegetable fibre after cotton. Some of the jute-based products include jute rugs, curtains, sacks, rugs, chair upholstery, and linoleum backing. It is 100% biodegradable, thus making it a great option for homes.

SCGJ has been developing models, policies, and standards to give the necessary impetus to the green business and the skills for using these diverse building materials efficiently. Among the various sectors of green businesses, SCGJ is also focussing on developing National Occupational Standards, undertaking skill–gap analysis, and certifying skilled manpower in the green construction sector.

SCGJ along with KPMG has carried out a sector analysis and skill-gap studies in green construction. As per the study, encouraging green building construction and retrofitting the existing buildings will help in mitigating the effect of climate change. In 2013–14, the residential sector and commercial sector consumed 22.5% and 8.7%, respectively, of the total energy.[4] They account for 30% of the total electricity consumption in India, out of which almost 72% is consumed by the residential sector. The buildings sector is responsible for roughly 12% of fresh water use, generation of an estimated wastewater of 22,900 million litres per day (MLD), most of which goes untreated to the sources, that is the rivers, streams, and oceans. As per the Central Pollution Control Board (2011), the current quantum of solid waste generated in India is around 62 million tonnes per annum, out of which 25% accounts for the construction industry.

From a business perspective, there is a lot of scope for new/altered business models for the green construction market. The building/construction sector is linked with many ancillary industries and, hence it has a large scope for creating large-scale employment opportunities. The material industry has a huge employment scope in the supply chain of materials/products in the construction Industry. It is estimated that 20% of the jobs generated in the construction industry would require workers skilled in green construction. The main drivers of green construction, those that would contribute towards the INDC commitments, are the promotion of energy efficiency, water efficiency, waste reduction, adoption of RE sources, and development of a sustainable habitat. Thus, the SCGJ provides the required impetus and opportunity for the building sector to introduce the green concept and techniques through creating a pool of skilled manpower which, ultimately, will aid sustainable growth.

4 As per the Central Statistics Office, 2015.

REGENT
LIGHTING

Tunable White

HUMAN CENTRIC LIGHTING. LED SOLUTIONS MAKE IT POSSIBLE.

Shades of Sustainability

Nature, our oldest muse, has inspired legions of green builders and architects. Be it art, literature, economics, or architecture, if we look closely, our best works reflect an unmistakable relationship with nature. In today's scenario, given the dire situation which we are in, the time has come to look back at the traditional ways of preserving what little remains of our reserves. In this article, **Sunanda Satwah** identifies and ponders over the challenges that have come to define this struggle.

'Only when the last tree has died, the last river been poisoned, and the last fish been caught, will we realize we cannot eat money.'

—A proverb of the Cree Indians

Sunanda Satwah, currently a visiting faculty at CTESCOA, has more than 15 year's of experience in the field of architecture and over a decade's experience in healthcare design. She can be reached at: satwah1@rediffmail.com

Shades of Green

Sustainable design is inherently in harmony with nature and thus affordable. However, many believe that going green is more expensive than the conventional route.

Question is, 'Can we continue walking on the conventional route?'

If not, then in what capacity can each one contribute to sustainability?

There is no one-size-fits-all solution. Peter Buchanan (2005) critically scrutinized the various green initiatives explored worldwide, their associated implications, and gave to the world '*Ten Shades of Green*'.[1] Alex Steffen (2016)[2] on the other hand, grouped contemporary environmentalists into 'light greens', 'dark greens', and 'bright greens', grouping them by their beliefs. Those who believe in achieving environmental sustainability through personal responsibility are marked as 'light-green environmentalists'; the ones that believe in radical industrial and political change are termed as 'dark greens'; and those who believe that long-lasting prosperity and sustainability can be achieved through innovative design and urban revitalization are termed as 'bright-green environmentalists'. Those who do not see any need for change are referred to as the 'greys'.[3]

Vernacular and regional architecture across the world is proof that sustainable design is possible without overexploiting the natural resources. It is testimony that through contextually sensitive and ingenious adaptations, we can prosper within our means and live in harmony with nature.

Traditional Wisdom

Anupam Mishra[4] narrates the story of a nation that successfully practiced rainwater harvesting in the Great Indian Desert 800 years ago. Our ancestors had the innate wisdom to intelligently collect

1 Buchanan P. 2005. *Ten Shades of Green: Architecture and the Natural World*. New York: Architectural League of New York.

2 Steffen A. 2016. *Bright Green, Light Green, Dark Green, Gray: The New Environmental Spectrum*; available at: Worldchanging: http://www.worldchanging.com; last accessed on November 21, 2017.

3 Refer to footnote 2.

4 Mishra A. *The Ancient Ingenuity of Water Harvesting*. Retrieved from TED Talks.

and harvest meagre quantities of rainwater, less than 200 mm, for all their annual needs through a network of *kund*s, *tankas*, *jaseris*, and *rejanis*[5] that could, over a monsoon season, harvest millions of gallons of pure drinking water. In stark contrast, fast forwarding to 2015, when the monsoons played truant in Maharashtra, Mumbai experienced up to 40% cut in water supply. In April 2016, a water train was sent to Latur.

Traditional methods of construction took cognizance of nature and were closely bound to the transience of life, adding meaning to every action. Carved stone pillars would mark the catchment regions for *kunds* and *tankas* in Jaisalmer to warn trespassers not to spit or despoil the surroundings. Women in Tamil Nadu traditionally lay a white *rangoli* pattern outside their house every morning, offering obeisance to God and acknowledging the patterns of nature, while also offering food to ants and small insects in the form of the white grounded rice powder.[6] This spiritual integration with nature, one that displays concern for all life forms, is not just humble but also necessary as it sheds critical light on the various disturbances brought on by human activities.

Recycling Lessons in Nature

Biologist Wilson's study claims that there are more than 8,000 different kinds of ants that not only live in harmony, but also sustain and nourish the earth. Animal architects reveal excellent examples of resourcefulness. The industrious garden spider spins its web from protein silk. Whenever the fragile web tears up, the spider repairs it or 'eats' it up and weaves a brand new web with the 'recycled' silk[7] offering a classic example of recycling in nature, with zero down-cycling. Brian Edwards (2001)[8] claims that nature not merely recycles but moves upwards towards higher complexity, diversity, and beauty, shunning cloning, repetition, and static modular solutions often found in man-made designs. Why then must we resign ourselves to perpetual down-cycling?

Alternative Architecture

Biomimics around the world are beginning to look at nature for lessons in long-lasting survival. Science writer Janine Benyus (1997) claims that after 3.8 billion years of R&D, nature knows what works and failures become fossils.[9]

There are claims that by 2040, a 100 people will be living in colonies on the moon. Designs are underway to make the moon suitable for human habitation by melting ice for water, cultivating plants in lunar soil, and 3D printing homes and tools. Architect Norman Foster and the ESA have proposed 3D-printable regolith (lunar soil) structures on the surface of the moon using the locally available regolith. This, however, may be a reality for an elite few, and not the masses.

India Then and Now

Does it not seem ironical, Homo sapiens' quest to 'grow' water on the moon, only to waste it on Earth? Technology seems obsessed with innovations and path-breaking (expensive) interventions, when, perhaps, all we need is to get in touch with the wisdom of our roots, honour what we have, and harvest it for a richer tomorrow! Saving water and rivers has been a war cry for some years now. How did our water-surplus nation with its rivers, lakes, water bodies, and *kunds* become water stressed? There is something we are not doing right.

Agreed that the population has increased manifold while resources remain limited, it is time we converted our linear patterns of consumptions into closed-loop systems and aim towards up-cycling our resources, growing from strength to strength!

Mumbai sends about 90% of its municipal solid waste, approximately, 10,000 tonnes, to landfills every day. In comparison, Sweden sends only 4% of its household waste to landfills, the rest either gets recycled or converted into fuel in its waste-to-energy (WtE) power plants.

For a predominantly agricultural country, it is horrifying that India is still largely rainfed and the farms are at the mercy of monsoons every year. Israel on the other hand, consisting of 60% desert and 40% arid land, is almost rainfall independent. Through innovative use of technology and adoption of a state-wide water conservation policy, Israel has freed itself from the vagaries of nature. Household waste water no less than 80% is treated and 90% of the recycled water is reused for agriculture.

We are proud to have tapped the power of the sun and have in Kamuthi, Tamil Nadu, the largest solar power plant in the world.

Some resources can be saved by merely managing them better and avoiding wastefulness. Installing water and energy metres

5 For an explanation of these terms, refer to: http://www.rainwaterharvesting.org/Rural/thar-desert_tradi.htm; last accessed on November 22, 2017.

6 Satwah S. 2017. 'Nothing is Constant except Change'. *Transient* (3): 1–5.

7 Frisch K V. 1974. *Animal Architecture*. New York: A Helen and Kurt Wolff Book.

8 Edwards B. 2001. 'Design Challenge of Sustainability'. *Architectural Design* 71 (4): 20–9.

9 Benyus J M. 1997. *Biomimcry: Innovation Inspired by Nature*. New York: Harper Collins Publishers Inc.

Photograph 1: (Top to Bottom) Kund and water scarcity in arid areas in India

to monitor resource usage go a long way, for that which cannot be measured cannot be saved.

There may, however, be valuable resources already lost to us due to mindless exploitation and callous consumption. Securing alternate resources, such as cleaner energy, are perceived to be expensive due to the associated capital cost.

Models of Affordability

Affordability frequently entails the financial quotient; however, there are other aspects of affordability, such as social affordability, moral affordability, and existential affordability that have to be accounted for when we discuss human beings and resources.

There is a time to do the right thing, but once that opportunity is lost, advanced and financially intensive technological investments will be required to manage the scarcity of resources. Some questions are outside the purview of simplistic economic equations and have dire implications and consequences, one such being 'Can we afford to live without water?'

They Paid the Most Who Had the Least

Abhijit Banerjee and Esther Duflo (2011),[10] narrate the dilemma of the world's poor in availing the benefits of equitable resources repeatedly offered by the state and why the poor continue to pay the highest price for basic necessities, such as water and sanitation. Development cannot merely happen from the state regulatory bodies. Making India slum-free by 2022 under the 'Housing for All' urban initiative, will require more than government–private-sector participation and ecofriendly technologies. To truly hail a sustainable urban reality, besides the ecological design solutions, requires environmental awareness and a genuine desire to adapt in keeping with change.

If It Is Not Affordable, It Is Not Sustainable

It is paramount to remember that we are dealing with a nation whose numbers, depending on how we look at it, could either be an impediment or a resource.

Singapore does not have enough water and has launched the 'NEWater' project to achieve water self-sufficiency by 2061, when its 100-year water contract with Malaysia comes to an end. Singapore's 'toilet-to-tap' concept converts wastewater into highly purified water fit for consumption.

Sulabh International has installed over 200 biogas plants in public toilets across the country which generate cooking gas and electricity from human excreta. Biogas-based electricity from 2,000 persons per day can generate approximately 65 units of power.

10 Banerjee V A and Duflo E. 2011. *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty.* U P: Random House Publishers India Private Limited.

Photograph 2: The BIQ House: first algae-powered building in the world.

How Much Is Enough?

Is it enough to be sustainable or can we aim for more? Is it enough to build 'nearly zero energy buildings' when they could be 'energy-plus buildings'? Can we give to the environment more than what we extract from it? Can our buildings purify air? Pollution-eating concrete that reduces oxides of nitrogen in the air and concrete that absorbs carbon dioxide have already been developed.

Can our buildings generate energy? BIQ in Germany converts algae biomass—placed within the sun-facing façade's double skin—to heat, and, eventually, electricity.

Can our buildings create water? Vittori's Warka Water towers in Ethiopia can harvest 13–26 gallons of potable water from the atmosphere daily, while fog harvesting has been practiced in Chile for many years now.

Can our buildings be made out of agricultural waste? Architect David Benjamin's 12-m-high tower for the MoMA exhibition in New York was made using bricks naturally grown from shredded corn stalk and mushroom mycelium, thus utilizing agro waste and reducing the building's carbon footprint.

Photograph 3: House made using baubotanik architecture

Can our buildings grow like trees? Dr Ferdinand Ludwig's Baubotanik or Living Plant Construction, intertwines the structural system of buildings with live trees, by not only using the tree's structural strength, but also absorbing carbon dioxide to strengthen its structure. Baubotanik combines the wisdom of arborsculpture with modern technology.

Conclusion

Can we live harmoniously without extracting more than what we can return? Also, can we repair that which we have harmed? Unless we reach this stage we cannot truly become sustainable and will not have to worry about affordability.

The materials we use are often energy-intensive taking into account embodied energy and life cycle assessment, and most financial costs are evident. What is not evident is the unseen cost of mining and depletion of land and its valuable resources that will not be replaced in our lifetime—the moral cost. Mine workers toiling in unhealthy conditions are the ethical cost; polluting of the groundwater from mine leachates are environmental and humanitarian costs that are often ignored when we discuss affordability.

Technological innovations are largely aimed towards reducing carbon footprints and combating the impact of pollution already caused; however, each of us can also contribute towards saving the environment by walking that extra mile towards a healthier, wholesome, and affordable future.

We can no longer afford not to be sustainable. It is time each one of us became 'green environmentalists'. There are, after all, so many shades to choose from. Which is yours?

Come and experience what life is like at

LOW DENSITY HOMES EMBRACED BY 8 ACRE CENTRAL GREENS

Park View Grand Spa

Sector 81, Gurgaon

A home life to envy.

READY TO MOVE-IN RESIDENCES

All Actual Pictures Displayed

Spacious 3 & 4 BHK	*Family Lounge*	*Servant Quarter*	*Select Few Penthouses*	*Signature Clubhouse*

OCCUPANCY CERTIFICATE OBTAINED | NO GST

For private preview, call

9871191923, 9871191927

Price starting from Rs.1.49 Cr* onwards

HOME LOANS AVAILABLE FROM LEADING BANKS

Bestech House: 51, Sector – 44, Gurgaon, Haryana – 122002
Site Address: Sector 81, Gurgaon, Haryana **www.bestechgroup.com**

License No. 112 dtd. 31.05.2008 | License No. 55 of 2009 dtd. 27.08.2009

*Terms & Conditions Apply

BESTECH

Making Sustainable Construction Affordable by Enhancing Quantity Surveying Skills

Of late, the construction sector has received much attention as one of the biggest contributors of waste and greenhouse gas emissions. In this article, **Vijay Kumar Sharma** identifies the profile of quality surveyors as important and necessary as a range of responsibilities, those ranging from managing costs to deciding on contracts fall under their purview.

Vijay Kumar Sharma, Chief Engineer (Jt. Secretary), has worked in various private firms in leading roles. With more than 40 years of experience in numerous sectors, ranging from conceptualizing to budgeting and cost control, he continues to shape and influence the field of sustainable construction and architecture. He can be reached at: ervijaysharma@yahoo.com

As per the Collins English Dictionary, 'quantity surveying', identified as a noun, has been explained as: 'The action or profession of a person who estimates the cost of the materials and labour necessary for a construction job.'[1]

A quantity surveyor (QS) is a construction industry professional with expert knowledge on construction costs and contracts, including, cost consulting, cost planning, and commercial management throughout the entire life cycle of the project from inception to completion.[2]

The term 'quantity surveyor' originated in the United Kingdom. QS professionals working in the construction sector are often regarded as people concerned with construction costs and contracts. Defined as those who '[manage] all costs relating to building and civil engineering projects, from the initial calculations to the final figures [they] seek to minimize the costs of a project and enhance value for money, while still achieving the required standards and quality including that all statutory regulations are met'.[3]

When asked, many people say that QS professionals are people who estimate quantities of construction material, but, in reality, they perform many other roles including managing costs and finances, advising on procurement routes, and deciding on construction contracts and related documentation. In fact, Quantity surveyors are widely recognized within the construction industry as the most appropriate cost advisers. Their skills in the measurement and valuation of construction work are without equal.[4] It may, however, be pertinent to point out that the roles of QS professionals vary from country to country.

While maintaining the expected standard and quality, a QS professional aims at reducing the total cost of a project and ensures value for money during each project phase and the actual

1 https://www.collinsdictionary.com/dictionary/english/quantity-surveying; last accessed on October 31, 2017.

2 https://en.wikipedia.org/wiki/Quantity_surveyor; last accessed on October 31, 2017.

3 https://www.prospects.ac.uk/job-profiles/quantity-surveyor; last accessed on October 31, 2017.

4 Ashworth A and Perera S. 2015. *Cost Studies of Buildings*. Qxon: Routledge.

procurement of a project.

Given the QS professionals' work in the industry, they may also be referred to as construction surveyor, engineering surveyor, commercial cost manager, or a construction cost consultant.[5]

Traditional Quantity Surveying Services

The main responsibilities of a quantity surveyor are cost consulting, estimating, planning, control, contracts negotiation, procurement advice, Preparing Bill of Quantities (BOQ), and the tender document, monitoring budget, preparation of payment application, certification, and valuation of construction work, understand implications of health and safety regulation, etc.

However, nowadays they perform more diverse roles, such as cost consulting, cost prediction/projection, cost planning, and commercial management throughout the life cycle of the project from inception to completion, value determination, risk management and calculation, procurement advice and assistance during the tendering procedures, tender analysis and agreement of the contract sum, etc.

A question that arises is how does QS help in improving sustainability? To answer this, we first have to look at issues that impact sustainability, and whether any of these will be impacted if QS services have not been rendered professionally.

Issues which may impact sustainability are:

- Site selection
- Design
  - » Architectural
  - » Engineering

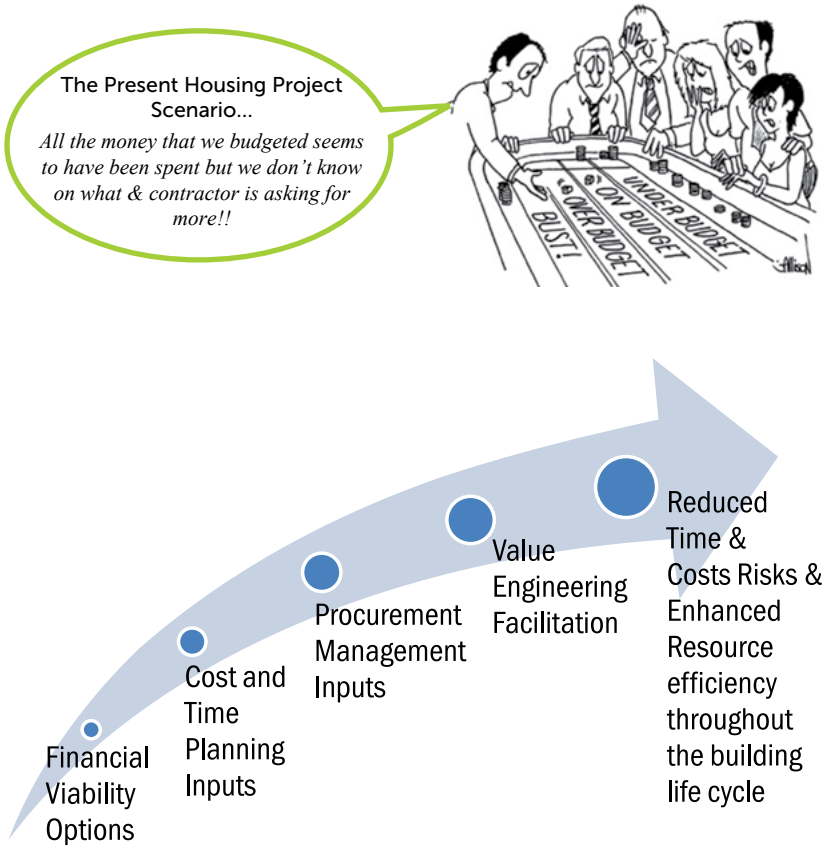


Figure 1: Enhancing QS skills help in sustainability through better project design and control at all stages of a building project

- Orientation of structure
- Buildability
- Cost
- Time
- Quality

In so far as the first four points are concerned, the role of QS professionals is particularly crucial in the early stages of the project.[6] It is a well-accepted management principle that what is measured gets controlled. This is the stage wherein QS professionals are required to perform the financial viability options in close coordination of the project owner and the project manager and perform tradeoffs as per the identified project requirements. It is the need of the hour to integrate sustainability into the affordable housing projects as there is a close relation to cost, durability, fire safety, weather resistance, thermal behaviour, water tightness, and acoustics.

In Part 7 of the National Building Code, aspects of project management have now been introduced.[7] The practicing project managers are required to strengthen these weak areas through enhanced database and quantity-surveying skills. Regarding the last four points, the connection between them and sustainability may not be self-evident but it does exist.

Buildability: All professionals involved in construction will agree that if the design of a building is easy to build, it will save time

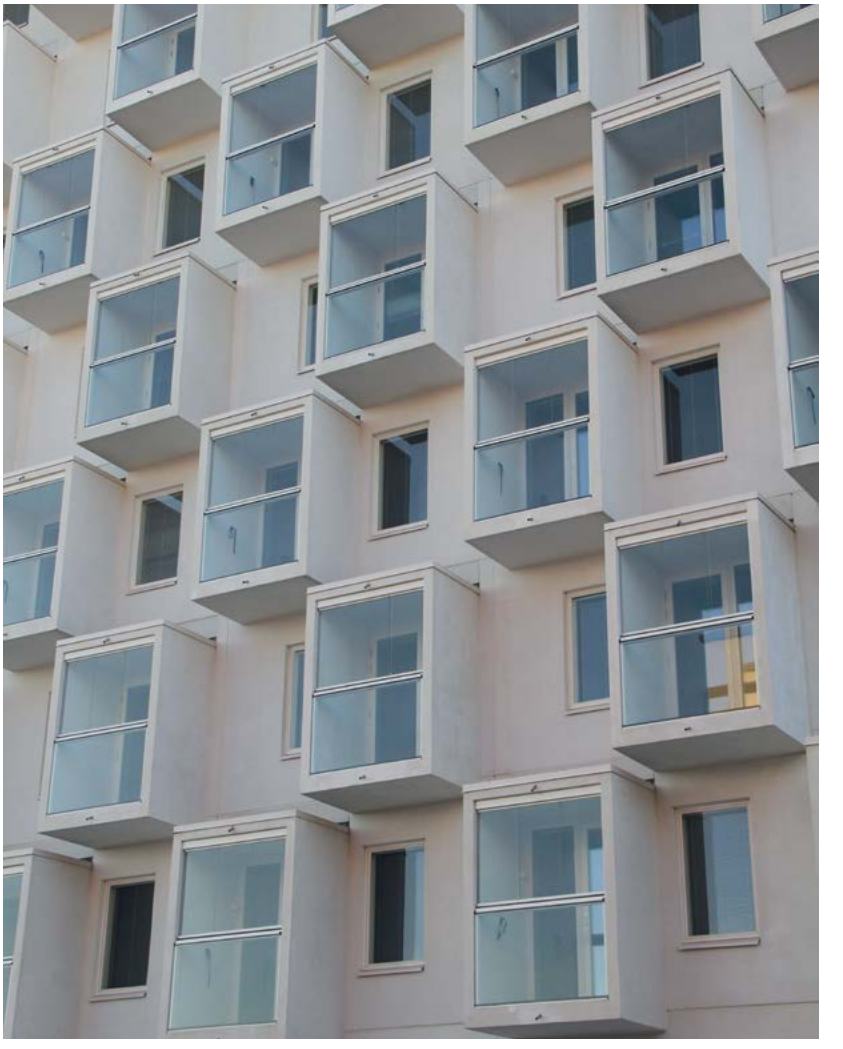
5 http://www.ricssbe.org/qs/; last accessed on October 31, 2017.

6 Refer to footnote 4, page 9.

7 National Building Code. BIS. 2016. s.l.: Bureau Of Indian Standard.

and money. More time spent on site means more energy consumed, thus directly impacting its sustainability. If we can save time in creating a building, we will have contributed in reducing energy consumption. This factor, that is, buildability is recognized by pioneering countries, such as Singapore, which examine building proposals from this aspect before granting permission. They have established that buildable designs increase productivity, thus reducing the man days required for a project. In fact, they are now moving more and more to off-site building manufacturing, thus nudging the building industry to adopt 'design for manufacturing approach using prefabricated prefinished volumetric construction techniques. These techniques automatically force building designs to be easier to assemble/build. In this aspect, QS professionals can contribute by evaluating the quantum of man days and duration for which the construction machinery will be required for different design alternatives, thereby helping in getting more efficient designs that are easier to build and without compromising on functionality and durability. By presenting a comparative of the quantum of labour and the duration of machinery required to be deployed for different options, a quantity surveyor can demonstrate and establish credits. Building and Construction Authority, Singapore, documents this as 'score' called the Labor Saving Index which evaluates the overall buildability of a proposal.

Cost: This issue, perhaps, belongs exclusively to the QS domain. After a design has been finalized, a QS professional can be asked to carry out a value-engineering exercise after which alternatives to expensive materials can be proposed to help curtail costs. Substitute materials may include locally available alternatives which, if used, will reduce costs of transportation and help lessen a direct impact on the environment. It is possible that local alternatives may have a higher initial monetary cost, but may prove to be cheaper in life cycle analysis. In order to reduce costs, a QS professional may also recommend adoption of standardized components which will not only reduce costs but may be available at a lower price. Use of standardized components will further reduce the energy consumed in the production of buildings.



Time: As mentioned above, lesser time spent on construction will result in lesser consumption of energy. However, some one of the factors that impact the actual time spent on site is contingent on the following: How precise is the BOQ; how lucid and precise are the specifications for works; how fair and balanced is the contract document; and how does the evaluation of bids get carried out so that the best agency gets selected for the execution? In all these areas, the expertise of the QS professional plays a big role. We are all aware that the construction industry is notorious for delays and one of the reasons is that disputes arise frequently during the execution phase, especially with regard to necessities and modifications taking place in

the BOQs. Since all change orders have a direct impact on the project economics, getting the same approved is a time-consuming process, especially for public-funded projects. If the designs have been finalized before tendering, as they should be, there is no reason why there should be variations. However, these do happen and it is primarily due to inadequate knowledge of QS. Thus better control and management of variations on site can result in reducing time over runs and QS can play a pivotal role in this.

Quality: Quality of a building impacts sustainability by reducing maintenance costs and efforts. Quality has, in our opinion, a direct relation with the specifications adopted and who is selected to execute the work. QS professionals play a direct and important role in both these operations.

For the three crucial aspects, cost, time, and quality, QS professionals are recommended to look at project management practices in other sectors. Project Management Institute's updated Project Management Body of Knowledge[8] is a good compilation to refer to.

Amongst other issues, one that impacts the role of QS is the change that technology has brought in. While, previously, calculating quantities was done manually, thus requiring the QS professionals to be proficient in reading drawings, now, with the introduction of BIM, quantities of even the smallest items can be taken out with nearly 100% accuracy and without human intervention. Does this mean that QS professionals have become redundant in the building industry? Like all professions, QS professionals will have to upgrade their skills and learn to play the role of a building economist more than that of professionals who only compute quantities. Skill upgradation should include not just the ability to create BIM models, including the ability to read them, but also to look into the overall economics of the projects. This should include being able to evaluate various options and present to project owners and financers evidence, such as which option will give the maximum internal rate of return (IRR) and which is the best in terms of costs and benefits by doing a cost-benefit analysis. Once this transition takes place, the role of a QS professional becomes more important, thus resulting in more sustainable buildings. This aspect needs to be emphasized, especially in the context of India and the need for quality and sustainable infrastructure.

8 https://www.google.co.in / search?ei=QbH6WbbcBsr 0m AHB6ImADw&q= PMI%E2%80%99s+updated+Project+ Management+ Body+of+ Knowledge+ &oq=PMI%E2%80% 99s+updated+ Project+Management+ Body+of+Knowledge+ &gs_l= psy-ab.3..0i71k1l4. 36367.36367.0. 36726.1.1.0.0.0. 0.0.0..0.0....0...1.1.64. psy-ab..1.0.0....0.mBdBjnMkp DM; last accessed on November 1, 2017.

A glimpse of one-day Students' training programme organized by the GRIHA Council for students participating in ZONASA'2017 (zone-4) held at the Royal Global University, Guwahati, Assam

EVEREST
FIBRE CEMENT BOARDS

BUILDING A GREENER TOMORROW, TODAY.

At Everest, we cater to the changing needs of modern day architecture through our dynamic product line. The green products portfolio of Everest Fibre Cement Boards is an endeavour to save the planet by lowering the carbon footprint caused during construction. These contemporary green building materials are resistant to moisture, fire, termites and carry enhanced sound and thermal insulation properties, making them ideal for applications ranging from drywall solutions to internal and external claddings to ceilings.


Rapicon Walls


Heavy Duty Boards


Cement Wood Planks


Designer Ceilings


Stone Cladding

The Economic Times ARCHITECTURE & DESIGN TOP 100 BRANDS

GRIHA

Everest Industries Limited
CORPORATE OFFICE: Genesis A-32 Mohan Co-operative Industrial Estate Mathura Road New Delhi 110044 India
Tel: +91-11-41731951/52 Fax: +91-11-46566370 Helpline: 09958037777

Understanding Direct–Indirect Evaporative Cooling

Given the pace at which we produce and package a number of perishable items, not to mention how a considerable portion is exported as well, cooling and heating have emerged as one of the prominent factors that determine the efficiency of this sector. In this article, **Ujjwal Singh Rao** discusses the technology that is best suited to our climatic conditions and the energy-efficiency criteria.

Ujjwal Singh Rao, CEO Levanter Air System, has extensive experience in HVAC system designing and building energy modeling and simulations. He can be reached at: ujjwalsingh.aksh@gmail.com

Air conditioning is amongst the finest luxury inventions. Whether it is a hotel, restaurant, or office, for efficiency purposes, a comfortable workplace has become necessary. In the absence of comfortable working conditions, many industries, especially the hospitality industry, stand the risk of losing their clientele. Industries that make and package food products and medicines cannot survive a day if their heating, ventilation, and air conditioning (HVAC) system malfunctions. But in all HVAC systems, be it a direct evaporative, vapour compression, or any hybrid combination of above mentioned, there is a cost of operation that needs to be taken care of along with other factors.

A food-processing industry in India cannot depend completely on a direct evaporative system as products may get damaged during monsoons due to higher humidity levels. On the other hand, a welding shop floor belonging to the heavy metal industry cannot use chillers without cutting a major chunk from their profits due to a high exhaust rate. The HVAC engineers are working rigorously on developing ways to provide mediating solutions where cooling needs are met without compromising on profits as well as maintaining environment sustainability. The indirect-direct cooling is one of the emerging techniques that look promising to fulfil the criteria.

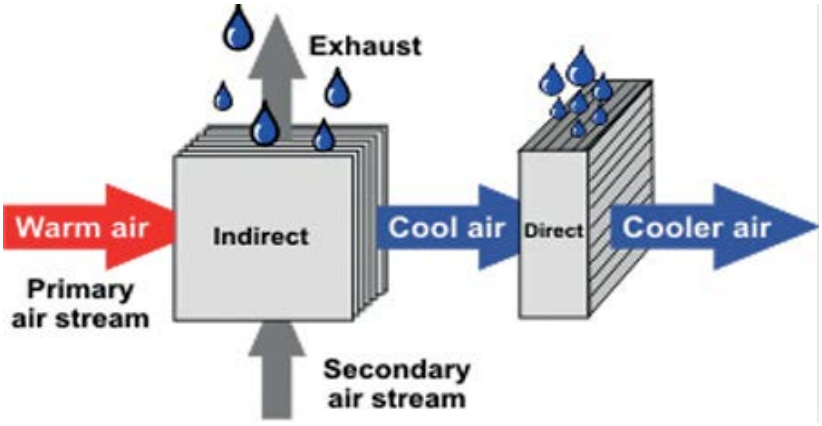


Figure 1: Indirect-direct evaporative cooling

Source: http://www.fairconditioning.org/resources; last accessed on November 17,2017

The indirect–direct evaporative cooling is a technique where water is cooled through ambient air in a heat exchanger to cool another stream of air sensibly (without adding moisture). The air used for cooling water is called secondary air, while the cooled air that will be sent to the room is called primary air. The secondary air is exhausted back into the outdoors while the cooled primary air is sent to the interiors after further cooling through direct evaporation (adding moisture). Since cooling is done in two stages, indirect and direct), it is also known as a two-stage evaporative cooling.

While the two-stage cooling system was first introduced

in India in the mid-1970s, it has gained popularity only in the recent years due to heavy electricity costs of refrigerant-based air conditioning systems and increased consumer awareness towards greener technological alternatives.

From an industrial perspective, money should be spent more on technology that drives businesses and less on auxiliaries that support it. For example, in a biscuit-making factory, systems, such as ovens and dough mixers are the driving technology while air conditioning is a support system. Every penny saved on air conditioning can be invested in improving the main technology.

For example

While the direct evaporative coolers save electricity, they can also make one feel sticky and uncomfortable due to high humidity levels. The two-stage cooling system seems to be a perfect solution where the humidity content and temperature can be maintained at a remarkably low temperature as compared to direct evaporative coolers while maintaining the power consumption at par with air conditioners, approximately 50%–60%.

Apart from power savings, another noticeable advantage of a two-stage system over air conditioning systems is that they provide 100% fresh air. Lack of sufficient fresh air directly affects occupants' health and productivity levels. VOC, odour, CO_2 content, and other indoor air quality parameters can be easily maintained to ensure occupant comfort using two-stage cooling systems.

Direct Evaporative Cooling (DEC)

The warm inlet air passes through a pad which is sprayed with water. The temperature of the spraying water is maintained equivalent to the wet-bulb temperature (WBT) of the inlet air. The heat is transferred by the air stream as sensible heat and is absorbed by the water as latent heat. Corresponding to the value of latent heat, a part of the water that is embedded by diffusion into the flowing air, is evaporated, thereby increasing the air's moisture content. The temperature of the outlet air decreases due to the sensible heat transferred by the air, but the enthalpy of the outlet air will be the same as that of the inlet air due to the latent heat recovered into the air as moisture.

Indirect Evaporative Cooling (IEC)

In this, two separate streams of air are used. A secondary air is used to cool water to its WBT through direct evaporation process (refer to Figure 4). Another stream of air, primary air, is used which is made to exchange heat with water cooled through the above process to lower its temperature

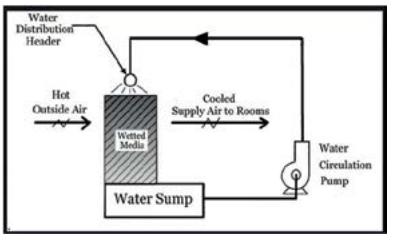


Figure 2: Direct evaporative cooling (DEC)
Source: http://www.fairconditioning.org/resources; last accessed on November 17,2017

by using a heat exchanger without adding any moisture and is sent to room for cooling. Meanwhile, the secondary air is exhausted back into atmosphere.

The IEC in a standalone mode can cool nearly up to ambient WBT depending on its heat exchanger efficiency. It is an effective option in spaces where additional moisture content cannot be allowed.

Indirect–Direct Evaporating Cooling (IDEC)

The IDEC is a combination of the above-mentioned techniques where we first cool the incoming

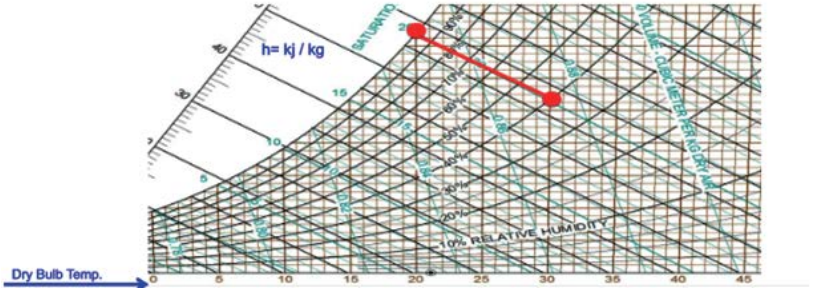
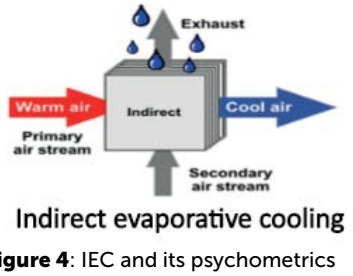


Figure 3: DEC psychometrics
Source: http://www.fairconditioning.org/resources; last accessed on November 17,2017



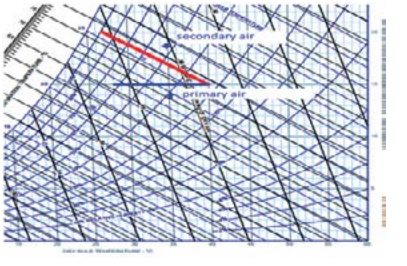


Figure 4: IEC and its psychometrics
Source: http://www.fairconditioning.org/resources last accessed on November 17,2017

air by the indirect technique and then through the direct technique. The important thing to note here is that since the air is first cooled though the indirect process, its WBT drops to a lower value, thereby making air cooler than direct evaporative or indirect evaporative alone. Given this, the temperature dips even lower than ambient WBT. Furthermore, since the air is cooled sensibly first, its moisture-holding capacity weakens making the air lesser humid than DEC.

Quantifying the Idea

Speaking quantitavely, there is an easy method for roughly estimating the temperature of outlet the air from a two-stage cooling system.

Step 1: Measure outdoor dry-bulb (BBT) and wet-bulb temperatures (WBT).

Step 2: Multiply the difference in DBT and WBT with efficiency of your heat exchanger (in case it is not known, 0.65 can be taken as efficiency in the absence of data.

Step 3: Now this is the temperature of air after indirect stage or stage 1, measure WBT of this new condition (one can use psycrometrics) and multiply it with saturation efficiency of your evaporating system (mostly honeycomb pads). Again, in case it is not known, one can take 0.9 as a factor.

Illlustrative Example:

Suppose the temperature outdoors during a summer noon were 40 °C dry-bulb and 24 °C wet-bulb; the difference in this case is of 16 °C. However, after multiplying it with 0.65, we get 10.4. This means that the air from Step 1 will be 10.4 °C cooler. As a result, the new DBT is 40–9.6, that is, 29.6 °C. Using psycrometrics, a new WBT corresponding with this air is approximately 21 °C, hence 8.6 × 0.9 is 7.7 and the final outlet air will be around 21.9 °C.

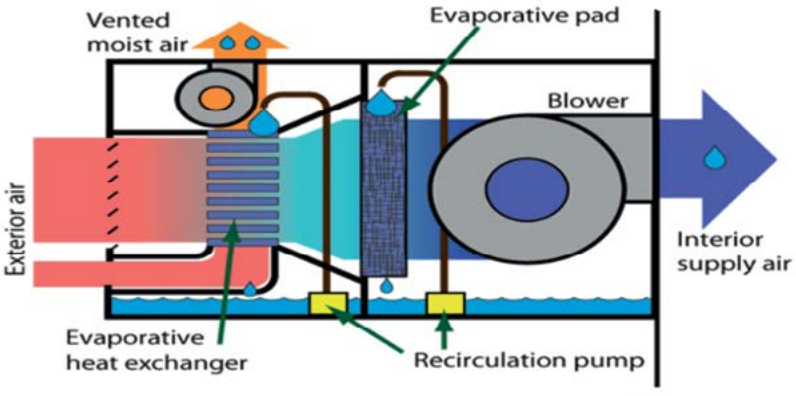


Figure 5: IDEC system

Source: www.energydesignresources.com last accessed on November 17,2017

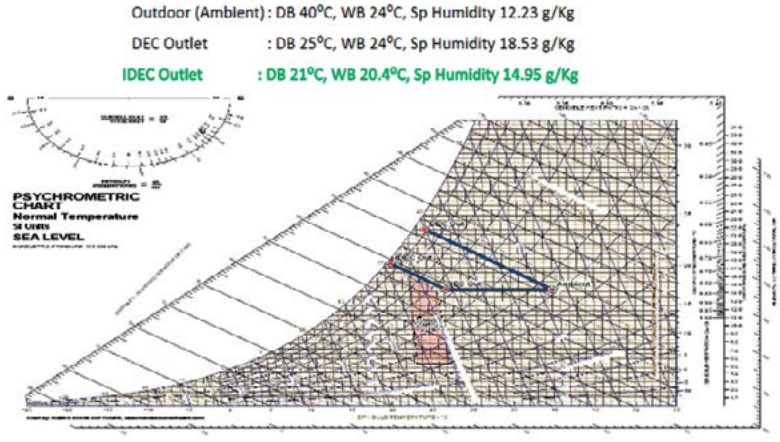


Figure 6: IDEC Psychometrics (1)

Source: http://www.fairconditioning.org/resources; last accessed on November 17,2017

An alternative and simpler way for non-HVAC professionals is to multiply the difference in outdoor DBT and WBT by factor 1.15 (the overall saturation efficiency) to get the drop in temperature.

40-24 is 16. 16 × 1.15 is 18.4, hence, the outlet air is 21.6 °C.

The IDEC can be coupled with DX coils to serve even lower temperatures and humidity levels or, conversely, for places with higher temperature and humidity.

Misting Type Two-stage Evaporative Cooling Systems

The MIDEC is an IDEC unit coupled with a DX coil operated through a chiller/heat pump. It has a unique feature of mist-cloud cooling technique where water breaks into a mist cloud during the direct evaporation stage. Mist cloud provides a huge amount of surface area interaction between the air and water causing the evaporative saturation efficiency to go as high as 95%–97%, thus requiring a smaller area for the same amount of CFM as compared to honeycomb pads. Since the mist cloud technique is also used in cooling secondry air, it considerably reduces the overall size of the MIDEC unit. The MIDEC unit has the following three modes of operation:

- In summers when the relative humidity is lower than 50%, it

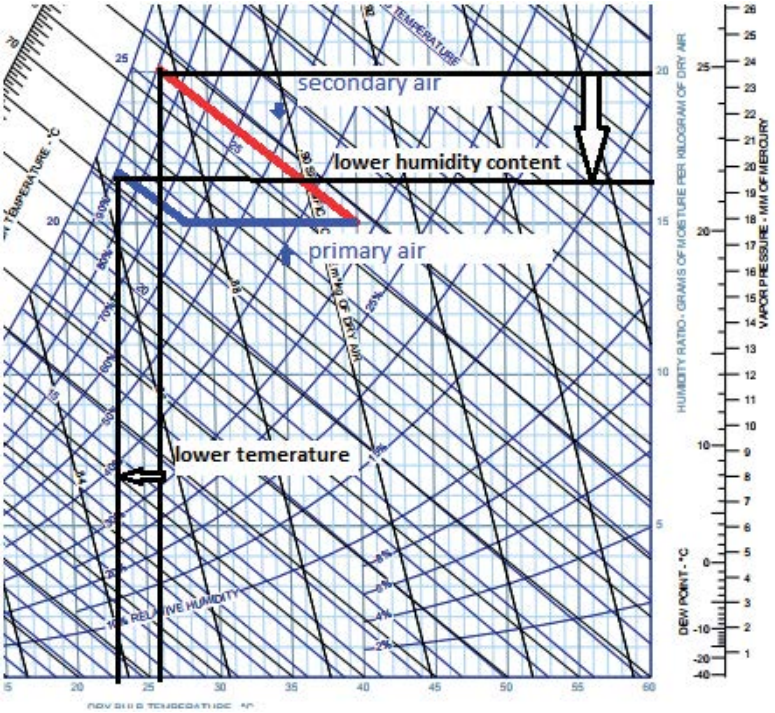


Figure 7: IDEC psychometrics (2)
Source: http://www.fairconditioning.org/resources; last accessed on November 17,2017

Photograph 1: Misting type IDEC (MIDEC)

works as an IDEC using mist-cloud technology.

- During monsoon, it can be operated through indirect + DX or DX alone where it uses only 20% fresh air and 80% of the room's recirculated air. Here, the secondary air is used to cool down the air-cooled condenser making it more efficient than regular air-cooled chillers.
- During winters, it acts as a heat pump and heats the primary air; secondary system works as a air heated evaporator while all misting systems are shut down during this period.

This is a semi-finished picture of the MIDEC without the outer skin. The same cooling coil we can see in the picture can be used as an IEC and chilled water coil, alternatively. A small 2" pad is used to hold the mist cloud inside the system (can be seen in a secondary air unit inlet; the unit's top part).

Though IDEC has been successful in industrial applications, the MIDEC, due to its compact size and efficiency, may be able to penetrate residential markets, too, in the near future. With few customizations these units can cope well a range of climatic differences.

With carbon footprint increasing everyday and with an increase in the daily needs for resources, such as food, water,clothing,transport, etc., the HVAC sector must lower its share in power to keep itself sustainable and profitable at the same time.

> "Every ton of recycled paper saves 17 trees."

ACTUAL SITE PICTURES

The Vatika Ecosystem

8 CITIES • 3,57,670 sq ft • 3,647 seats

BUSINESS CENTRES

vatika BUSINESS CENTRE

COMMERCIAL

DELIVERED 5.5 million sq ft

RESIDENTIAL

DELIVERED 36 million sq ft
9,400 homes and 6,710 plots

WALK TO WORK

PLOTS
FLOORS
CONDOMINIUMS
VILLAS

WALK TO SHOP

RETAIL

DELIVERED 0.6 million sq ft

vatika INDIA NEXT
NEW GURGAON
477 ACRES

vatika City Central
AMBALA
174 ACRES

vatika INFOTECH
JAIPUR
460 ACRES

FOOD & BEVERAGE

INSPIRED BY A BILLION FOODIES

NUKKAD WALA

LEISURE

THE WESTIN

PVR CINEMAS

WESTIN • Hotel + Resort & Spa
PVR • Tie-up for 28 screens

vatika
SINCE 1986

EDUCATION

MatriKiran

8.25-acre campus • 2 locations
WINNER, Innovation category
Times School Survey 2016 (Gurgaon)

INTERIOR SOLUTIONS

VATIKA INTERIOR SOLUTIONS

DESIGN TO PRODUCTION for Interiors

FACILITIES MANAGEMENT

envirO facilities management by vatika

Managing more than 70 million sq ft

A developer is **more than** the sum of its parts

vatika
creating lasting value

Corporate & Registered Office
Vatika Limited,
Vatika Triangle, 4th Floor
Sushant Lok-1, Block-A
MG Road, Gurgaon 122002
Haryana, INDIA

vatikacollections.com • *vatikagroup.com*

CIN - U74899HR1998PLC054821

Vatika Direct
9555 930 930

* DISCLAIMER: Projects under various stages of development. Contents of Vatika Group website in terms of project details are subject to The Real Estate (Regulation and Development) Act 2016, rules framed there under and implementation thereof. Customers are advised to have their independent evaluation. Concepts alluded herein are subjective. The purpose is to highlight scale and not solicit queries.

In Conversation with

Eugene Pandala

Eugene Pandala, an Indian architect, is known for building with values of environmental sustainability. He, given his preference for interesting organic forms, designs buildings using natural materials and ensures biodiversity conservation and landscape design.

What is 'Earth architecture'? How is it different from conventional architecture?

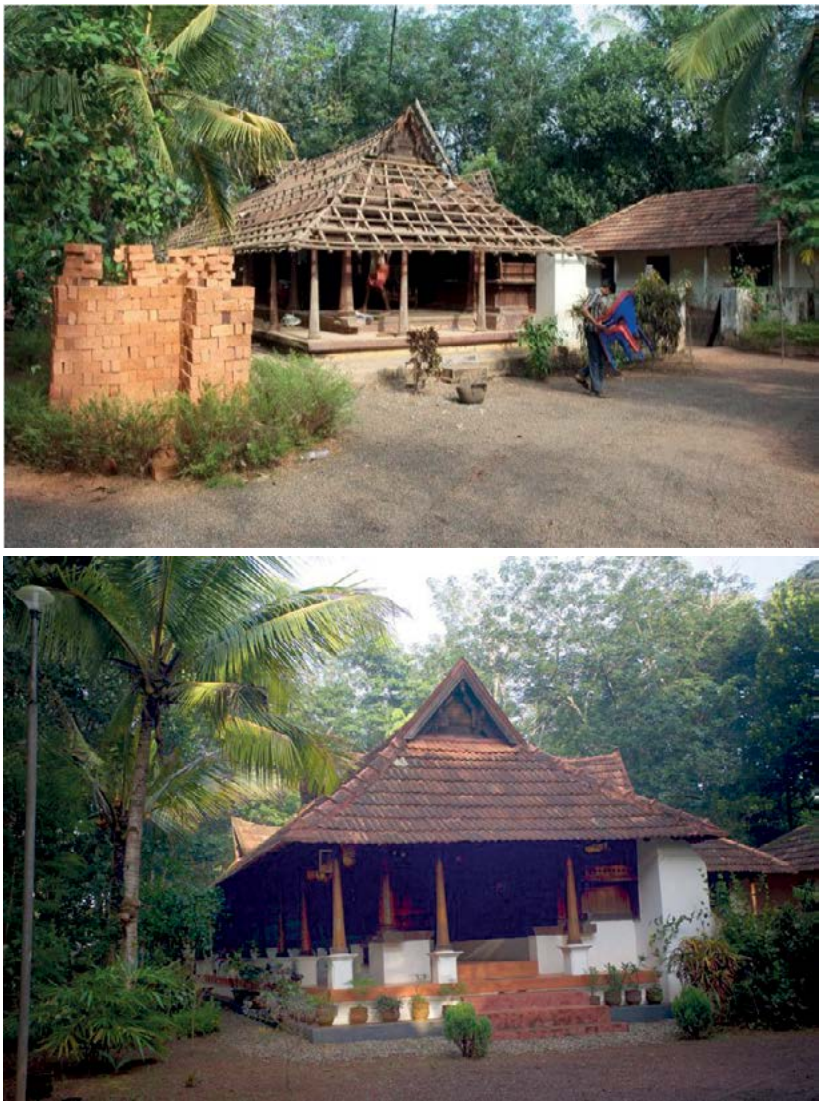
I disagree with the terminology, 'Earth architecture'. We use different materials to implement our designs to create 'good' architecture. Earth or mud is only one of such materials. Each material differs in its properties, looks and feel, functionality, and appropriateness in its context.

One of the important criteria of 'good' architecture, especially in today's circumstance, is its sustainability. Global warming and climate change challenges call for responsible architectural practices.

Ideally speaking, lifestyle modification of every individual, design, and construction style modification are urgent requirements to mitigate global warming of any product that we make out of depleting the natural resources. Most of the contemporary buildings are noted notorious energy guzzlers and are identified as unsustainable. The vocabulary of building materials and components needs urgent reconsideration, of which mud or earth can be one of the possible options for review and can also be a possible substantial constituent. Earth or mud is such a basic, viable, and highly sustainable element that it can be appropriated as a building material, if the context allows.

Is there any specific person whose work you admire and what is the source of your inspiration?

Every good piece of creation is an inspiration for me. Our natural and cultural heritage inspires me a lot. I was inspired by Hassan Fahey, an interaction with him in the early 1980s influenced me to look into the amazing traditions of our good architecture with basic materials, the kind of sustainable architecture that prevailed all over our rural areas, the practical, down-to-earth technologies which could be adopted with some tweaks to suit our modern needs to achieve cost effectiveness.



Photograph 1: (Top to bottom) Project Sooranad before and after restoration

What are the challenges and opportunities one could come across while working with natural materials? Are these materials truly affordable?

Working with natural materials is lot of fun, but the challenges are many. We have many times tested sustainable ways to deal with natural materials. Any affordable, sustainable material of a locality can be the best choice to work with, and, naturally and most likely these may have been the choice of the previous generations building stuff.

The architectural institutions of the contemporary era teach only the use of materials that came up after industrialization. In the history of architecture, historically important monuments are discussed and studied. Vernacular architecture, which has the best cost-effective sustainable technologies, is ignored and is not introduced to the students in the ways it should be. I cannot blame anyone because architectural education is now all about modern architecture, modern construction technology, and modern management systems. The history of architecture is taught only to fulfil a course criterion. In my opinion, the materials, technology, and its sustainability of informal architecture have to be taught to the students of building technology.

Can construction with natural materials withstand natural forces, such as earthquakes, torrential rains, cyclones, etc., which are occurring more frequently because of changing climate? If yes, how?

Let us take Japan, a country with frequent earthquakes. They have judiciously managed the earthquakes by using appropriate building technologies. Light structures made of bamboo, mud, timber, and paper comprised their safe built environment. Kerala, Goa, and most of the coastal areas of India have a rich cultural heritage with all forms of local materials, such as mud, lime, bamboo, thatch, and weeds. Additionally, these are also settlements that have withstood climatic challenges; also, there are plenty of buildings that are built sustainably using only local materials.

There have been many restrictions or limitations in the recent past on the usage of local materials in the construction sector for the preservation of natural resources. What are your thoughts on that?

Yes, sadly, there is no restriction on the availability of concrete which uses huge amounts of rock, crushed aggregates that are further crushed to form fine aggregates or river bed-mined fine aggregates; moreover, the cement, which requires a huge amount of energy for its manufacturing, is usually manufactured by the dirty fuel, coal, which is also the main contributor of greenhouse gas

Photograph 2: Banasura hill resort: Rammed earth architecture

emissions. There are restrictions for digging out mud for building habitats as there are on the transportation of mud.

Unfortunately, some of the architects in India still use concrete with a lot of passion; they build walls that could, functionally, need be only one to two inches, with 23 to 30 centimetre of concrete.

Did you come across the belief, 'natural buildings are for poor people' in your architectural practice? If yes, how did you break this myth amongst the common people?

Yes, I had an opportunity to design houses for a tribal habitat deep inside the forest, and I was unable to convince the users about the houses I proposed to build with natural materials. They had a basic question that if all the 'civilized' people live in concrete houses, why should they be forced to go back to the basics? Natural buildings are the obvious option for those who are aware, that is, people who have

Photograph 3: Juxtaposition of the natural materials in a residential project

an understanding of the urgent need to contribute to the efforts to mitigate global warming.

How do you think one can dissolve the growing gap between traditional knowledge and 'modern' practices? Do you think it is a good idea to integrate both to achieve a better outcome? If yes, why?

Traditional knowledge and systems are time-tested and they are all sustainable. If you take a traditional building, it will truly be sustainable without requiring any kind of certification, and, in all likelihood, the materials and methods used would have been considered commonplace. There is no harm in carrying forward the continuity of our culture. It is safe and will have the least side effects.

You have worked extensively in the areas of urban design and heritage conservation. What challenges did you come across with respect to booming real estate establishments and how did you tackle the pressure, if that had been the case?

Kerala, the place where I live, is rich in natural and cultural heritage; the recent real estate boom in urban areas displaces both. I was once a propagator of low-rise development. Due to increasing urbanization, the destruction of natural and cultural heritage became rapid, and, as a result, I now propagate smaller building footprint with sustainable technologies.

In 2011, the Lalit Kala Akademi conferred you with the first Laurie Baker Award for your continuing work in sustainable and cost-effective buildings. How do you feel about that and in what way has the validation encouraged your work?

I was very enthused by the first Laurie Baker Award given to me by the Lalit Kala Akademi. I felt I should do more and more and think about using cost-effective technologies that can be easily deployed. Sustainable certified buildings have to be cost-effective, otherwise, they cannot reach the masses. The intention to build sustainably is to mitigate global warming and is not just for the rich 10% of our population. Sustainable technologies should be available to all the people at affordable cost. Certification should not restrain sustainability and should instead provide the most simple and affordable technologies to everyone.

Tell us about the interesting projects you are involved with currently.

I am currently working on many building projects, some regular and some interesting, that use natural materials; one such project is happening in Rajasthan. Another challenging project is under way in Madhya Pradesh; here, I am reusing some recycled building materials for construction.

> "What is now called 'green architecture' is an opportunistic caricature of a much deeper consideration of the issues related to sustainability that architecture has been engaged with for many years. It was one of the first professions that was deeply concerned with these issues and that had an intellectual response to them."
>
> — Rem Koolhaas

Explore the Road Less Traveled
like we do...

Since 2008 | 10K organic followers | Global Engagement

Our vision is to raise awareness about the environment and promote knowledge and education on prime environmental concerns. We also focus on exploring knowledge through online and social media about the emerging environment issues and highlight how people can get ready for the challenges of tomorrow, thus ushering a safer and more secure future for everyone.

We facilitate steps that help reduce carbon footprint so not just education but also **'end to end consultation'** as we believe learning should be followed by real action.

- Seminars & Workshops
- CSR & Sustainability Consultation
- Social Media Engagement

facebook.com/greendreamfoundation
instagram.com/greendreamfoundation
twitter.com/thegreendream
+91 9910857735 / +91 9654864887

www.greendream.foundation

IIM Udaipur

A Sustainable Campus for Future Leaders

Climate change and its devastating effects have now become a pressing concern. With GRIHA's Large-Development rating system, long-term benefits, such as sustainable design, cost savings, and better quality of life, can be achieved. In this article, using IIM Udaipur as an example, **Ashu Dehadani** discusses how a sustainable building is not just energy and cost-effective but also a necessity.

Ashu Dehadani, manager (technical and publications) at GRIHA Council, has more than 11 years of experience in the field of sustainable architecture, green buildings, and design. She can be reached at: ashu.dehadani@grihaindia.org

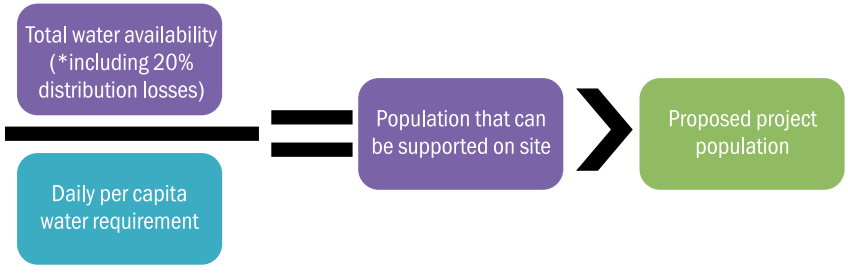
The 21st century witnessed a surge in population, especially in the larger cities. Today, according to the UNDP, more than 54% of the world's population lives in urban areas, which, incidentally, is expected to increase to 66% by 2050. These urban centres draw on resources, natural as well as human, from their surrounding areas as well as from areas at a distance. While large cities are extremely productive and provide employment opportunities to many; however, with the rapid influx of new migrants, the cities present an overwhelming challenge to the already-overburdened infrastructure.

As the gravity of the situation becomes clear to us, a dedicated movement—one that aims towards making our homes and cities greener, cleaner, and less energy- and water-intensive—has become the need of the hour. The Government of India has a comprehensive set of policies to drive the sustainable development movement in the country.

As India is overpopulated, there is an ongoing, large-scale campaign to provide housing to the people, to educate them, to provide treatment, and to provide employment. Large-scale projects, such as educational campuses, hospitals, townships, SEZs sprawling over hectares of land are coming up around the cities to cater to these needs. Considering the requirement of a large, consolidated land at a particular location, these cannot be accommodated in the city.

Large-scale projects disturb the ecology and biodiversity of the area and exert extreme, unjust pressure on the surrounding human settlements. Apart from generating tonnes of waste, resources, such as water and energy, are also strained. Although the Environmental Impact

Figure 1: Sections of GRIHA LD



*Derived from service level benchmarks for non-revenue water of Ministry Urban Development, Government of India

Figure 2: Carrying capacity of available water on site

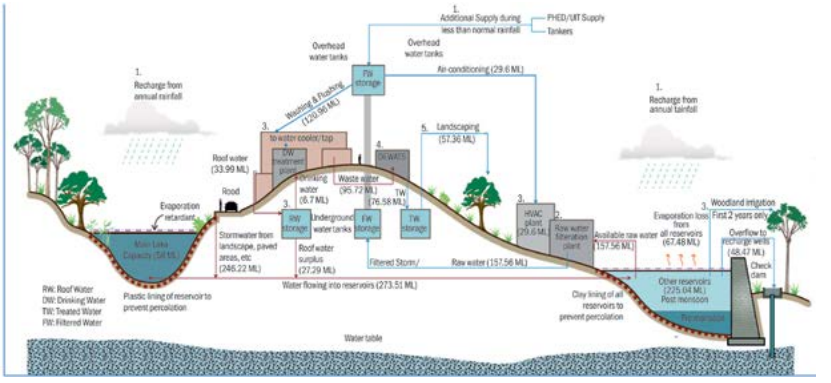


Figure 3: Cross-section showing water management in the IIMU campus

Assessment process is geared towards curbing these negative impacts however, considering the threat of climate change, erratic weather, depleting resources, a more wholesome and sensitive approach is required.

These parameters can be better understood with an example of a large-scale educational campus project, that is the Indian Institute of Management in Udaipur (IIMU). The IIMU is a sprawling, 300-acre campus with a contoured site.

A 50-metre-deep valley, acting as a natural barrier, divides the site into two parts. After rigorous resource mapping, more than 70% of the natural features, such as contours and vegetation, have been preserved in their natural state.

The project has set an example in master planning by achieving a 5-Star GRIHA Large Development rating; LD which was created to assess the environmental performance of larger developments, singular units that together make up cities, neighbourhoods/townships. Carrying capacity, carbon footprint, and green cover are the three indicative parameters in the rating based on which a project is assessed.

Carrying capacity is, essentially, the ability of a system, natural or artificial, to cater to the population inhabiting it without considerable damage or degradation. The water and green cover availability on the site must be the deciding factors while proposing the expected population of the site. The campus is designed in synchronization with Udaipur, with interspersed and interlinked water bodies in the master plan, thus resulting in a water-independent campus. Based on the topography and geology, three hydrological zones have been demarcated as the basis of the entire water management system. A connected network of bio swales, green pockets, and retention ponds ensure sustainable urban drainage system integration on the site, thus controlling the run off from the site, reducing the level of pollutants in the storm water, and encouraging groundwater recharge.

Although the existing site is sparse with scattered bushes, intensive landscaping will be undertaken to ensure that approximately 200 m^2 per capita green cover will be available on the campus, which is much more than 9 m^2 per capita requirements defined by the World Health Organization. In the spirit of self-sufficiency, about 7% of the landscaped area has been dedicated to food production. The landscaping will have a mix of grass, scrubs, woods, and intensive plantation along the riparian edge to prevent soil erosion and mud slides.

As per the IPCC, nearly 30% of the global GHG emissions are contributed by the transport sector. Carbon footprint is defined as the total carbon dioxide equivalent (CO_2e) emissions released from energy use within a development/city/state/country/sector. The IIMU campus has striven to lower the carbon footprint, less than the national average of 1.19 tCO_2/capita, by proposing reduction of energy use within the proposed development, by involving green construction practices, adopting clean energy on site, and reducing the use of motorized vehicles on site.

Photograph 1: DEWATS will be integrated into the landscape[1]

Urban Heat Island Effect is another ramification of urbanization that has increased the HVAC demand, thereby resulting in a further increase in temperature. Hard-paved surfaces absorb more heat than soft-paved surfaces (e.g., grass, shrubs, water bodies, etc.). The campus has been designed to ensure less temperature increase by balancing the urban geometry and green areas in an optimum manner.

Urban centres of India are facing severe energy shortage. Therefore, it becomes imperative to design and construct upcoming large developments in a manner that they are energy-efficient and are minimally dependent on conventional forms of energy. All upcoming buildings on the IIMU site will be designed as per the EPI benchmarks of GRIHA while complying with the visual and thermal comfort standards of NBC 2005/ASHRAE55. All buildings will also comply with the mandatory clauses of Energy Conservation Building Code. Additionally, all street lighting will be designed to adhere to minimum energy-efficiency norms, as described in the guidelines and benchmarks for large-area developments, MNRE, and TERI, as well as to meet the minimum illumination levels and uniformity coefficient for different street categories. Moreover, the energy generated from the renewable sources will help in reducing the overall energy that the project will require from the utility grid/diesel gensets.

As the project is an educational campus, priority has been given to pedestrian movement, including cycling, to increase the walkability and reduce carbon emissions due to vehicular movement. Additionally, a shuttle service has been provided for intra-campus movement and electric charging points will be provided to encourage electric vehicles.

Water as a basic necessity has often been neglected in the construction industry; however, the recent incidents of water scarcity have ensured its due attention. Most cities and towns in India have serious floods during monsoons due to reasons, such as lack of infrastructure specific for storm water discharge, clogging of drains and water bodies due to pollutants loading specially during and after storm events, blockage of natural drains from improper waste management, lack of systems to recharge groundwater with runoff or to harvest rainwater, and unplanned urban development

1 This is as per the Environment and Public Health Organization.

with relation to the drainage patterns.

The entire water cycle in buildings consists of source water (surface or ground), water treatment and distribution, use and reuse, and waste water treatment as well as the connection of this cycle to the surrounding hydrological basins. Following the water-sensitive design, decentralized waste water systems have been proposed to treat the waste water, along with a series of various filters, such as horizontal filtration, sand filters, carbon filters, and grease traps to ensure supply of potable water to the campus.

Access to clean, potable water ensures the prevention of diseases and the ensuing health benefits of its residents. Water required on site for various purposes must meet the quality norms established by the BIS for the given use. Similarly, all the harvested rainwater must undergo necessary filtration to ensure that it meets the quality standards of the BIS.

Additionally, the water fixtures will be low flow to decrease the water requirement of the campus. Rainwater from rooftops shall be collected and segregated to be used for drinking purposes. The UV filtration system will ensure potable quality of the drinking water.

Waste generation is another glaring issue in current times. In metro cities in India, an individual produces an average of 0.8 kg/waste/person daily. About 40% of all MSW is not collected at all and hence lies littered in the cities/towns and finds its way to nearby drains and water bodies, causing choking as well as pollution of surface water.[2]

Organic waste, because it is biodegradable, does not have the same dangers associated with this disposal of other solid wastes, such as plastics, e-waste, or hospital waste. The IIMU campus will treat 100% of the organic waste generated on campus through vermicomposting and biogas generation. Waste segregation at the source and contractual tie ups with the recycling agencies will help in decreasing the burden of municipal systems, including landfills. As this is an educational campus, there will be significant e-waste generation in the form of batteries, computer parts; these will be managed by engaging an external agency.

Additionally, the social aspect of the development has not been neglected. Equitable access, universal accessibility, ensuring safety and sanitation for the construction workers, banning child labour on site, and spreading environmental awareness in the occupants are different parameters for achieving social sustainability.

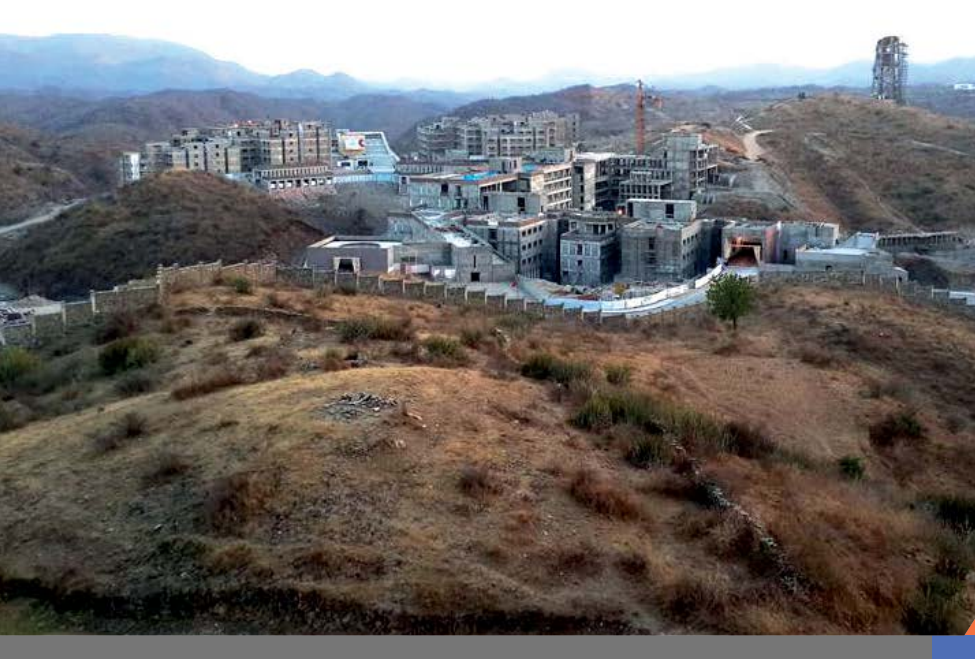
The conversion of the Earth's surface in to urban cities is, perhaps, one of the most drastic alterations on the global biosphere. Large-scale projects can be regarded as 'small cities' as they are not only cumbersome to carry out, but also heavily populated with various complex activities taking place on the premises that in turn impact the environment directly or indirectly. The initiatives, such as GRIHA Large Developments Rating, are a step towards minimizing these adverse impacts and such endeavours should respond dynamically to the changing climate and resource deficiencies. As part of the rating process, the entire project team goes through an intense thought process before the conception of the master planning, thus paving the way for a greener, more self-sufficient design. As long-term landholders, with concentrated assets and complex infrastructure within a given area, such projects are in an optimal position to capture and harness the long-terms benefits associated with sustainable design, especially cost savings. The inclusive, sustainable planning also adds long-term value to the institution, since such projects will have lesser resource consumption and better quality of life.

Acknowledgements
The project team comprising the principal architect, Vastu Shilpa, landscape architect, Earthscapes Consultancy Pvt Ltd, DbHMS, Green Building design and certification, structural consultant, Ducon Consultants Pvt Ltd, and MEP consultant, Jhaveri and associates, hold copyright of the published photographs.

> 'Seventy-eight percent of marine mammals are threatened by accidental deaths, such as getting caught in fishing nets.'

2 This is as per the India Water Portal

IIM Udaipur: GRIHA LD 5-Star Rated Campus



Mr Sameer Divekar,
Managing
Director, dbHMS

We have been working on the IIM Udaipur project since the last few years. Initially, we were planning for GRIHA rating system, and then, GRIHA LD was launched. At first, we were skeptical and faced many questions, such as 'How we will be able to migrate from GRIHA to GRIHA LD?' 'Will it be relevant to the project?' 'Since this is recently introduced system, will it add further delay to the project?' With these questions in mind, we started looking through the GRIHA LD ratings in depth. We were pleasantly surprised to see the vigour with which the GRIHA LD rating is formulated. The rating is very practical and appropriate given the enormous scale of the project. Some of the difficulties that we faced trying to follow GRIHA for large-scale projects were all well resolved with this new GRIHA LD rating system. The system allows projects to go in phases, there is more emphasis on infrastructure planning, and the scoring is based on actual impact on the environment.

We further worked on the project with the GRIHA team to further fine-tune our design strategies. The online calculators in GRIHA LD are very easy to use; at the same time, they capture the technicalities in depth. Regarding the requirement, wherever we had doubts, the GRIHA team was quick to resolve. With this combined effort, the project actually managed to get 5-star rating from GRIHA LD rather than a 4-star rating which was possible with GRIHA.

GRAPHENSTONE

THE ORIGINAL & AUTHENTIC

World's first ecological paints

GRIHA

GRIHA Council

This is to certify that the products

"Graphenstone® lime-based products"

have been included in the GRIHA Product Catalogue under the following categories:

Ecosphere Premium

GRIHA V.2015 criterion: 13, GRIHA V.3 criterion: 26 & SVAGRIHA criterion: 12

Biosphere Premium

GRIHA V.2015 criterion: 3 and 8, GRIHA V.3 criterion: 5 and 14 & SVAGRIHA criterion: 2 and 5

These products can be used in GRIHA & SVAGRIHA registered projects to meet the GRIHA & SVAGRIHA norms, respectively. This is valid only for the products which have been mentioned above.

The certificate for the above mentioned products is valid from **3rd May 2017 - 2nd May 2019**

Sanjay Seth
Chief Executive Officer

Note: This evaluation has been done based on the documentation - in the form of 3rd party test results and/or declarations - submitted by the manufacturer to GRIHA Council.

GRIHA Council is a joint initiative of Ministry of New and Renewable Energy, Government of India and The Energy and Resources Institute (TERI) to implement GRIHA (Green Rating for Integrated Habitat Assessment), India's National Rating System for Sustainable Habitats.
www.grihaindia.org

PAINTS FOR THE *green* GENERATION

www.graphenstone.in

Economic Value Addition through Workplace Productivity in Green Office Buildings in India

Studies have shown how green buildings are integral to working better in an office environment. While such buildings aim to take the best of environmental, social, and economic factors, green ratings are the yardstick that evaluate such efforts. In this article, **Shweta Manchanda** and **N Bala Chathurvedy** discuss the importance of developing green buildings for improving productivity.

Shweta Manchanda, Associate Professor at the School of Planning and Architecture, has extensive experience as a sustainable design expert. She can be reached at: shweta.manchanda@gmail.com

N Bala Chathurvedy, Research Associate at the School of Planning and Architecture, has worked on various research projects related to 'green' buildings.

Green Buildings in India: An Overview

Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle, from designing, construction, operation, maintenance, renovation, and deconstruction.[1]

Building 'green', a concept driven primarily by concerns of climate change addressed at a global level, has been on the national agenda for a few years now. Through new agendas, the national policies have constantly endeavoured to extend the reach and understanding of 'green' buildings.

The idea of building 'green' has gained such momentum that its benefits have been appropriated by the environmental, economical, and social sectors. With respect to these, while, at a broader level, environmental issues have received considerable attention, issues of health and well-being of occupants in relation to economic and social aspects are yet to be comprehensively researched and evaluated.

Green ratings aim to quantify all environmental, economic, and social benefits of green building design with emphasis on sustainable site planning, optimized energy performance, efficient construction practices, water and waste management, as well as indoor environmental quality.

Importance of Occupant Productivity

Productivity is defined as the ratio of output to input. In the case of office environments, productivity can mean different things, such as individual performance, team performance, and organizational performance.[2]

1 https://archive.epa.gov/greenbuilding/web/html/about.html; last accessed on November 17, 2017.

2 Heerwagen J. 2000. Green buildings, organizational success and occupant productivity. *Building Research and Information* 28 (5): 353–67.

Green building councils across the world are acknowledging the importance of occupant productivity. Occupant productivity may have direct a relationship to absenteeism and insurance costs, organizational productivity and profits, turnover and retention, as well as to sales and marketing advantage.[3] In light of the impacts, building-related factors should be reviewed for their influence on occupant productivity.

Estimating Productivity Outcomes

There can be several different methods for productivity measurement.

This work of professionals in today's offices is, however, knowledge intensive and the inputs and outputs are not easily quantifiable. The direct measurement of professionals in an office environment would require the monitoring of the following:

- The ability to focus and think, synthesize, and add value to the firm
- The ability to measure the contribution of individuals who work in a team environment
- The ability to monitor the quality of work as well as efficiency and output.[4]

Therefore, in this case, traditional productivity measures are not always applicable. Also, there are relatively fewer studies of objective productivity outcomes in field settings.

As a result of these problems, research in office settings often resorts to an old approach based on an individual's subjective assessments using surveys on self ratings of productivity.[5]

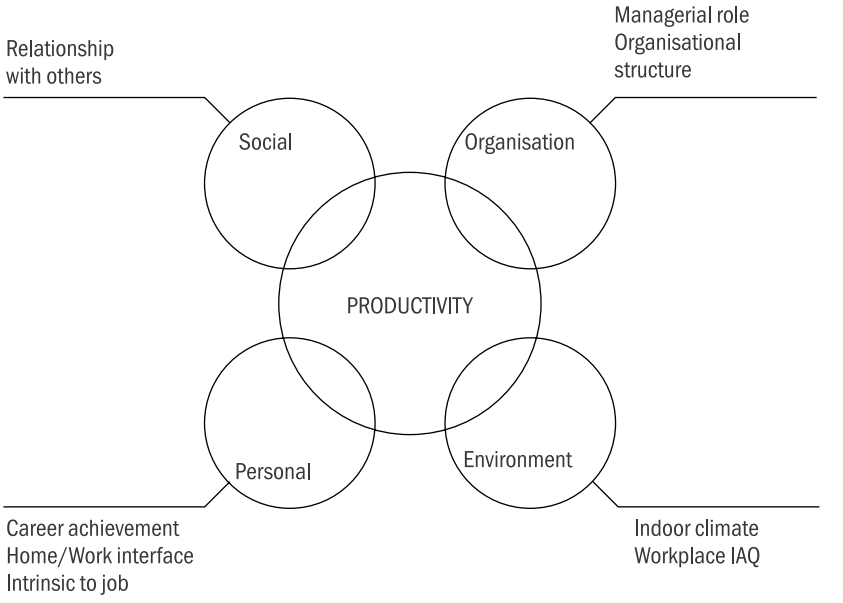


Figure 1: Factors affecting human productivity in a workplace

The Productivity Variables

Four main aspects that are considered to affect human productivity in an organizational working environment are personal, social, organizational, and environmental factors (refer to Figure 3).[6]

Amongst the environmental factors, occupants of buildings in various studies have identified five aspects of the environment that they believe affect worker productivity.

The above aspects, all with significant interactions and **crossover between them, could be grouped as follows:**[7]

- Functional environment (disturbances, interruptions, distance from work, and resources)
- Physical environment (air quality, climate, and noise)
- Psychological environment (privacy and territoriality)

The eight factors of indoor environmental quality listed by Horr et al. (2016)[8] along with factors identified by Leaman and Bordass (2010)[9], such as those of environmental control, are grouped under the classification given by Feige et al. (2013) in Heerwagen (2000).[10] These were studied in relation to their impacts on productivity, alongside

3 Refer to footnote 2.

4 Miller N, Pogue D, Gough Q, and Davis S. 2009. Green buildings and productivity. Retrieved from *The Journal of Sustainable Real Estate*: http://www.josre.org/04-green-buildings-and-productivity/; last accessed on November 17, 2017.

5 Refer to footnote 4.

6 Clements-Croome D. 2000. *Creating the Productive Workplace*. Retrieved from Research Gate: https://www.researchgate.net/publication/279190533_Creating_the_Productive_Workplace; last accessed on November 17, 2017.

7 Feige A, Wallbaum H, Janser M, and Windlinger L. 2013. Impact of sustainable office buildings on occupant's comfort and productivity. *Journal of Corporate Real Estate* 15: 7–34.

8 Horr Y A, Arif M, Kaushik A, Mazroei A, Katafygiotou M, and Elsarrag E. 2016. 'Occupant productivity and office indoor environment quality: a review of the literature'. *Building and Environment*, 105, 369-389. Retrieved from ScienceDirect: http://www.sciencedirect.com/science/article/pii/S0360132316302001; last accessed on November 17, 2017.

9 Leaman A and Bordass W. 1995,. 'Comfort and complexity: Unmanageable bedfellows? Workplace Comfort Forum. London: RIBA. Retrieved from Usable Buildings: http://www.usablebuildings.co.uk/Pages/Unprotected/Bedfellows1.pdf; last accessed on November 17, 2017.

10 Refer to Footnote 3.

Table 1: Physical environmental factors affecting workplace productivity as per various studies

ASID survey findings (AIA Conference on Highly Effective Buildings)[a]	Improving Office productivity: A Guide for Business and Facilities Managers[b]	Occupant productivity and office indoor environment quality: A review of the literature[c]	Productivity in buildings: The 'killer' variables[d]
Comfort and aesthetics	Physical (temperature, light, noise, air quality),	Indoor air quality	Comfort and control
Privacy	Space (plan, layout and privacy),	Thermal conditions	Responsiveness to need
Distractions			
Flexibility of space and customization	Ergonomics (workstation and controls	Daylighting and lighting	Ventilation type
Access to people and resources	Aesthetics (colour and quality)	Noise and acoustics	Work groups and layout
		Biophilia and views	Design intent
		Office layout	
		Look and feel	
		Location and amenities	

[a] Wheeler G. 1998. Presentation of ASID survey findings. AIA Conference on Highly Effective Buildings, (pp. 12–14).
[b] Bartlett P, and Oseland N. 2000. Improving Office Productivity: A Guide for Business and Facilities Managers. Work Study, 49(3). Retrieved from Emerald Inside: http://dx.doi.org/10.1108/ws.2000.07949cae.003
[c] Horr Y A, Arif M, Kaushik A, Mazroei A, Katafygiotou M, and Elsarrag E. 2016. Occupant Productivity and Office Indoor Environment Quality: A Review of the Literature. Building and Environment, 105, 369-389. Retrieved from Science Direct: http://www.sciencedirect.com/science/article/pii/S0360132316302001
[d] Leaman A and Bordass W. 2010. Productivity in Buildings: The 'killer' variables. Building Research and Information. Retrieved from Usable Buildings: http://www.usablebuildings.co.uk; last accessed on November 17, 2017

a listing of the pertaining green building criteria from the prevalent certification systems.

'Green' that Affects Productivity

That said, how might benefits of productivity accrue in 'Green' buildings, that is, what are the key 'green' building features and attributes?[11]

The main categories of most 'green' building rating systems are set up for focussing on the engineering aspects of buildings, such as site usage, energy, water conservation, building material components, and recycling of waste materials. Many systems have an indoor environment quality category that focusses on thermal comfort, indoor air quality, lighting and daylighting, quality of views, and acoustic performance. These criteria, however, primarily target the mechanical aspects of indoor environmental quality assessment, and while they affect occupant health and comfort, they may or may not address productivity.[12]

To summarize the brief overview of productivity, as it relates to 'green' building design, shows the key factors associated with workplace performance as: thermal environment, especially temperature, humidity level, and ventilation, air quality, and lighting; personal control over ambient conditions, especially temperature and ventilation.

The factors regulated by the green ratings that may be related to occupant productivity are:

- Ventilation and mechanical systems
- Interior air quality and pollutants
- Building materials and furnishings
- Daylighting and interior lighting quality
- Exterior views and visual comfort
- Exterior noise and interior acoustics
- Location, access, and some amenities
- Bioclimatic response, biophilia, and landscaping
- Occupant control and building monitoring

However, studies directly assessing the achieved occupant benefits of green certified buildings have been few, with none in India, and even fewer have evaluated the productivity benefits or comparison with other buildings. For an increase in the uptake of 'green' buildings, it is essential that the accrual of benefits becomes apparent.

11 Refer to footnote 3.

12 Refer to footnote 8.

Objectives of the Study and Research Scope

This study aims to evaluate the occupant productivity benefits of green buildings in the country. The study attempts to do this by:

- Reporting self-assessments of productivity as perceived by occupants of 'green' buildings.
- Relating perceptions of various indoor environmental quality parameters with productivity assessments.
- Relating other functional, physiological, and psychological factors with the productivity assessments.
- Benchmarking the productivity assessments with those from other similar studies globally.

The study examines buildings in Delhi-NCR. The composite climate is considered representative of the worst-case scenarios of the five climate zones classified in the country (hot dry, hot humid, composite, moderate, and cold dry). Also, the NCR has the maximum concentration of 'green' buildings in one area.

Further, due to limitations of time and access, only 'green' buildings could be evaluated as part of the sample database and a comparison could not be drawn with conventional buildings that are not green rated but could form a part of an extended study later. Also, the study evaluates only commercial green-rated projects and does not include residential or even healthcare typology within its purview.

Table 3: Rating details of case study buildings

Building Name	No. of Occupants	No. of Respondents
AU	300	49
CL	70	53
DA	50	43
ED	30	26
GG	40	16
ID	350	13
IO	350	89
IT	150	30
KG		11
PB		29
SU	2,500	54

Evaluation Methodology and Research Methods

The research methods are based around the core strategy of a survey approach through empirical field studies across a transverse selection. Arising from the literature review, the key variables were operationalized through the tool of a questionnaire survey.

The delivery was put together in the form of questionnaires for respondents. Responses were recorded using primarily closed-answer formats.

Questions relating to relevant criteria of 'green' building rating systems with possible influence on occupant productivity were grouped under sections as described below:

Data collected was analysed using various statistical techniques to draw inferences.

The selection of case studies was made from the listing of green-certified buildings in Delhi NCR.

Table 2: Compilation of functional, physical, and psychological comforts from various researches

Functional Comfort	Physical Comfort	Psychological Comfort
Outdoor views	Thermal comfort	Health and well-being
Open areas	Indoor air quality	Occupant productivity
Water availability and quality	Noise and acoustics	Overall conditions
Waste disposal	Daylighting and lighting	
Location and access to amenities	Control	
Energy efficiency		

Results and Discussion of Findings

The average productivity rating for the dataset (number of respondents=372) was found to be 5.75 on a scale of 1 to 7 (std dev =1.12, SE=0.058).

The Building Use Studies international dataset of n=192 in the UK found a perceived productivity mean of –1.9% for their question, 'Please estimate how you think your productivity at work is increased or decreased by the environmental conditions in the building?' on a scale of 1 to 9, with 5 being 0 and every level

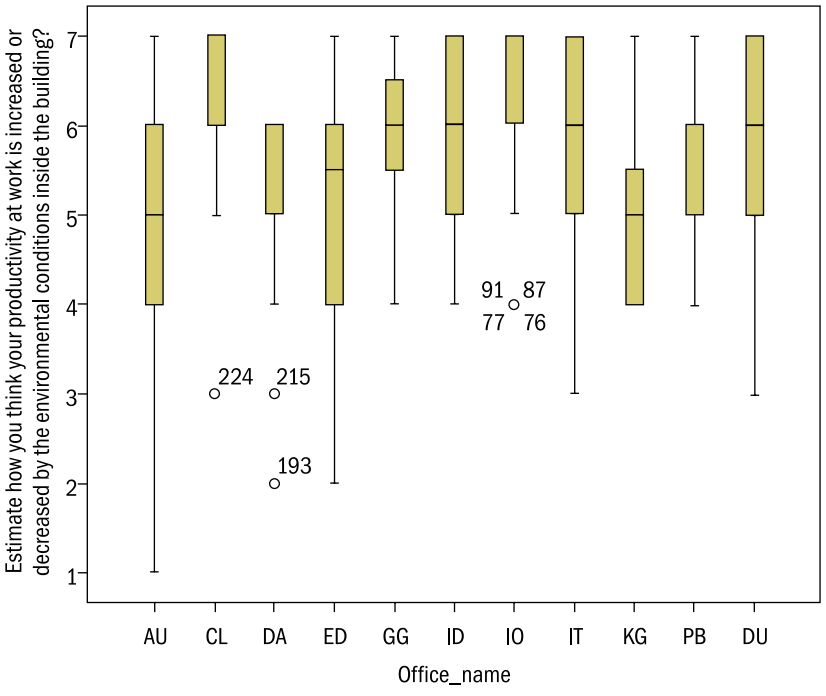


Figure 2: Average productivity ratings and standard deviations by building

having an increase or decrease of 10% on either side.

On the other hand, the survey of 500 certified buildings in the US found 43% respondents to agree that the employees in the buildings were more productive compared to previously occupied buildings with an average increase of 4.88% in the productivity.

Compared to the other studies, the productivity ratings found in this dataset, therefore, seem very encouraging as they indicate an increase in productivity by 1.75 points over the median vote (of 4 on a scale of 1 to 7 from decreased to increased) wherein occupants were asked to estimate their productivity to be increased or decreased by the environmental conditions inside the building.

Occupant responses, otherwise, were also generally high with mean scores falling between 5–6. These especially related to scores for temperature, indoor air quality, acoustics, and lighting. The highest mean ratings given by occupants were related to

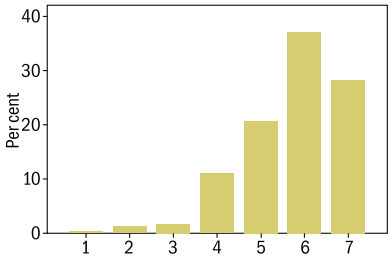
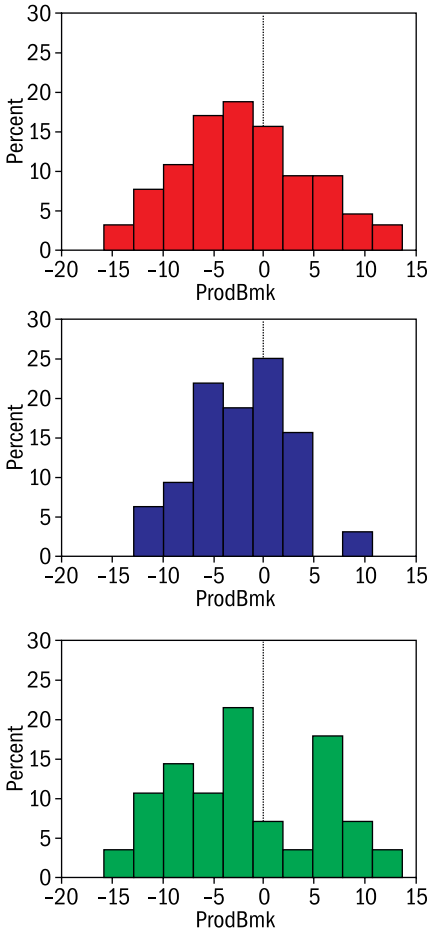
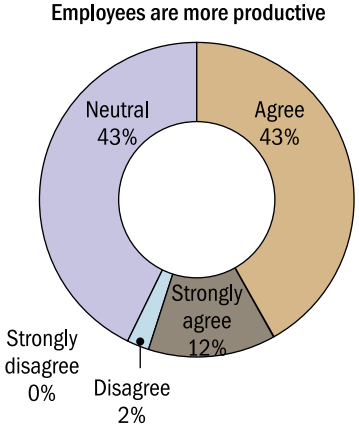


Figure 4: Productivity response from the survey

water and the lowest related to transportation.

Productivity was correlated with the overall satisfaction at a strength of 0.713 ($p<0.001$). The extent and strength of relationship between comfort and productivity is also established by other notable studies, one in the UK by the Building Use Studies group and the other from the US by the Centre for Built Environment.





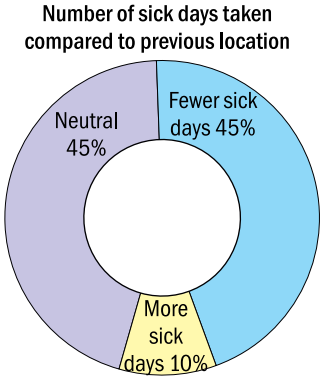


Figure 3: Findings of the UK dataset for all (top), ac (middle), and nv (bottom) buildings

Similar findings were noted again where productivity and health were correlated at a strength of 0.664, ($p<0.001$).

Self-assessed productivity also seems significantly correlated with perceptions of control and responses to complaints.

While we should note that not all tenants found productivity increases, and the literature suggests that organizational influences may mean as much or more than environmental factors, the productivity gains, where reported, can have significant impacts on organizational profits. Besides, there may be many other indirect impacts of productivity and gains from building green.

Acknowledgements
The project could not have been completed without the support of RICS Research Trust and University of Melbourne, Australia. Their contributions are sincerely appreciated and gratefully acknowledged.

A glimpse of one-and-a-half-day training programme organized by the GRIHA Council for students of Maratha Vidya Prasarak Samaj's College of Architecture and Centre for Design, Nashik, Maharashtra on September 7–8, 2017

Leasing Commences

Experience the exceptional.

Grand View High Street

A Super Premium Retail Format

Prominent Location

- Intersection of Golf Course Road & Golf Course Extension Road
- High visibility from GCER and 350 m frontage along Sector Road

Part of 30 acres mixed-use project

- Grand Hyatt Hotel & Spa
- Grade-A Office Tower
- Grand Hyatt Residences

Iconic Design

- Designed by Foster Partners, UK (designer of famous Apple HQ, Paolo Alto)
- Low rise (G+2) with double height (6m) façade

Unique Experience

- 17m wide boulevard interconnected with four themed courtyards
- Premium Multiplex
- Multiple Anchors,
- Food& Beverage Hub

For leasing contact: 9811043165

Urban Landscape Design and Biodiversity for Affordability

Since the beginning of civilization, the orderliness and geometry of spatial organization has fulfilled the aesthetic and functional requirements of urban landscape design. In India, as per the Town and Country Planning Organization, in 2001,* the urban area was 0.2% of the total land area; however, the population was very high. In this article, **Pooja Nandy** sheds further light on this predicament and on the need of the hour which is to study nature and the ecology of landscape by paying close attention to natural, historical, and cultural landscape values.

Pooja Nandy, Deputy General Manager (projects) at HUDCO's Human Settlements, has extensive experience in landscape design and plantation plans. She can be reached at: pooja.nandy@gmail.com

The creation of sustainable habitats that harmonize the relationship between man and nature are based on the appreciation of the values of the landscape. This skill is displayed by ancient civilizations, the traditional societies of Japan, Gardens of Paradise, and vernacular city builders.

Landscape Ecology

'From the ecological point of view, one can see that since life is only transmitted by life, then, by living, each one of us is physically linked to the origins of life and ... to all life.'[1] Landscape ecology is frequently used for studying the spatial patterns for lakes, landscape forestry, delineation of wetlands, fisheries, and agriculture.

Photograph 1: Zen Garden

Land Use Planning

Through public participation and awareness, raising the value of the natural processes, a realistic assessment of the urban land policies, and mechanisms of provisioning a sustained supply of land for the masses have to be built into the overall city and town

* Forest Survey of India, Ministry of Environment and Forests (MoEF), GOI, State of Forest Report, 2001.

1 McHarg I. 1971. *Design with Nature*. Natural History Press.

Photograph 2: Shalimar Garden, Char Bagh Design

development process. Activities, such as street tree planting projects, checking the water quality in water bodies, vacant land to transform into community gardens, and observing birds and their involvement in the urban ecology should be encouraged. The roofs may be utilized for terrace gardens and rainwater harvesting from rooftops. Innovative concepts, such as xerophytic gardens, rain gardens, and vertical gardens, infuse aesthetics and environmental benefits in an urban scenario.

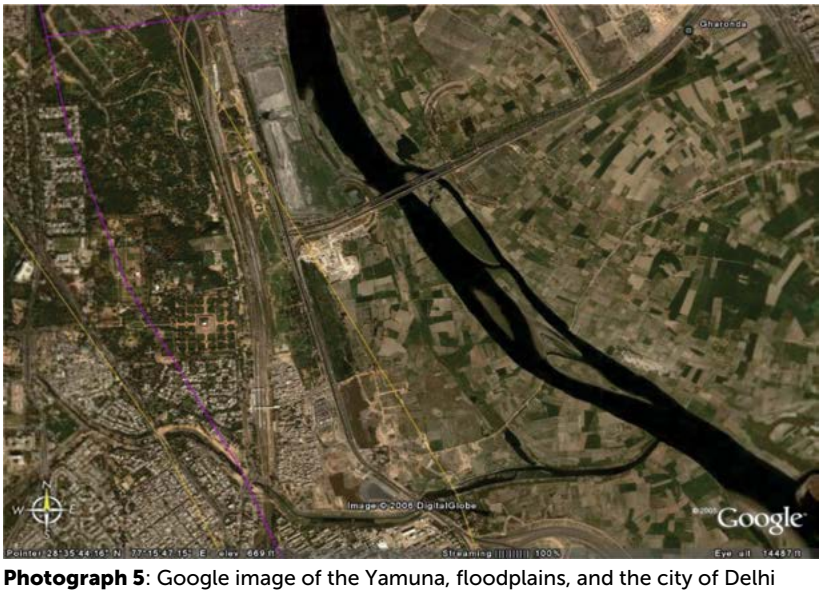
Urban Landscape Design

Public parks, roadways, highways, and commercial centres portray culture, tradition, and aspirations of a society. Through these patches of nature in the environment, man reconnects, learns, and experiences the rhythm of life, the very core of his existence. The importance of the availability of land supply to be accessed by the poor not only for affordable housing but also for social infrastructure as well as active and passive recreation cannot be undermined.

A home is man's basic shelter and the front garden, terraces, and the surrounding parks, all extensions of the home, comprise his microcosm that symbolizes the forests, rivers, and mountains, places with which he intuitively connects. However, the economically weaker strata of society are relegated to the fringes and, due to lack of provisions, are forced to relive themselves on streets and roadsides, thereby disturbing the urban aesthetics. Landscape design is seldom integrated with these realities and

Photograph 3: Private Garden, English Park Design

Photograph 4: Lodhi Gardens, Public Park



Photograph 5: Google image of the Yamuna, floodplains, and the city of Delhi

the open spaces have to cope with such vagaries that over time and due to neglect and lack of maintenance begin losing their charm.

Urban Revitalization

The solutions to the plight of the cities should be at the landscape scale so as to understand the structure of the natural system that sustains all life. The action for change should start now to revitalize the city through design interventions for enhancing the green cover, rejuvenating the water bodies, cleaning the air, and enriching the soil. For large projects, the master plan should focus on land patterns, landscape values, such as the base rock, soils, groundwater, and urban hydrology and disaster vulnerability. The schemes of AMRUT and HRIDAY have made a new and innovative beginning towards inner city rejuvenation.

The Indian Scenario

Trees have an important bearing on the ecological system and, in India, the number of trees are increasing and so is the area under trees. Given these measures, India's position in terms of ecological vulnerability should be less. Evolving an indigenous strategy suited to the geographical, social, and climatic conditions is advisable. India's national plan on climate change has set out eight 'National Missions' and one amongst these is the 'National Mission for a Green India'.[2] There is likelihood of introduction of three new missions for health, coastal zones, and waste to energy.

2 National Mission for a Green India, MoEF, GOI, India's National Action Plan on Climate Change.

Table 1: Zone-wise estimated holding capacity of an existing urban area

		(Population in '000)	
Zone	Holding Capacity MPD 2001	Existing Population 2001	Population in 2021
A	420	570	570
B	630	624	630
C	751	679	788
D	755	587	813
E	1,789	2,798	2,800
F	1,278	1,717	1,975
G	1,490	1,629	1,955
H	1,865	1,226	1,865
Sub total	8,978	9,830	11,396
Dwarka		597	1,300
Rohini III		96	160
Rohini IV and V		198	820
Narrela		179	1,620
Sub total	3,222	1,070	3,900
Grand total	122 lakh	109 lakh	153 lakh

* Population figures are only broad planning guidelines.

Source: http://delhi-masterplan.com/statistics/ Source: Delhi Development Authority; last accessed on November 17, 2017

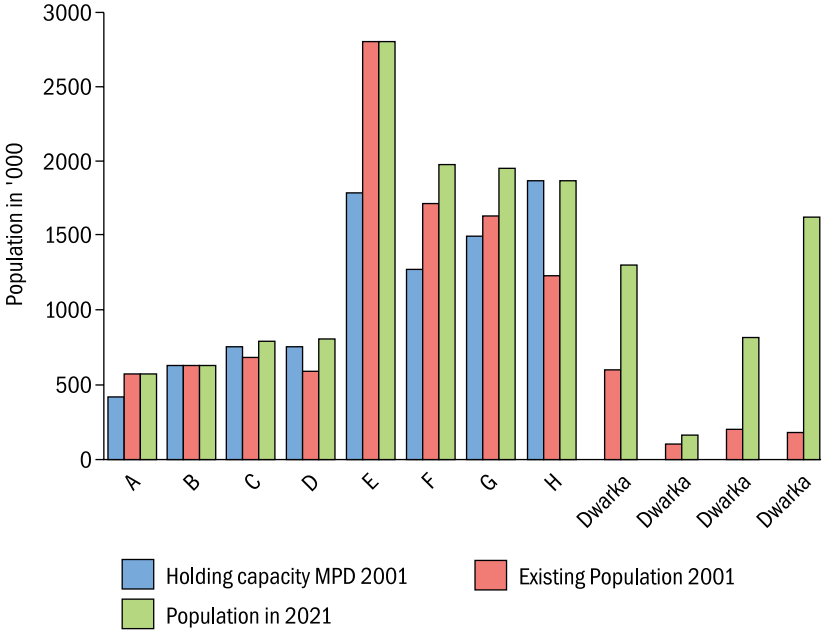


Figure 1: Zone-wise holding capacity of Delhi

Metropolitan Delhi

Master Plan, DDA

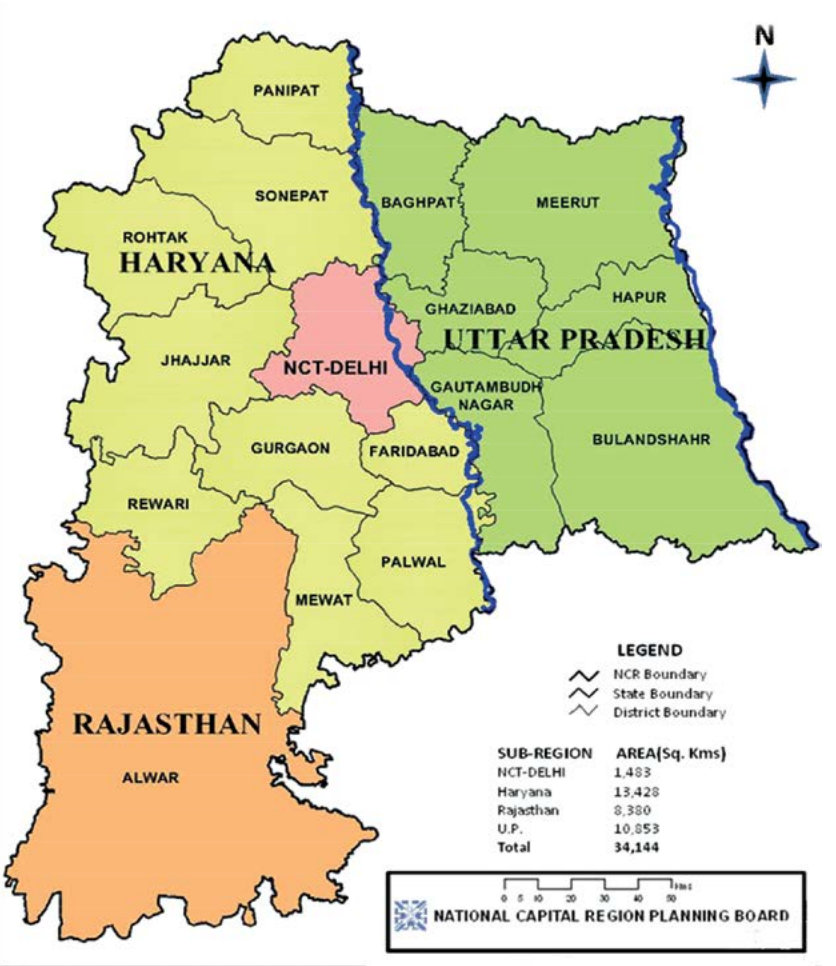
Delhi is the fastest growing metropolis in India. Its population has multiplied nine times in the last 50 years, thus witnessing a densification which the development authorities were unprepared for and an ecological footprint that exceeds the carrying capacity of land. The ecology of the precious natural resources of the capital, that is the Yamuna river, the Ridge, the wetlands, the wildlife preserves have been considerably degraded. The census and the projections made by the DDA subgroup estimate that the population of Delhi shall be 230 lakh though the estimated holding capacity is 152.96 lakh. Delhi has an area of 1,484 sq.km and it has one of the highest densities, that is 22,917 per sq.km amongst Indian metropolitan cities.

The emphasis towards land acquisition and land regrouping (land pooling) in government sectors for future development in the master plan should be tempered with the understanding of the city's image contributed by its visual heritage of green, for example, in Delhi the LBZ area, ridge, views, vistas, tree-lined avenues, and parks. Moreover, solutions of increasing housing density shall require correspondingly higher facilities, commercial and institutional areas, more infrastructure, and most importantly, food security for the additional population.

The National Capital Region

The Regional Plan 2001

This was approved by the board in November 1988 and visualized the important goal of 'a balanced and harmoniously developed region, leading to dispersal of economic



Map 1: National Capital Region: Regional Plan 2021, Constituent Area

activities and immigrants to Delhi, thereby leading to a manageable Delhi'. The plan proposed 'a policy of strict control on [the] creation of employment opportunities within the Union Territory of Delhi, moderate control in the Delhi Metropolitan Area, and encouragement with incentives, in the areas outside Delhi Metropolitan Area within the NCR'.

The Regional Plan 2021

The constituent areas of the National Capital Region are as shown in Map 1. The evaluation of the physiography, geology, slopes, hydrology, and availability of ground water, lithology and geomorphology has been done in the NCR planning board report at the regional level.

NCT- Delhi

Through the economic, transport, and environmental policy framework, the aim is to achieve the following land use plan:

- To provide a rational land use pattern in order to protect and preserve good agricultural land and utilize unproductive land for urban uses.
- To promote sustainable development in the region to improve quality of life.

Landscape Assets of the National Capital Region

The noteworthy, man-made landscapes include the Central Vista in Lutyen's Delhi, the Hauz Khas tank, the water ways, and the biodiversity parks that are being developed. The Natural Heritage Sites are listed in the regional plan, the significant being Ganga, Yamuna Wetland System, Sariska National Park, Alwar, Rajasthan, and Sultanpur National Park, Gurugram, Haryana, the Sohna and Badkal lakes, Najafgarh Jheel, and the Delhi Ridge.

However, the existing forest cover in NCR is a dismal figure of 4.02%, which is not sufficient to maintain the ecological balance of the region. It is proposed to enhance this area to 10%. The 'Land Use and Land Use Change' is highlighting the habitat fragmentation due to colonization, logging, agriculture, mining, etc. Based on satellite imagery, the land use change analysis of the NCR shows that the built up area in NCT increased by 47%, the land under agriculture shrank by 8.12%, and environmentally fragile and sensitive areas, such as the Yamuna riverbed/wetland, ridge areas, and forest areas are being subjected to authorized and unauthorized development.

Trees are Beneficial to Cities

In New York in 1994, the value of the city's trees in removing pollutants was estimated at $10 million per annum. Planting 11 million trees in the Los Angeles basin saves $50 million per annum on air conditioning bills.[3] Manchester university's adaptation strategies for climate change in the urban environment project has found increasing green spaces in cities, thereby resulting in reducing the surface temperature by 10%, that is by 4 °C due to water evaporating (transpiration)

3 McAliney M. 1993. *Arguments for Land Conservation: Documentation and Information Sources for Land Resources Protection*, Trust for Public Land, Sacramento, CA.

into the air from trees and other vegetation.[4]

Calculation of CO_2 Sequestered by Trees

The United Nations Environment Programme (UNEP)[5] has presented indicative figures for the CO_2 sequestered by an average tree as 12 kg and such a tree emits enough O_2 for a family of four for a year. If the average life span of a tree is assumed to be 20 years, it sequesters 240 kg of CO_2 equivalents (CO_2e) in its lifetime and this is the carbon dioxide absorption capacity of an average tree. A carbon footprint of 1 tonne of CO_2e can be thought of as the same as planting of approximately four trees. [6]

Biodiversity: India's Forest and Tree Cover

The community spends considerable human effort and resources to grow and develop trees. The tree cover on public land may have increased while the tree cover on private land has decreased due to intense, high-density developments. The tree species suitable for large plantations are utilized, but restoration of a mix of native bio-diverse species to enhance the effectiveness of carbon sinks in forest ecosystems is required. The example of the great banyan tree at Howrah, West Bengal, covering an area of 404 sq. m, is a case in point as the lone tree functions as a habitat for varied flora and fauna. There are scores of sacred groves that play a vital role in the conservation of biodiversity, for example, the Orans in Khejarli, the sacred groves of Vrindavan,Nidhivan, and Kishorevan.

Conclusion

Cities provide an opportunity to mitigate or even reverse the impact of global climate change as they provide the economies of scale that reduce per capita costs and demand for resources. Urbanization can acquire a harmonious growth pattern by the amalgamation of sustainable urban landscape design and ecologically suitable land use to achieve biodiversity and affordability.

Urban projects in towns, industrial or infrastructure projects in megacities necessitate a holistic approach in terms of balancing energy and natural resources. It is recommended that infrastructure support as well the support from ecosystems available in the vicinity of protected and reserve forests should be the criteria for proposing urban growth centres.

4 Fisher P. 2007. 'Why We need the Urban Forest'. *Urban Magazine* July.

5 Billion Tree Campaign of the United Nations Environment Programme; available online at http://www.unep.org/billiontreecampaign/FactsFigures/FastFacts/index.asp; last accessed on November 15, 2017.

6 The National Computational Science Leadership Program and The Shodor Education Foundation.

SARGE है तो सोलर चार्ज है

www.sargeglobal.com, +91 9009944433 / 9644564455

Turnkey Solutions for Solar, Lighting, Smart City & Agro Lights

Engineers India Limited Campus, Gurugram

Mr Gurneet Singh,
Director,
Environmental Design Solutions, New Delhi

It was great working with the GRIHA Council on Engineers India Limited Campus at Gurugram. GRIHA's rating provided the necessary framework for an environment-friendly design to the project team. GRIHA's emphasis on designing the building to maximize benefits from the prevailing microclimate pushed the project team to opt for a passive solar building design. This resulted in the two towers with spaces that are regularly occupied (open office, cabins, etc.), situated on the north side, to enjoy glare-free, natural light as well as the other spaces (AHUs and restrooms) or buffer spaces (conference rooms, meeting rooms, etc.), situated on the south side, to minimize the building's heat gain.

The GRIHA team was also very supportive during the three site visits and gave important inputs to the contractors and the site team on how to further improve the sanitation/safety facilities for the construction workers. The GRIHA rating has been an integral part in the process of creating a world-class energy, resource-efficient, and 5-Star EIL campus at Gurugram.

WFM
CONSTRUCTION INDUSTRY MARKETPLACE

LEADING MARKET PLACE FOR CONSTRUCTION SPECIALITIES

- Largest database of Architects / Builders / Contractors / Qualified lead generators
- Verified supplier
- Genuine & quality products
- Your online salesman

BE A PART OF THIS BUSINESS FRIENDLY WEBSITE DIRECTORY IN A MINUTE

LOG ON TO http://www.wfm.co.in/directory

BROWSE BY CATEGORY:

- Accessories & Hardware
- Adhesives & Sealants
- Claddings
- Doors
- Facade Elements
- Glass
- Machineries
- Railings
- Raw Materials
- Window Accessories
- Windows
- Others

Corporate Office: C-55, Okhla Industrial Area, Phase-1, New Delhi-110020 | Ph: +91-11-40623344 (100 lines)
Email: info@wfm.co.in | Mobile: 09560925255

Project Management

The Tool for Making Sustainable Construction Affordable

Housing is central to global urbanization and, of late, it has emerged as a global concern as well. Not only does it define the success of an urban establishment, it also impacts the environment in several ways. In this article, **Mukul Gupta** analyses the different approaches that can be used while initiating a construction project.

An engineer and MBA with more than 35 years of experience, **Mukul Gupta** specializes in project management with diversified sector projects. He can be reached at: mukul@shimuk.com

The National Building Code (NBC) 2016[1] has retitled Part-7 as 'Construction Management Practice and Safety'. Till its last version it was known as 'Construction Practice and Safety'. Globally, project management has emerged as a profession in its own right and has contributed immensely to IT, computers, healthcare, and space programmes, and virtually all sectors that define our age. The building sector also stands to gain from the project management techniques due to the complexities of performance requirements and the growing footprint of the building sector.

The government, the prime driver of a country's construction sector, has also acknowledged the importance of project design and life cycle costing. General Financial Rules (GFR) 2017, which is binding and the basis of all government procurements, note under Rule 136 (1) *'No works shall be commenced or liability incurred in connection with it until:.... (iii) a properly detailed design has been sanctioned; while designing the projects etc., principles of life cycle cost may also be considered'*. The subsequently issued *Manual of Procurement, of Goods*, the Department of Expenditure, Ministry of Finance also desires to appropriately formulate and built-in sustainability criteria into Technical Specifications.[2]

The change in perception *'Construction Practice and Safety' to 'Construction Management Practice and Safety'* by extending its scope to include wider issues is contemporary.

The Energy Conservation Building Code have already been notified as mandatory in several states, and for other states, the notification process is at an advanced stage. GRIHA's Green Building ratings have aspirational sustainability goals that include/integrate more sustainability indicators besides the energy indicators prescribed by the ECBC Code.

The NBC 2005 identified an integrated approach for the application of the code as its Part 'Zero'. In Part 7 of the code, provisions on construction project management elaborates (2016) project formulation and appraisal aspects. Construction project management is only a part of the bigger unique product or service. Therefore, project management skills need to be enhanced for improved project success rates.

The PMBOK® Guide (Project Management Body of Knowledge) and its construction extension, both publications to PMI® (Project Management Institute), USA, are designed to fill the project management skills gap. The rest of the article identifies the present environment and recommends the key project management concepts to meet our objective of, 'making sustainable construction affordable'.

The Construction Sector Still Works in Silos

Historically, construction practices have grown in silos. For example, the water supply engineering practice and wastewater treatment

1 National Building Code. 2016. s.l.:Bureau of Indian Standard, 2016.

2 Manual for Procurement, of Goods. 2017. Manual for Procurement of Goods. Manual for Procurement of Goods. s.l.: Government of India, 2017, p. 20.

practices developed and work as separate identities/departments. The building construction practices grew along similar lines and continue to reflect working separately in isolation.

They have their own jargons and tend to solve the simplest of problems in complex settings. This approach works in isolated command and control situations but at the cost of great inefficiency.

The NBC 2005 emphasized on having a multidisciplinary team approach for successfully accomplishing building/development projects. As a consequence, many organizations had put up teams but for a lack of project management maturity in the sector, were superimposed with old legislative regulations and work culture. The objective of 'making sustainable construction affordable' requires borders to be merged, as has been done in other industries where project management is extensively used as a tool for success of the projects.

The fragmentation till now was not limited only to the main construction industry sector. It covers the domain of the top-level policymakers. The MoHUPA (Ministry of Housing and Urban Poverty Alleviation) looking after the PMAY (Pradhan Mantri Awas Yojna, i.e., the Prime Minister's housing scheme) and the MoUD (Ministry of Housing and Urban Development) looking after technologies identification were two separate central ministries. Now the MoHUPA has been merged into MoUD. The CPWD (Central Public Works Department) as a technical advisor to the central government remains attached to the MoUD. As a result, implementation of the identified technologies would be faster and efficient and would help in achieving the objective of making sustainable housing affordable.

Government Initiatives

The government has attempted to increase transparency and implement regulation through the RERA (Real Estate Regulatory Authority) for the real estate sector which will impact our subject objective.

The NITI Aayog has been entrusted with transforming the policy framework on the globally adopted 17 SDGs (Sustainable Development Goals). This is synonymous with the role of the PMO (Project Management Office) in the project management context. Merging of the MoHUPA with the MoUD is an outcome of this process.

The project management context has been included in the NBC 2016[3] and the GFR 2017 (rule 136), which is a guiding factor for all the subsequent policy decisions at various levels for achieving affordable sustainability. For example, the Haryana government has already come out with their building by-laws 2017 promoting GRIHA for sustainability.

Ease of doing responsive business has also been reflected in the base policies and foundational documents circulated by the Ministry of Environment, Forest and Climate Change (MoEFCC).[4] With the release of Model Building Bye-Laws 2016 by the MoUD, state governments and urban local bodies are set to release the required legislations,[5] thereby nudging India towards sustainability.

The housing for all mission is one of the most important initiatives of the government to ensure respectable housing for all by 2022.

Besides what the government has already done, further impetus is expected as affordable housing directly or indirectly supports all the SDGs and forms the basis of all further development.

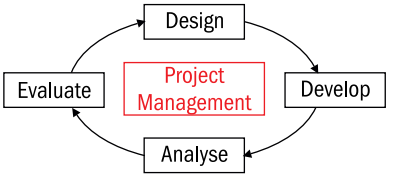


Figure 1: Project management, a necessary framework for project teams

How Project Management Can Help in Making Sustainable Housing Affordable?

In the project context, stakeholders need to be identified and engaged from the very beginning. With their inputs, besides cost and completion time along with the sustainable housing parameters (performance requirements, such as thermal comfort, acoustics, etc.), specific requirements need to be clearly defined.

Project development would begin with technological options availability and would require the help of subject matter experts, such as architects and structural engineers including quantity surveyors in order to ascertain the initial viability and suitability of particular technologies. This might require the integration of technologies and further expert inputs. After this the stage would be ready to integrate the inputs of all other services that are required by the project. This would, typically, require several iterations till it is optimized.

With the evolution of the PM approach, in view of fast-changing requirements, agile

3 National Building Code. 2016. s.l.: Bureau of Indian Standard, 2016, p. 8, Part 7.

4 MoEFCC Notification No. No. 2910; dated December 9, 2016.

5 TCPO, Ministry of Urban Developement. 2016. Model Building Bye-Laws. New Delhi : s.n., 2016.

project management has played a significant role in the success of the IT industry, which, incidentally, could also be adopted in the fast-developing construction sector, especially during the project development.

Accommodating this trend in project management, PMBOK® Sixth Edition issued on September 6,2017, incorporates agile project management with traditional project management. This also refers to a hybrid type of PM where agile can be used in some part of the project and traditional in another part, thereby combining the benefits of both the approaches. This amalgamation is irrespective of the phase or the dominance of the project management approach envisaged for the project. Determining which type of project management is to be used depends on the phase/project characteristics. This entails that the skill set of the project manager and team will have the understanding of both the types of project management approaches.

Although it will make the management process more complex, due to the best of both approaches, this will soon be rewarded with success.

The agile approach can be useful in the following ways:

We can use this approach wherever development can be done in smaller deliverables so that lessons learnt from each iteration can be applied to the subsequent iterations incorporating changes/improvements proposed/observed so that better deliverables can be delivered at the agreed time.

This approach has an edge over the traditional one since the latter only benefits from the advantage of retrospective analysis rather than the lessons of the ongoing projects.

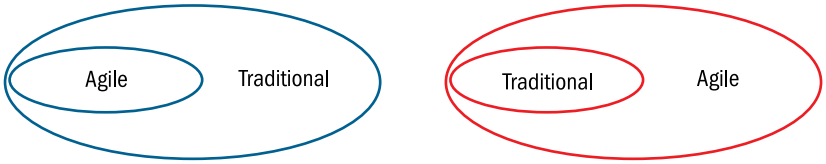


Figure 2: Hybrid project management with agile and traditional approaches

The following are scenario-specific examples:

- Collecting the various project requirements
- The design project/phase
- Construction phase where a number of units are to be constructed in phases
- Linear projects, such as roads and highways, canals, water/sewerage networks, cross country pipelines, railway projects, etc.

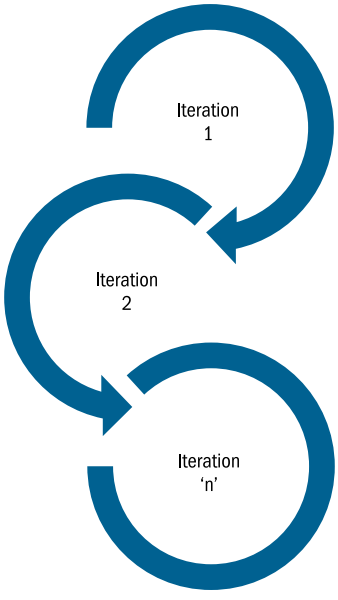


Table 1: Comparison of agile and traditional project management (SBOK®, 2017):[8]

Approach	Agile	Traditional (Waterfall)
Emphasis	People	Process
Domain	Unpredictable/ exploratory	Predictable
Documentation	Minimal, only as required	Comprehensive
Quality assurance	Customer centric	Process centric
Process style	Iterative	Linear
Organization	Self-organized	Managed
Upfront Planning	Low	High
Approach	Agile	Waterfall
Perspective to change	Adaptability	Sustainability
Prioritization of requirements	Based on business value and regularly updated	Fixed in the project plan
Management style	Decentralized	Autocratic
Leadership	Collaborative, servant leadership	Command and control
Performance measurement	Business value	Plan conformity
Returns on investment	Early/throughout project life	End of project life

* SBOK®, Edition 2017. 2017. *A Guide to Scrum Body of Knowledge*

PM Best-Practice Recommendations

The NBC 2016 for the first time presented itself as a living document and in the forward itself proposed to bring out the code periodically.[6] It is a norm of all rapidly developing professions. PMI® has been revising its body of knowledge every 4th year.

Based on the study of various standard documents mentioned above, the following are recommended:

- **The National Building Code**: The processes and knowledge areas as briefed in the NBC have been detailed in the context of construction management. This may not be adequate to our subject requirement which is fast evolving thus needing the project management approach.
- **Project management approach and skills**: The best practices of the traditional project management, as also recommended by the PMBOK®, should be adopted to enhance the project management skills for better implementation and project success.
- **Agile project management**: Agile/Adaptive approach to project management is a highly visible trend that can be adopted along with the traditional project management approach. Lessons learnt are applied to the project itself in the agile approach through iterative processes and retrospection. Value is delivered iteratively instead of at the end of the project. It also involves stakeholders in a much more collaborative role than the traditional approach which is beneficial for the overall health of the project.

A further detailed study needs to be done in this aspect; however, if we start applying the hybrid project management approach (the agile approach, wherever possible, along with the traditional project management approach), we can reap the benefits in terms of general project success as well as meet our objective of making sustainable construction affordable.

The project developer may like to develop the project using the agile practice and complete the project design and business plan in iterations till the desired affordability is achieved. The principles of empirical process control, self-organizing team, collaboration, value-based prioritization, time boxing, and iterative development would lead to the goal of making sustainable construction affordable' with minimal efforts.

6 National Building Code. 2016. s.l.: Bureau of Indian Standard, Volume 1, p. viii.

The First Five Star Green Building of Eastern India

5 स्टार बंग्लो : एक प्रोडक्टिव आर्किटेक्चर

वास्तु विहार®
एक विश्वस्तरीय टाउनशिप
AN ISO : 9001 : 2008 : 14001 : 18001 : 2007 COMPANY

in Association with GRIHA

★ Star-1 Design :-

(क) Square Grid Pattern से भवन का आर्किटेक्चरल प्लानिंग एवं स्ट्रक्चरल डिजाईन, 20' तक के Span में Cost Effective निर्माण संभव एवं भवन की लागत में 15% की कमी।

(ख) डिजाईन ऑप्टीमाइजेशन : मोडुलर इन्वेलप के भीतर कमरों का जरुरत के हिसाब से परिवर्तन। इसके लिए आर्टीफिशियल इन्टेलिजेंस का समुचित इस्तेमाल।

(ग) 8"-10" मोटी RCC थर्मोकॉल इन्सूलेटेड फिलर स्लैब के इस्तेमाल से कीमत में 25% की कमी, दुगुनी भार वाहन क्षमता एवं इन्सूलेशन में 60% की वृद्धि। इससे फ्लोर के ऊपर, कही भी हल्का पार्टीशन वॉल देना सम्भव ताकि जरुरतों के हिसाब से कमरों का आकार-प्रकार एवं संख्या बढ़ाई घटाई जा सके।

★ Star-2 Technologies & Resourses :-

(क) राबिस (ब्रीक फिल्ड फ्लाई एस) एवं स्लज लाइम से बने इंटर लॉकिंग ब्लॉक से बनी, बिना मोर्टार की दीवार,बिना प्लास्टर की दीवार तथा स्टोन की तरह फनिशिंग।

(ख) वेल्डेड वायर गर्डर से कॉलम एवं बीम एवं वेल्डेड वायर मेस से छत का निर्माण, इससे स्टील की मात्रा में कमी एवं भूकम्प प्रतिरोधी निर्माण।

(ग) केले के पेड़ साथ लीचपीट, ताकि सिवरेज ट्रिटमेन्ट के साथ केले का उत्पादन।

(घ) वैक्टेरिया इन्डयुस्ड क्लासिफिकेशन से वाटर प्रुफिंग।

★ Star-3 Energy :-

(क) सोलर पैनल छत जो सूरज के दिशा के साथ घूमता है एवं घर के लिए 9 घंटा तक दिन में बिजली पैदा करता है साथ ही छत के उपर एक अतिरिक्त छत प्रदान करता है। सामान्य सोलर सिस्टम मात्र 4-5 घंटा समतुल्य बिजली पैदा करता है।

(ख) हाइब्रिड एयरकंडीशनर, जो धूप और बिजली के मिश्रण से चलता है एवं 60% तक बिजली बचाता है एवं बाथरुम एवं किचेन में सोलर गीजर से उपलब्ध गर्म पानी का इस्तेमाल।

(ग) घरेलू गैस एवं उर्जा के स्त्रोतों के रुप में धान के छिलके से बने गैस एवं बिजली का इस्तेमाल। इससे निकले बाई प्रोडक्ट, बायोचार का कई औद्योगिक इस्तेमाल।

(घ) कोयले की जगह पॉल्ट्री वेस्ट से ईट की पकाई।

★ Star-4 शून्य उर्जा वाले साज सज्जा एवं मेनटेनेन्स :-

(क) भीतर के दीवारों पर देवदार लकड़ी का वॉल पैनल जो स्टील कम्पनी के मशीनों के बेकार पड़े पैकिंग मैटेरियल से प्राप्त की गई।

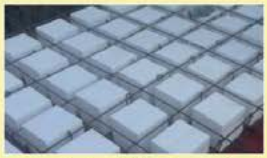
(ख) भीतर या बाहर के दीवारों पर कहीं भी पेंटिंग की जरुरत नही जिससे आजीवन पेंटिंग के झंझट एवं भी.ओ.सी. से मिली मुक्ति।

सोलर हाइब्रिड एयरकडीशनर

रोटेटिंग सोलर रुफ

सोलर हाइब्रिड एयरकंडीशनर

वेल्डेड स्टील



आर.सी.सी. थर्मोकॉल फिलर स्लैब

राइस हस्क गैसीफिकेशन : ग्रीन इनर्जी

वैक्टेरियल इन्डयूस्ड कैलसाईड एन्टी कोरोजन ट्रिटमेंट (बैसिलस पौस्चूरी + गोमूत्र)

वेलडेड वायर गर्डर का स्ट्रक्चरल स्टील मे इस्तेमाल

औद्योगिक पैकेजिंग से निकले लकड़ी से इंटीरियर

केला शौचालय से सिवरेज एवं इफ्लूएन्ट ट्रिटमेन्ट एवं केले का उत्पादन

★ Star-5 अन्य जरुरतें :-

(क) दीवारों में वर्टीकल फार्मिंग से ऑर्गेनिक सब्जी का उत्पादन।

(ख) राज मिस्त्री का ग्रीन बिल्डींग निर्माण के लिए स्कील डेवलपमेंट प्रशिक्षण ताकि देश-दुनिया को 2 लाख ग्रीन बिल्डर्स दिये जा सकें।

(ग) ज्यादातर औद्योगिक कचडों का इस्तेमाल निर्माण में उर्जा का इस्तेमाल निर्माण में उर्जा का इस्तेमाल में 50% की कमी।

(घ) आजीवन घरेलू बिजली गैस तथा अन्य उर्जा जरुरतों में 100% की कमी की सम्भावना एवं कुल लागत में 30-40% की कमी

अब मात्र टिकाऊ (Sustainable) से बात नहीं बनने वाला
अब हमें प्रोडक्टिव निर्माण की जरुरत है।

www.vastuvihar.org | Call Centre : 95340 95340 | email : info@vastuvihar.org

GRIHA for Rapid Metro Green Rating

A Perspective of Sustainability

It is now well known that sustainable habitats form the core of successful urban planning in which rapid metro connectivity plays a pivotal role. In this article, **Ashutosh Pathak** discusses how the rating system can help in streamlining this important process, thereby contributing towards bolstering the nation's urban planning and connectivity.

Ashutosh Pathak, currently pursuing a PhD with TERI University, has more than 35 years of experience in project constructions with the government as well as with a number of premier private organizations. He can be reached at: ashutosh.pathak@grihaindia.org

The GRIHA for Existing Buildings green rating, which has been released earlier this year and addresses all types of buildings. Rapid metro stations are an essential part of affordable sustainability. This article explores why and how the same sustainability parameters of the GRIHA for Existing Buildings[1] could address the requirement of these special habitats with appropriate adaptations. The article also looks into how the entire Indian urban scenario can be made sustainable through a mass movement covering the four pillars of sustainability affordably, namely, institutional, social, economic, and physical.[2]

The IPCC's assessment reports on climate change and the historic Paris Agreement of 2016 have brought about a paradigm shift over how humanity perceives and acts to mitigate and reverse the anthropogenic damage to our planet. This changed scenario necessitated the GRIHA Council to contribute to all possible areas and, specifically, to expand its reach to the existing buildings that contain untapped resource-conservation potential. This realization provided the theme, 'Transforming Existing Buildings to Sustainable buildings' as the central idea of GRIHA's Existing Buildings Rating. It is all about maximizing the sustainability impact within the shortest possible cost and time, and, accordingly, simplicity and flexibility were built around the evolved GRIHA principles of, 'What gets measured is gets managed', 'Less is more', and 'Local and national policies promotion' in the existing buildings context.

Thus the GRIHA for Existing Buildings was conceptualized to rate all the existing buildings. It captures all the updated best practices as evolved and propounded by GRIHA. It has gone through a thorough research process and comprehensively adheres to 'India's Intended Nationally Determined Contribution: Working towards Climate Justice', submitted to the United Nations.[3] The mentioning of GRIHA as India's own rating system in the INDC document[4] reflects the trust the efforts that were made with the above perspective in view.

The process of its evolution involved collective and individual stakeholder engagements in shaping and evolving GRIHA's thematic concepts to the present context of the existing buildings. Numerous process iterations were made to attain the required balance for optimizing the inclusion of all possible variety of operational buildings.

Extending the same analogy of cost and benefit effectiveness

1 GRIHA Council, GRIHA EB. 2017. *GRIHA for Existing Buildings*, Version 1, Abridged Manual.

2 'Liveability Standards in Cities, MoUD'. 2017. New Delhi: MoUD, p. 48; available at: moud.gov.in/pdf/59b66fb7063ecLiveabilityStandards.pdf; last accessed on November 21, 2017.

3 UNFCCC. 2015. 'India's Intended Nationally Determined Contribution: Working towards Climate Justice'.

4 UNFCCC. 2015. 'India's Intended Nationally Determined Contribution: Working towards Climate Justice', p. 4.

to a larger scale, it is argued that extending the rapid metro services into the already matured habitats can bring about sustainability to the Indian urban scene at the least marginal cost. Accordingly, the transit metro stations green rating has been imagined to imbibe the concepts of 'GRIHA for Existing Buildings rating' while benefitting its service catchment areas through collaboration with the Urban Local Body (ULB).

The rapid metro services can work as a catalyst to bring about sustainability throughout India's urban habitats. Metro projects have transformed and revived many areas already. Furthermore, in the process, valuable lessons have been learnt and by replicating and extending the sustainability best practices; also, several nearby areas are being integrated to amplify the urban Indian scenario.

Rapid Metro Green Rating Context

The DMRC work culture has brought all the civil engineering best practices to India, especially regarding site safety and work environment during construction. These set the norm for all other construction streams to follow. The best project management practices were adopted and the system permitted the hiring of the best globally.

High-grade construction, especially precast and pre-stressed building elements extensively used for metro structures are expected to have a longer life span than traditional constructions. Well-protected and maintained steel building elements are also expected to have a much longer life than the other building types, barring monuments. Thus, the sustainability parameters considered for an existing building are applicable and relevant even for a new rapid metro construction. The proposed green rating system would ensure that the collective efforts of the rapid metro and urban local bodies (ULBs) result in sustainability at the urban habitat level.

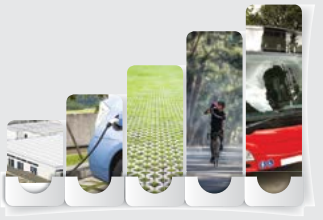
The newly launched city-sustainability assessment[5] by the Ministry of Urban Development (MoUD), Govt. of India provides an opportunity and the right context for taking these as the best practices and exploring the mutual advantages for both the concerned rapid metro station building and the ULBs. These incentives are available for smart cities, capital cities, and cities with a population of above one million each. Given this scenario, the rapid metro systems are an appropriate choice in such cities. The model buildings by-laws,[6] those that have been circulated by the MoUD, also facilitate the needed flexibility for collaborative actions.

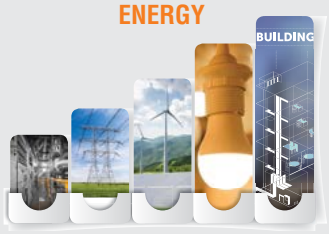
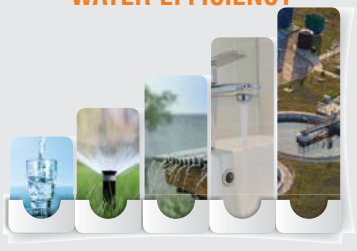
Table 1 suggests a criteria-wise contextualization of GRIHA for Existing Buildings for a Rapid Metro Green Rating. To make our cities 'liveable' is the overarching goal of our national mission and schemes. The suggestions have been made to enhance the various sustainability indicators that the ULBs have been tasked with, that is to enhance the livability of their respective cities.

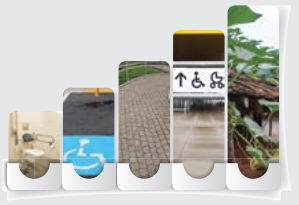
5 Refer to footnote 2.

6 MoUD, TCPO. 2016. Model Building Bye-Laws. New Delhi: s.n., 2016.

Table 1: Rapid Metro Green Rating: The City Liveability Context, GRIHA for Existing Buildings Framework

Section*	Intent/Appraisal*	Compliance/ Adaptation/ Suggestions**
SITE PARAMETERS 	1.1.1 & 1.1.2 Services & Transport Accessibility	It is possible to follow the provisions as it is. Integrated services integration by the ULB shall further enhance the rapid metro user's experience
	2.1.1 Analyse total number of trees	May be possible by permitting the inclusion of the surrounding area. Appraisal flexibility may be provided accordingly. Policies of increasing FAR for the well-served green areas could be justified though benefit–cost modelling
	2.1.2 Site surfaces	Relevant and applicable; would enhance the resilience of urban areas against local flooding and heatwaves
MAINTENANCE & HOUSEKEEPING 	3.1.1 Protocols maintained for electrical, HVAC, plumbing systems, and civil repair, as per EB	Relevant and applicable; protocols and work culture may be proactively furthered into the serviced area by and through the ULB
	3.1.2 CFC free installations/ phase out plan	Relevant and applicable
	Green Procurement 3.1.3 Purchasing environment friendly cleaning and pest control products.	Relevant and applicable; would help in the dissemination of the best practices
	3.1.4 Policy of purchasing appliance	Relevant and applicable
	Waste Management 3.1.5 Provide infrastructure dustbins etc.	Relevant and applicable; needs contextualization
	3.1.6 Provide dedicated, segregated, and hygienic storage spaces	Relevant and applicable; needs contextualization
	3.1.7 Provide contractual tie-ups with waste recyclers	Relevant and applicable; rapid metro practices may be catalytic in promoting such recycling practices
	3.1.8 Implement strategies to treat all organic (kitchen and landscape) waste on-site.	Possible relevant and applicable to a few bigger stations
	4.1.2 Advanced metering requirements	Relevant and applicable; could be used to disseminate acceptance in wider context

Section*	Intent/Appraisal*	Compliance/ Adaptation/ Suggestions**
ENERGY 	5.1.1 Provide building energy consumption information possible as per EB	Relevant and applicable
	5.1.2 Implement preventive maintenance (no cost EEMs).	Possible as per EB; relevant and applicable
	5.1.3 Demonstrate percentage reduction in energy consumption	Customization required; quantitative assessment might require tweaking
	6.1.1 Alternative I: On site / On-site and off-site combination of renewable energy system	Possible as per EB; relevant and applicable
	6.1.2 Alternative II: Off-site renewable energy system	Possible as per EB; relevant and applicable
WATER EFFICIENCY 	7.1.1 Detailed water audit report	Possible as per EB; a contextual audit template would be required
	7.1.2 Reduction in building water consumption	Possible as per EB; relevant and applicable
	7.1.3 Minimizing lawn area	Possible as per EB; might be non-applicable in many situations
	7.1.4 Water-efficient irrigation system	Possible as per EB
	7.1.5 On-site sewage water treatment system	Possible as per EB
	8.1.1—8.1.4 Cumulative water performance	Possible as per EB
HUMAN HEALTH & COMFORT 	9.1.1 Thermal comfort requirements of NBC or ASHRAE 55, IAC	Possible as per EB
	9.1.2 Artificial lighting Lux level	Possible as per EB
	9.1.3 The indoor noise levels	Possible as per EB; might require a separate standard for public areas
	10.1.1 Smoking must be banned/ prohibited	Possible as per EB; relevant and applicable
	10.1.2 Meet the requirements of CPCB Standard(NAAQS)	Customization required; relevant and applicable

Section*	Intent/Appraisal*	Compliance/ Adaptation/ Suggestions**
SOCIAL ASPECTS 	Universal Accessibility 11.1.1 As per Harmonized Guidelines	Possible as per EB; relevant and applicable
	Environmental awareness 11.1.2 Adopt any three measures	Possible as per EB; relevant and applicable
	12.1.1 Project can adopt a maximum of two innovative strategies	Possible as per EB; relevant and applicable. Collaborative efforts with ULD shall provide many new innovative opportunities

* Adopted / referred to from GRIHA for Existing Buildings Version 1 (Abridged Version)

Qualitative analysis suggestions are based on the perceptions of sustainability conscious users. These conceive and create a win-win solution and opportunities for all stakeholders.

The rating of the rapid metro with the GRIHA for Existing Building's rating framework with the perspective of enhancing the city's liveability rating is not only possible but should be made mandatory in order to set in motion the necessary action needed for urban sustainability. It would require the flexibility and adaptation on the part of ULBs. The requisite facilitation, Green Rating Framework, and replicable methods/technologies are available through the national missions, GRIHA for Existing Building Rating System, and the Metro work culture.

Disclaimer

The views expressed in this article are those of the author's and do not represent the GRIHA Council's.

100% FDI Real Estate Developer

EXPERION
THE POSITIVE SIDE OF LIFE

10 BIG REASONS TO BUY THE HEARTSONG. NOW IS THE TIME.

NO FEAR OF UNTIMELY COMPLETION

READY TO MOVE-IN*

TAX SAVING ON CAPITAL GAINS

YOU GET WHAT YOU SEE

YOUR INVESTMENT IS SECURE

CONNECTED TO DELHI THROUGH 75 MTRS WIDE ROAD

CLUB CHORUS - ONE OF DWARKA EXPRESSWAY'S BEST COMMUNITY BUILDINGS

NO HVAT**

INCOME TAX SAVINGS

NO SERVICE TAX**

The Heartsong™
Sector 108, Gurgaon

Corporate Office: First India Place, First Floor, Block B, Sushant Lok-1, MG Road, Gurgaon-122002, Haryana, India, www.theheartsong.in

PREMIUM AIR-CONDITIONED APARTMENTS

Call: 124 4422 641 I SMS: THS TO 56767

Follow us on:

Financing Green Buildings
In Affordable Segment

Given the financial proximity between the economic and housing sectors, it is no wonder that, of late, a lot of focussed attention is being given to this. Shelter is a basic necessity and given India's population boom, it is now becoming a challenge. In this article, **Dr Ajitabh Ambastha** discusses the scope and urgency of financing green buildings.

Dr Ajitabh Ambastha, currently working with Tata Capital Housing Finance Ltd., specializes in competitiveness, strategy, quality, business excellence, HR and OD, business development. He can be reached at: Ajitabh.Ambastha@TataCapital.Com

Housing Finance Market

Housing is an important driving force for the Indian economy as it interlinked with nearly 269 other industries.[1] Studies have shown that the progress of the housing sector in India, given its complexity and the two-way engagements with most of the sectors,[2] can impact the GDP growth, productivity, employment, and so on. Thus, the role of financing institutes, including both banks and housing finance companies, has grown significantly over the years.

The government, at the centre and state, acts as a facilitator and is assisted by two regulators, the RBI and NHB. The housing finance market is dominated by commercial banks, both domestic and foreign. In addition, it also includes cooperative banks, housing finance companies, self-help groups, micro-finance institutions, and NGOs. The RBI regulates commercial banks and partially cooperative banks governed by the state governments, whereas the NHB regulates the housing finance companies.

In global comparison, the penetration level of housing finance in India still remains quite low. The growth rate of housing finance over the last 7 years or so results in a CAGR (Compound Annual Growth Rate) of 18%; nonetheless, affordable housing finance, a recent entrant, promises to have a much higher CAGR.[3] Given the shortage for housing in India, and the prevailing government schemes to bridge this gap, the housing finance plays a critical role in meeting these demands.

1 http://www.iimb.ac.in/sites/default/files/u201/Housing%20Market%20in%20India.pdf; last accessed on November 17, 2017.

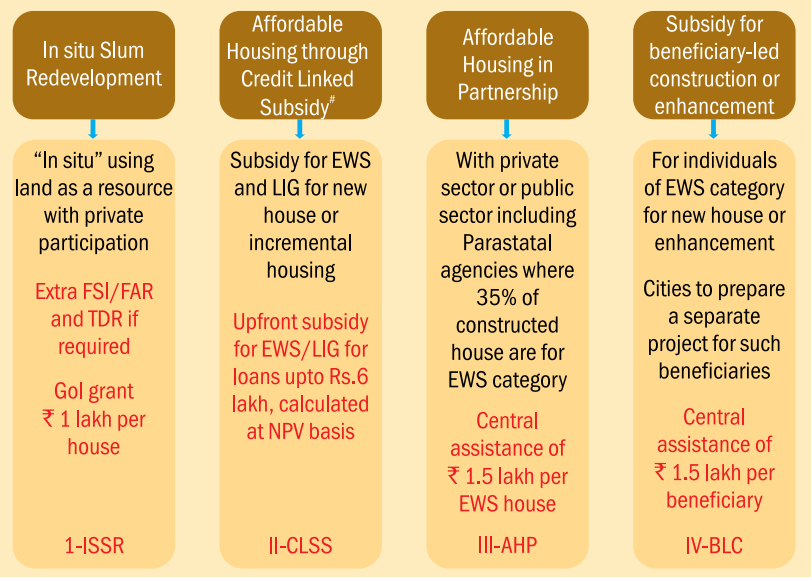
2 Kumar D. 2016. 'Growth and Impact of Housing Finance on Indian Economy: A Review'. *International Journal of Research in Management, Science and Technology*; available at: http://www.ijrmst.org/download/vol4no1/10.pdf; last accessed on November 17, 2017.

3 Kothari V. 2017. India Housing Finance Report 2017; available at: http://vinodkothari.com/wp-content/uploads/2017/09/India-Housing-Finance-Report-2017.pdf; last accessed on November 17, 2017.

Pradhan Mantri Awas Yojana (PMAY)

With a vision of 'Housing for All by 2022', the Government of India launched a flagship programme 'Pradhan Mantri Awas Yojana (Urban) – Housing for All' on June 25, 2015, to meet the housing shortage amongst the urban poor. The PMAY (U) envisages construction of houses with basic amenities. The mission is being implemented since 2015 and is expected to be completed by 2022. The mission also provides central assistance to urban local bodies (ULBs) and other implementing agencies through the states/UTs for:

- In situ rehabilitation of the existing slum dwellers using land as a resource through private participation
- Credit-linked subsidy
- Affordable housing in partnership
- Subsidy for beneficiary-led individual house construction/ enhancement.



*Under PMAY (U), beneficiaries can avail benefit of one component. * Grant/Subsidy/ Assistance available in each component.# The scope of CLSS has been enhanced to cover the middle Income Group (MIG) in the year 2017, w.e.f. 1.1.2017

Figure 1: Components of PMAY (U)

Source: http://mhupa.gov.in/writereaddata/PMAY_Single_leaflet.pdf; last accessed on November 17,2017

TCHFL's Prapti Home Loans under PMAY

Prapti Home Loans under the PMAY offers subsidized home loans at attractive interest rates. The home loans start at 4% and are applicable for households with annual incomes of ₹6 lakh and below.

Tata Capital Housing Finance Limited (TCHFL) intends to provide affordable housing across Tier II and Tier III cities, semi-rural areas, and the urban poor segment. Tata Capital aims to play a very critical role in empowering this segment in helping them buy their dream homes by offering special offers, schemes, and best rate of interest, with hassle-free processing. The TCHFL has a dedicated vertical that reaches out to around 50 locations catering especially to the housing finance needs of this segment. Apart from providing long-term funds for housing purposes, the TCHFL also provides loans for residential property purposes, land purchases, home improvements projects, and construction, and project finances to developers.

Conclusion

Having a self-owned home in India, generally, exemplifies a lifetime of savings of many individuals, therefore, the government needs to be sensitive to the housing sector. Moreover, the EWS and LIG often find it difficult to secure a formal housing finance due to a lack of documentation to establish the credit worthiness. Therefore, financial literacy training and assistance is the need of the hour for the segment, and non-banking financial companies have stepped in to provide the necessitating support to such customers in securing home loans. Thus, having an influential financial ecosystem, one that can mobilize capital towards sustainable and inclusive development, is beneficial in the long run.

Having said that, the TCHFL is committed to the government's 'Housing for all by 2022' and prioritizes and promotes affordable housing for the weaker sections through credit-linked subsidy (PMAY- CLSS). The developers and builders are encouraged to construct green buildings (certified by GRIHA/ IGBC) and avail the extended benefits.

> "Every time you open the refrigerator door, up to 30 per cent of the cold air can escape."

www.hrjindia.com

JOHNSON®
REDEFINING LIFESTYLES, WORLDWIDE.

Towards a GREENER WORLD

As a socially responsible company, we have initiated measures to reduce energy consumption and to conserve and preserve precious natural resources. Our manufacturing operations are increasingly using greener fuels like biomass and other renewable sources of energy. We leverage local resources and manufacture and distribute locally in order to cut down on fuel consumption in transportation. We also use minimum water, mostly harvested rainwater, reuse energy diligently and recycle in process waste and industrial waste from other industries. High grade pollution abatement devices in all are manufacturing locations that restrict the release of noxious gases such as SOx, NOx and SPM into the environment.

H & R Johnson is a recipient of the prestigious energy conservation award of Gas Authority of India Limited (GAIL) and the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India.

The bigger reward, however, is the fact that we are leaving the planet behind for our children, like the way we found it, Pure and Green.

Our flagships products are GRIHA certified

TILES I BATHROOMS I KITCHENS I ENGINEERED MARBLE & QUARTZ

The Economics of Sustainable Design in the Indian Context

In Affordable Segment

Practicing environmental architecture in a developing country such as India has unique advantages as well as challenges. While vernacular architecture is deeply rooted in passive design, urbanization has led to highly populous cities with 60% of the urban population living in metropolitan cities, such as Delhi, Mumbai, etc. This has resulted in overcrowding, lack of space, and, consequently, skyrocketing real estate rates equivalent to any other metropolitan city in developed nations. In this article, **Manit Rastogi**, **Nitin Bansal**, and **Piya Gupta** discuss the importance of design efficiency for the built environment.

Manit Rastogi, founder partner of Morphogenesis, is known as an architect who consistently pushes the boundaries of sustainable design. He can be reached at: media@morphogenesis.org

Nitin Bansal, a senior associate at Morphogenesis, has 11 years of experience in architecture with a specialization in sustainable environment design.

Piya Gupta, an associate at Morphogenesis, has over 4 years of experience. She specializes in sustainable architecture.

Sustainability and affordability come together to create contemporary and global architecture while responding to the local climatic conditions and, subtly, to our-deep rooted, socio-cultural instincts. This process of integrated design has been illustrated through an IT-office project in the hot–humid climate of Hyderabad.

Climate

Analysing the climate is the first step towards understanding the possible passive strategies applicable to the site. This process is critical in setting the project parameters for comfort and usability of open spaces. The prevalent tropical climate in India demands a combination of passive strategies for year-round comfort. High intensity of solar radiation adds to the challenge of creating a glare-free, 100% day-lit working environment while ensuring effective solar control (for reducing cooling loads). The Indian Model for Adaptive Comfort Study[1] addresses the thermal adaptability of people living in tropical climate typologies inherent to the country.

Sustainable Design Brief

Historical precedents suggest that architecture itself was a response to a lack of availability of resources and response to climate, the principle being that nothing was ever wasted. The approach, 'No is More', that is imagining one has little or no resources at one's disposal becomes an inspiration for creating truly optimized built spaces catering to present-day issues of stress on resources. Based on an approach that began

1 The Indian Model for Adaptive Comfort Study. 2015. *Green Rating for Integrated Habitat Assessment* (GRIHA)-Appendix-1. New Delhi: The Energy and Resources Institute.

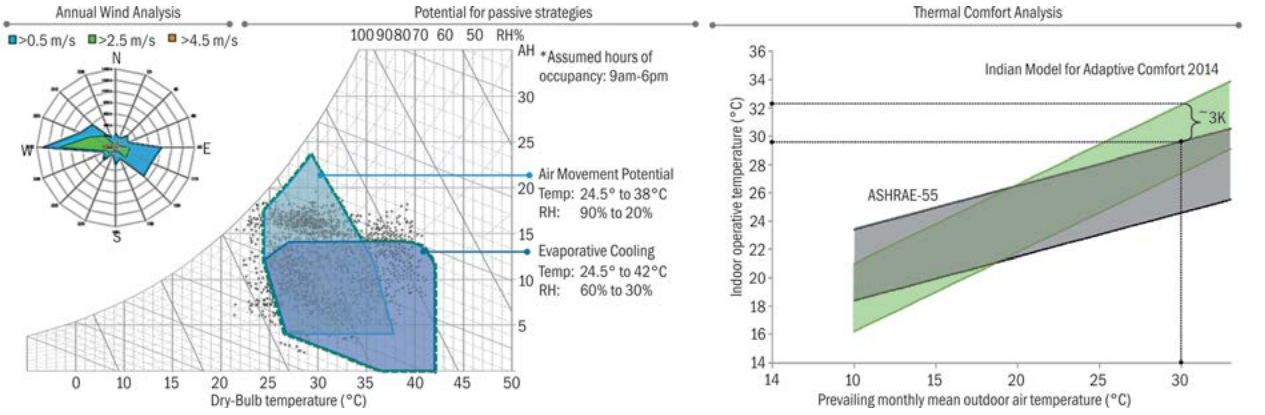


Figure 1: Climate analysis and thermal comfort standards in Hyderabad

with the carrying capacity of the land, the 100-acre site for an IT campus in Hyderabad was found capable of serving the conventional water demand of 14,400 persons. A 3 m-deep water reservoir of approximately 14 acres was designed to be located in the low-lying section of the site. The annual energy consumption for the project was targeted at 60 kWh/m^2/yr. with primary energy consumption estimated at 35 kWh/m^2/yr. and 25 kWh/m^2/yr. being the load from the equipment.

Integrating renewable resources to offset the energy demand presented a requirement of a 13-acre solar farm. Comparable spatial requirements allowed the solar farm to be planned on top of the water reservoir expected to significantly reduce evaporative losses while cooling the solar panels at the same time.

Urban Design and Masterplanning

Designing tor utilize prevailing winds, visual comfort through daylighting, and solar control resulted in a series of urban design solutions. Six schemes were generated without imposing any preconceived notions of aesthetics, responding purely to the density and environmental performance targets. The schemes were first analysed through the process of Computational Fluid Dynamics to understand the movement of air in open spaces and the potential to naturally ventilate the buildings. The resultant was a master plan translating the sustainable design brief, thereby generating a microclimate of comfortable outdoor and semi-outdoor spaces with the potential of being utilized for the interactive common functions of the programme. In order to maximize the functionality of the courtyards, the effect of introducing a roof, elevated air speeds, and dry mist systems were explored as targeted strategies for open spaces. Direct solar control strategies for the courtyard helped almost double the period of comfort during occupancy hours. Enhancing the air movement by morphology as well as introducing active methods such as fans proved to be successful in increasing the hours of comfort to 60%, annually, and increased the capital cost negligibly by £ 1/sq.ft. Moreover,

Table 1: Carrying capacity for water resources

Site Area	4,09,961 sq. m
Annual rainfall*	0.822 M
Potential annual Rainwater collection (50% run-off, 10% evaporative losses)	1,68,494 cu.m
Water requirement per day per person**	45 lpcd
Carrying capacity of site based on water demand	14,400 persons
Size of water reservoir required(@3M depth)	56,165 sq. m (~14 acres)

Sources: *www.rainwaterharvesting.org, ** National Building Code-2005

Table 2: Carrying capacity for renewable energy

Carrying Capacity (Based on water demand)	14,400 persons
Total Built-up area required @ 9.29sq. m/ person (100 sq.ft./person)	133,781 sq. m
Target Energy consumption	60 kWh/sq. m./yr
Total Annual energy consumption	8,026,830 kWh
Area required for installing solar PVs*	53,512 sq. m. (~13 acres)

Sources:*1500kWh energy generated annually per 1 kWp of installed capacity, requiring 10 sq. m/kWp.

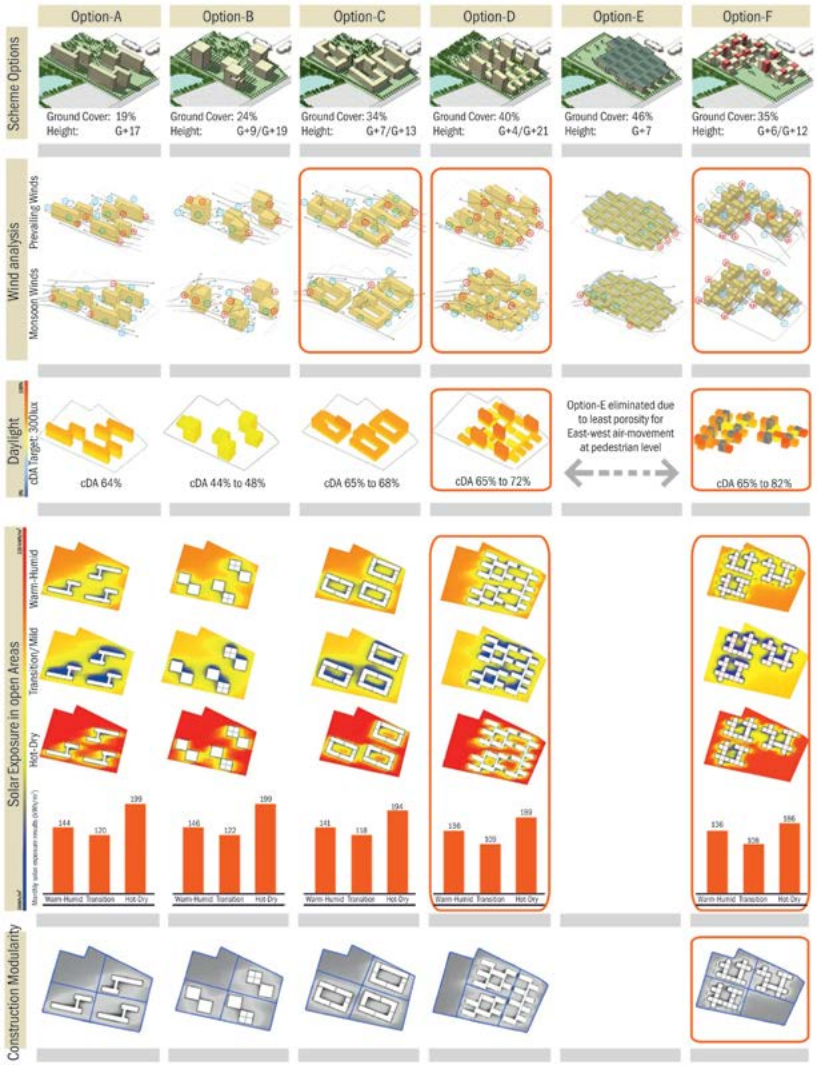


Figure 2: Methodology of urban design and masterplanning for an IT campus in Hyderabad

mist-cooling systems drastically improved the micro climate by achieving comfort in 97% of the occupied hours while adding to the investment by £ 4/sq.ft.

Finally, common functions, such as food court seating and even part of the library were designed as semi-outdoor protected spaces encouraging a dialogue between the natural environment and the users, proving applicability of adaptive comfort strategies in hot–humid climate conditions. Using the above-mentioned processes, over 1,00,000 sq.ft., comprising 9% of the total built up area, was successfully eliminated from the construction requirement. Moreover, in addition to being a grand arrival plaza, the courtyard becomes a multi-functional gathering space at 10% of the conventional capital cost.

Built Form

A modular efficiency involved an inside-out approach using a structural grid of 11.5 m x 8.5 m that could be the multiple of a workstation module as well as the lowest unit of a car parking bay. Workspace efficiencies of up to 45 sq.ft./person were achieved with an overall 85 sq.ft./person on built up area. This further saved 15% of construction area as compared to conventional standards of 100 sq.ft./person.

The design of the built envelope can be governed by balancing shade, glare, daylight distribution, and solar heat gain reduction. Solar control for the external façade involved vertical fins and overhangs spaced according to the different orientations. Shading devices were designed with conscious attention to controlling glare without hampering the daylight distribution. External façade treatments are often eliminated during the course of a typical project as capital cost is generally given more thought over controlling operational costs. Moreover, maintainability of these features becomes more challenging over time due to high intensity of sun and air pollution levels in larger cities. These issues led to an integrated façade designed as an extension to the structure of the building with concrete slab projections and monolithic vertical fins, spaced relevant to the orientation. The façades facing the courtyards were mostly protected by roof coverings and could, therefore, be allowed to open up to the micro climate. Illuminance targets of 110 lux were achieved by effective daylight distribution. The cumulative solar heat gains from the designed façades were calculated to assess the overall thermal efficiency of the envelope. Finally, the solar heat gain for the entire building was calculated and resulted in an overall thermal efficiency of 0.8 W/sq.ft.

Active Systems

Thermal comfort has proven to be crucial in achieving occupant satisfaction as well as workplace productivity. Setting comfort targets when the end

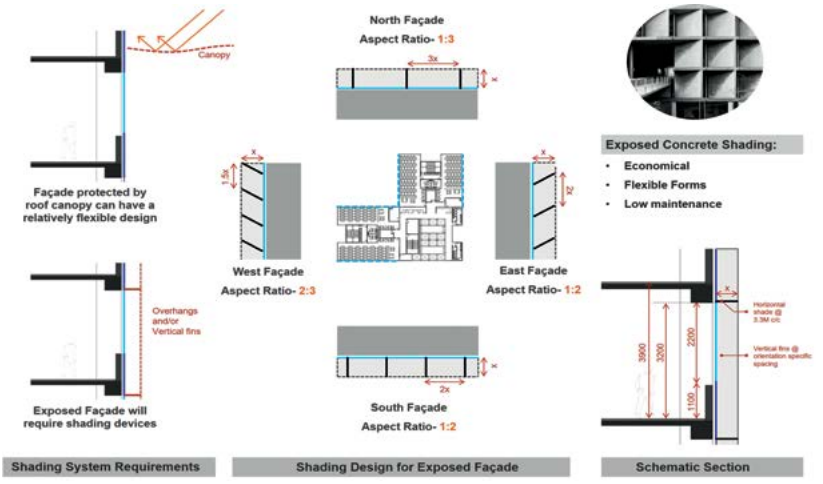


Figure 3: Integrated façade design for reducing solar gains through building envelope

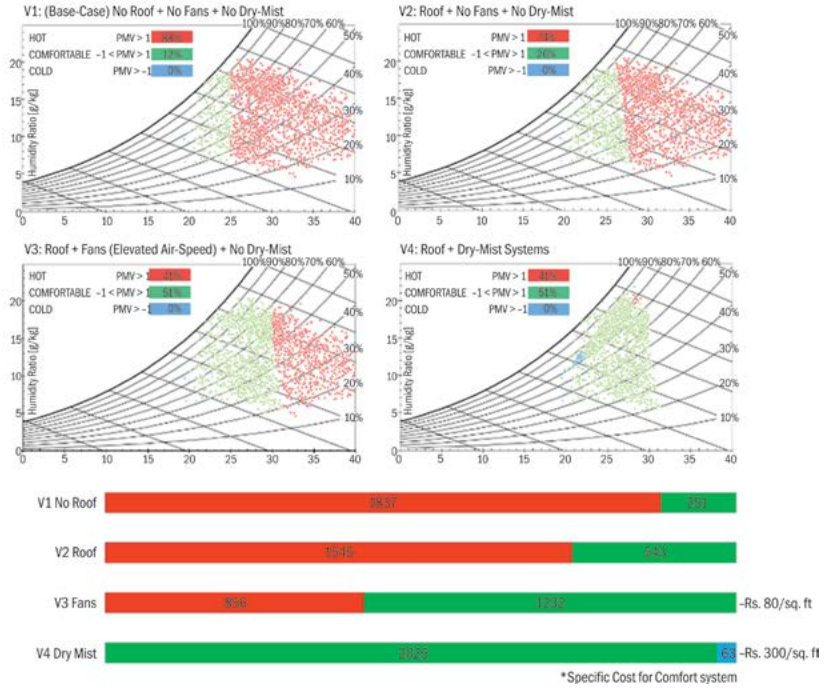


Figure 4:Comfort and cost evaluation for outdoor spaces using the PMV model for adaptive comfort

user is not involved makes it essential to consider not only the adaptive factor but also expectations of comfort which may vary for different climate typologies. Working spaces demand consistent and controlled indoor environments for minimal distraction during focused tasks. Although minimal, the cooling loads as a result of micro climate creation and robust envelope design needs to be countered with active systems to achieve the desired comfort levels indoors.

Multiple cooling systems were analysed to achieve an optimized solution specific to the project constraints. Feasibility analysis studies concluded with the selection of under-floor cooling system for controlled thermal comfort requirements in working spaces. The primary advantage was that the system offers flexibility in internal layouts enabling any future changes in market standards and user requirements. Under-floor cooling systems are, generally, useful due to the stratification of air in high-volume spaces. Adding air movement at ceiling level is undesirable in such cases as it is expected to counter the process. However, floor heights limited to 3.9 m–4.5 m are unable to benefit from stratification since temperature variations only up to the range of 0.5–1 °C are achieved. Enhanced air movement in such spaces significantly adds to the physiological comfort. The overall advantages offer flexibility to the architecture as well as active systems.

A combination of natural ventilation and evaporative cooling may work for hot–dry conditions but highly humid environments make it difficult to open to the outdoors without adding systems for dehumidification and enhanced air movement. Learning from the analytical studies, where the effect of elevated air speeds on the micro climate was tested through installing ceiling fans in indoor spaces, hybrid systems were created to reduce mechanical cooling loads. A robust envelope design enabled common interactive functions within the built spaces to be opened up for natural ventilation by using the same strategies of dry-mist systems in combination with fans. The basic understanding was that when occupants are not at work or are involved with interactive activities in a work environment, they tend to be more accepting and adaptive to their surroundings. Consequently, the micro climate could be further extended to

comfortable transition spaces where another 35% of the total built up area of the office building was made comfortable at half the cooling energy requirement of conventional practices. Combining passive principles of solar control and active systems for cooling proved to save another 50% of cooling energy in fully air conditioned spaces (refer to Table3).

Conclusion

The comprehensive design process discussed above concluded at an overall construction cost falling well within £ 40/sq.ft. This factor was extremely crucial when addressing the budget constraints of projects in developing nations where saving in capital investment is more important than operational costs. Overall, the office project in hot–humid conditions of Hyderabad can be seen as an example of successful application of sustainable principles in hard-core, cost-driven markets like India. Pushing the potential of sustainable design requires expert inputs from multiple contributors, such as architects, climate engineers, structural consultants, mechanical, electrical, plumbing consultants, etc. Designing optimized systems and low-energy consumption starts making commercial sense only when complemented by spatial efficiency. Energy consumption per capita becomes a crucial factor in analysing the efficiency of sustainable architecture in high-density markets. Similar applications of integrated design across the various tropical climate typologies have proven to be equally effective as can be seen in Figure 7.

Table 3: Relative savings in construction area and cooling energy consumption

Area Distribution	Use	Measures Considered	% age Area	Cooling Energy Savings
Air conditioned spaces	Workstation areas, meeting rooms	Under-floor cooling + Fans	56%	45%–67%
Naturally ventilated spaces	Cores, library, food court, gym, lobbies, discussion areas	Natural ventilation + Fans + dry-mist systems	35%	50%
Shaded outdoor areas	Outdoor open cafeteria seating, recreation, library, arrival plaza	Tensile roof + fans + dry-mist systems	9%	49%

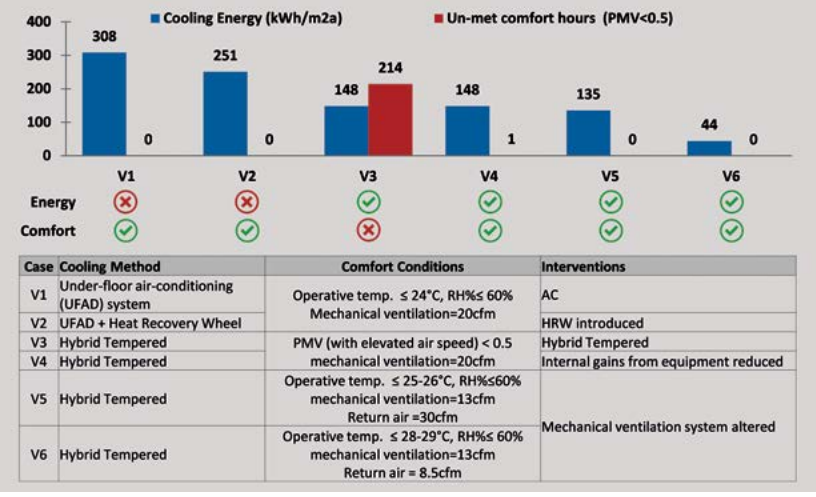


Figure 5: Sensitivity analysis for hybrid systems integrating elevated air speeds

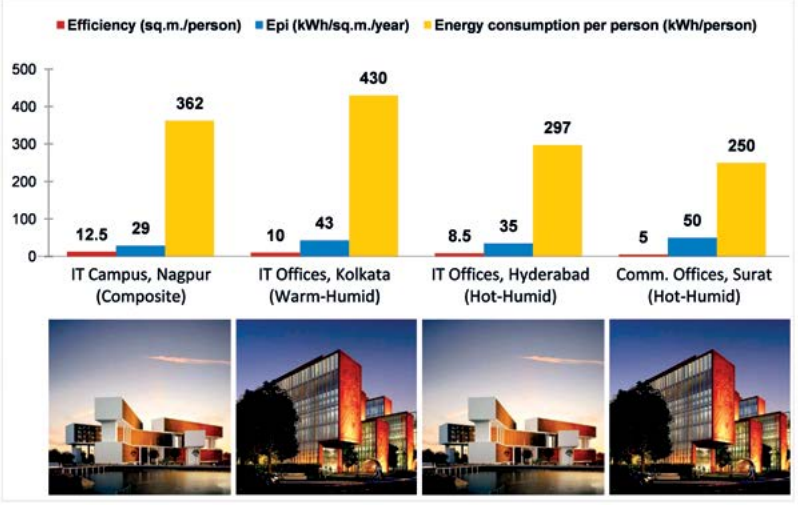


Figure 6: Applicability of integrated design approach across different tropical climate typologies

IIT Sports Facility and the Gymkhana Project

Mr Sunil Kumar
Sr manager at Godrej & Boyce Mfg Co. Ltd

I have been working on building commissioning and green building facilitation since 2007 at Godrej & Boyce. In 2013, I was entrusted with the responsibility to start working on GRIHA-certification projects in our organization. It was not before 2017, that we got the first GRIHA project certification at G&B; a 4-star provisional rating for the new sports facility was completed at the IIT Powai, Mumbai, campus. It is the first sports facility to achieve a GRIHA rating. The project houses many indoor sports, such as table tennis, squash, gymnasium, billiards, board games, and a common training hall.

The journey was not easy and there definitely were ups and downs, as is to be expected. But, what is important is how the difficult times were dealt with and how we ended up with achieving our goals.

Being a sports facility, the project was the first of its kind, there were no case studies or prior examples for the green certification of a similar building. The GRIHA team was very supportive through the entire journey and helped us in understanding the intent of the various appraisal clauses. Despite having a predetermined set of criteria and clauses, the GRIHA rating system is adaptable enough to accommodate alternate compliance methods to achieve the criteria objective which played a key role in the certification of a project with unique usage.

GRIHA, which is adopted by the MNRE as the national rating, has evolved tremendously in the past decade. The rating requirements have been regularly updated to match the latest industry standards and new versions are launched from time to time. With the newer versions, it is undoubtedly getting simpler to understand and easier for the project team to practice.

SUBSCRIBE

TerraGreen

INDIA'S LEADING MONTHLY ENVIRONMENTAL MAGAZINE

http://terragreen.teriin.org

TerraGreen promotes the concept of sustainable development. Launched in June 2004, this magazine from TERI is an effort to bring forth information and knowledge in the fields of energy, environment, and sustainable development. The magazine is in keeping with our mission to expand the base of environmentally conscious readers and popularize sustainability issues at the local level. *TerraGreen* aims to provide the readers with the necessary inputs to enable them to be a part of the process of change. The magazine stays away from all jargon, so that the educated, informed, yet lay readers are updated on all that happens around them everyday.

Tick one	Term (yrs)	No. of issues	Cover price	You pay	You save	per cent saving
			₹ USD	₹ USD	₹ USD	
	1	12	600 120	540 102	60 18	10
	2	24	1200 240	1020 192	180 48	15
	3*	36	1800 360	1440 252	380 108	20

* Free online access to those subscribing for 3 years

*Name of the Customer (IN BLOCK LETTERS).....

Designation..... Company / Organization.....

City..... State.....PIN.....Country.....

Email.....

PAYMENT PROCEDURE

Enclosed a Cheque/Draft number.....drawn in favour of **'TERI'** payable at New Delhi for ₹/.....for 1/2/3/ year subscription of *TerraGreen*.

* Offer only for new subscriber * Valid till stock last.

To SUBSCRIBE or make online payment, visit: http://bookstore.teri.res.in/TerraGreen

For subscription related queries,
contact: +91 11 2468 2100 / 4150 4900
Email: teripress@teri.res.in

THE ENERGY AND RESOURCES INSTITUTE
Darbari Seth Block, IHC Complex, Lodhi Road, New Delhi – 110 003
Tel. 2468 2100 or 4150 4900, Fax 2468 2144 or 2468 2145, India +91 • Delhi (0) 11
http://terragreen.teriin.org

teri
The Energy and Resources Institute

Thermal Insulation System for Energy-Efficient and Green Buildings

Essentially an energy-saving measure, insulation is a way to inhibit heat loss during winters and the excessive heating up of buildings during summers. A necessity more than luxury, this is a technique should be practiced in tropical countries, especially India. In this article, **K K Mitra** sheds light on its importance.

K K Mitra has more than 29 years of experience in the field of thermal insulation and has been working as Senior Vice President in Lloyd Insulations (India) Limited. He can be reached at: kk.mitra@lloydinsulation.com

An insulation system comprises materials, ancillaries, and finishing substance over the building envelope. A building envelope is insulated to stop the flow of heat and cold from the environment. A thermal insulation system, when applied on roofs and walls, creates a thermal barrier and offers resistance to the flow of heat and cold. There are specific advantages of insulating the external side of the roof and wall as compared to applying it from inside the building. Typically, this is done in tropical countries such as India as these countries face extremes of temperature and monsoons. While the aspect of proper finishing is a design aspect, there are various provisions available as well.

Need for Thermal Insulation in Buildings

A building envelope transmits 80% of the heat and cold into the inside of the building. After the external side of roofs and walls are insulated, heat coming from the outside gets trapped, thus preventing the reinforced cement and concrete roof and brick wall from heating up. Similarly, vis-à-vis insulation application from the inside, the reinforced cement concrete roof and wall will first get heated, but will stop the heat from getting transferred. Insulation application either way is way of creating a comfortable atmosphere inside the building. Usually, if the roof is cool, then the air circulated by a ceiling fan will also be cool, even if the building is not air conditioned. This can be a unique, beneficial, and much-needed feature for residential houses. The inside temperature can only rise if the doors and windows are opened. In case the building is air conditioned, once the set temperature is achieved, the compressor's running time

Photograph 1: Underdeck reinforced cement concrete insulation

Photograph 2: Steel-roof building insulation

Photograph 3: Roof overdeck insulation with PUF slab and spray system

will be considerably reduced. However, in case a building is not insulated, there cannot be a way of stopping the heat from coming inside. This in turn will result in the compressor running for a longer duration, meaning higher electricity consumption.

In a way, thermal insulation has become a necessity to stop the heat ingress during summers for the purpose of creating comfort and saving energy.

Thermal Insulation System Design

A thermal insulation system design starts with the selection of a thermal resistance 'R' value of the roof and walls; here, the optimum 'R' value has to be considered. The optimum 'R' value is the thermal resistance that, while maintaining thermal comfort, minimizes the total cost of electricity consumption and insulation. 'R' determines the extent or thickness of insulation which is based on mathematical calculations concerning the thermal conductivity 'K' of insulation material. Also, a selection of optimum thickness is essential. Optimum thickness is the thickness that gives the minimum total cost. Total cost comprises the cost of insulation material, cost of installation, plus the present worth of electric energy consumption cost. The cost of insulation increases linearly (Lins) with the thickness of the insulation; and the cost of electricity consumption decreases with the insulation thickness (the decrease is rapid at small Lins and increases gradually at large Lins). The thermal mass (density) of insulation is important for energy savings; hence the use of critical mass of insulation is important.

How to Determine Optimum Insulation Thickness?

Due reference should be taken from the ECBC to determine the thickness. ECBC provides 'R' values for the building type (roof and wall) and climatic zone. By utilizing R = L/K (L is the thickness and K is the thermal conductivity of the insulation product), insulation thickness can be calculated.

The following are ways in which insulation can be applied to buildings.

Roof Insulation

The roof can be insulated by doing an underdeck or overdeck insulation. In the case of underdeck insulation of reinforced cement concrete buildings, GI channels are installed from the inside of the roof and fibrous insulation materials such as bonded mineral wool of density 48 kg/m^3, wrapped either in polythene sheet or with aluminium foil lamination, is placed between the GI channels and held in position with criss-cross GI wiring. Finally, gypsum or cement fibre board is fixed to the GI channels. This way the insulation becomes sandwiched between the finishing board and reinforced cement concrete ceiling. The insulation material should be non-combustible as per BS: 476 Part-4 also, because it is applied inside, it should be water repellant so that any moisture trapped by condensation should not create problems in the future. Another method of underdeck insulation is using rigid insulation materials with aluminium foil lamination of 32 kg/m^3 density which can be directly fastened using GI washers on to the reinforced cement concrete. This system is suitable wherever there is a false ceiling. Rigid foam is also fire safe and has Class O fire rating as per BS: 476 Part-6 of the fire propagation test.

Similarly, for metal sheet roofing of a pre-engineered building (PEB)

or residential houses in hilly areas with metal profile sheet roofing, an underdeck insulation is very common using an expanded metal mesh fixed to mild steel cleats welded to the steel structure. Fibrous insulation of 48–64 kg/m^3 density with aluminium foil lamination and thickness ranging from 75 mm–100 mm is placed over the metal mesh and then the metal profile sheet is fixed on top. Here the insulation stops the heat and cold and, at the same time, provides acoustical noise protection from rainwater drops.

Overdeck Roof Insulation

Overdeck insulation is a method whereby thermal insulation material is fixed directly over the reinforced cement concrete followed by waterproofing and final finish. A commonly followed method in India is using rigid foam slabs of 36 kg/m^3 density and thickness ranging from 50 mm to 75 mm fixed with cold adhesive on the reinforced cement concrete slabs. The entire reinforced cement concrete is covered with foam slabs and then plaster is applied followed with waterproofing and finishing arrangement. This is the most common method for insulating small-sized roofs. But there is another method whereby polyurethane foam insulation ingredient chemicals can be sprayed over the reinforced cement concrete roof surface irrespective of the area. The chemicals sprayed through special guns instantly react and foam up to form a homogeneous jointless cover over the entire roof. This foam spray is CFC-HCFC free and can be sprayed over the roof area at the coverage rate of 300 to 400 square metres per day. This sprayed foam is a close cell and there is negligible water absorption. The density of foam

Photograph 4: Double brick-wall cavity insulation

Photograph 5: Cavity wall insulation with aluminium stone finish

Photograph 6: Double brick-wall insulation

is 42 to 45 kg/m^3 which ensures foot traffic load resistance. Subsequently, cement screeding arrangement is provided followed by waterproofing and finishing item. Spray foam is the latest technology for roof insulation in India where the reinforced cement concrete is totally covered and not exposed to environmental hazards. Large roofs can be covered very fast; overdeck insulation stops the heat right at the source.

Wall Insulation

Wall insulation is very important and there are various methods to carry out the same. In the case of internal application, galvanized iron channel framework is fixed on to the walls creating cavities and non-combustible water-repellant grade mineralwool insulation slabs with aluminium foil lamination are placed into the cavities and then covered with gypsum or cement bibre boards. In the case of external application depending upon the type of finish the specifications are drafted. Suppose it is of double wall specifications, after the main load-bearing wall is erected, insulation covered with polythene sheet from all sides is fixed externally with fasteners and then the second wall is constructed (cavity insulation). The density recommended is 64–96 kg/m^3. There are buildings where stone cladding is used; in such cases, after the steel framework for holding the stone is erected, insulation encased in polythene is fixed with fasteners in between the holding clips. The same is also followed for aluminium cladding when insulation is placed between the holding framework. For such cavity wall insulation, fibrous mineralwool insulation materials are used of higher-grade densities, for example, 48–64 kg/m^3 to take advantage of extreme rigidity and antisag properties.

Wall insulation is also possible with fire-safe rigid slab which can be mechanically fastened to the walls. Rigid foam spray is also feasible on walls.

The most versatile method recommended nowadays is applying rigid foam slab from the outside and then finishing it with plaster. In this procedure, rigid close cell CFC-HCFC free foam slabs of 36 kg/m^3 density and thickness ranging from 50mm to 65 mm is fixed with a special polymerized water-based adhesive directly to the plastered walls. The adhesive dries up in two hours. Thereafter, polymerized plaster in

Photograph 7: External wall insulation with close cell CFC-HCFC free-rigid foam-slab insulation

Photograph 8 (a): External-wall insulation with polyurethane chemicals poured in situ

Photograph 8 (b): External-wall insulation with spray foam insulation

Photograph 9: Prefab panel buildings

2 layers of total thickness, 6mm with a synthetic reinforcement, is applied directly on to the foam slab. In this way the entire wall is insulated and plastered from the outside. Subsequently, various architectural finish can be provided with PoP. Another method is creating a cavity and pouring pre-mixed polyurethane chemical that foam and dry instantly, thus filling the gap and creating a homogeneous virtual wall of insulation.

By external insulation on the wall, the base wall never gets exposed to the atmosphere and the heat and cold is stopped at the source.

It is essential that the temperature range of the insulation material should be higher (more than 75 °C) to ensure that it remains in position for a long time and does not get detached from the wall; the plastic, too, should not get detached. The finishing component (plaster, tile) usually touches a 15 °C to 20 °C above the ambient temperature during summer.

Prefab Panels

Nowadays buildings are constructed with steel pre-engineered building technology, a latest concept in building construction. The entire steel components are fabricated at the factory and sent to site in smaller components. For such steel-framed buildings, prefab panels are used for roofing and wall panelling. These panels comprise colour-coated steel sheets facing both sides with core of rigid or fibrous insulation materials. Such steel buildings can be multistoreyed and used for construction of office buildings, malls, residential houses, schools etc. The panels provide an aesthetically pleasing look and can be erected fast without using much labour. The thickness varies from 50 mm to 80mm, or 1.96 inch to 3.14 inch, suitable for building construction.

Such steel buildings with panel roofing can be ideally fitted with solar panels on rooftop. Individual house modules can be built equipped with solar panels to generate self-sufficiency energy, also known as net-zero buildings.

Conclusion

Thermal insulation is an important provision to stop heat/cold from leaking in and out of buildings and, if judiciously selected and applied, can result in energy and capital savings. In order to derive maximum benefits, thermal insulation needs to be decided during the designing of a building and not after installation.

Acknowledgements
The author would like to acknowledge that the photographs have been taken from the following project sites in India: at IREO-Gurugram; Escorts Farmtrac-Faridabad; Prism-Gurugram; LANCO-Korba; Parliament Annexe Building, New Delhi; Bharti Mall-Ludhiana; and 3C Net-Zero Building.

Greenifyi™

Technologies That Greenify Your World

www.Greenifyi.com

Visit Our Website Today & Get in Touch With Us

RECYCLABLE STEEL BUILDINGS

Do You Want to Construct Your House, Office, Institute or any Building with in 50% Lesser Time than traditional Brick-Mortar-Concrete Buildings ?
Try The New Big Thing in Construction.
Reject Concrete, Switch to Steel Buildings with Greenifyi !

SOLAR ENERGY

Do You Want to Generate Electricity In Your Own House at an Affordable Cost ?
Want to have a Comfortable Temperature in Your Building along with Hot Water in a cost-effective manner ?
Try Greenifyi's Solar Solutions !

GREEN BUILDINGS

Do You Want Your House, Office or any Building to be Intelligent, Responsive to Your Needs, That Saves Your Running Cost? Do You Want to Give a Little Back to Mother Nature Who Takes Care of You All The Time?
Switch to Green Buildings & Habitats !
Greenifyi Shall Help You in a Smooth Transition To The New Way.

2017 from GRIHA's Lens

Driven by the aim to utilize resources efficiently, protect occupants' health, and minimize waste, GRIHA rating has evolved from being a methodology to a way of thinking. In this article, **Chitrangada Bisht** gives a comprehensive overview of GRIHA's journey in 2017 and the ways in which it continues to shape and influence the construction sector.

Chitrangada Bisht, manager with GRIHA Council, is an architect and has been working in the field of green buildings since the last 10 years. She can be reached at: chitrangada.bisht@grihaindia.org

GRIHA has come a long way since its inception in 2005. Custom designed to address sustainability in the Indian construction sector, GRIHA has always been aligned to the national policies and guidelines. GRIHA for Existing Buildings (EB), the latest variant of GRIHA, was launched early in the year to make the existing building stock more resource-efficient.

Considering that 'sustainability' has taken centre stage in the 21st century, a lot of recent policies are around this agenda. The rating system is in sync with various acts, national guidelines , National Solar Mission' and '*Swachh Bharat* Mission'. Moreover, out of the '100 Smart Cities', 33 have highlighted 'Green Buildings' as a key strategy in their proposal.

Acknowledging GRIHA Rating's role in implementing the national agenda, many state governments and urban local bodies offer incentives for the projects that adopt GRIHA Rating. Haryana and Andhra Pradesh are the latest ones to join the movement.

The proposed additional Floor Area Ratio (FAR) incentive by the Government of Haryana was finalized in March 2017. As per the new building bylaws of Haryana, all new projects are eligible for 3% to 12% additional FAR on achieving the GRIHA Rating. This decision has been welcomed by the developers and a lot of them have come forward and committed their future constructions for GRIHA rating. Many leading developers of the country, Vatika, IREO, Godrej Properties, and Vilas Javdekar Developers, to name a few, have signed MoUs with GRIHA Council for adopting GRIHA rating for their upcoming projects.

The number of GRIHA registered projects have already crossed 1000, amounting to more than 40 million sq. m built-up area. Engineers India Ltd Campus, Gurugram, 5 Star GRIHA and Power Grid SR-II RHQ Office Building, Bangalore, 4 Star are among the projects that achieved rating in 2017.

In September 2017, a Memorandum of Understanding (MoU) was signed between the Capital Region Development Authority of Andhra Pradesh (APCRDA), State Energy Efficiency Development Corporation of Andhra Pradesh (APSEEDCO), and The Energy and Resources Institute (TERI) for the implementation of green buildings and sustainable habitat through GRIHA at the upcoming new capital township of Amaravati. The Government of Andhra Pradesh also offers 25% subsidy of the total fixed capital investment of the project for GRIHA-Rated projects as an incentive for the establishment of industrial enterprises as part of the

Photograph 1: SPARSH, A green building mockup at UN

Photograph 2: MoU Signed by Dr Shreedhar Cherukuri, Commissioner, APCRDA, Mr A Chandra Sekhara Reddy, APSEEDCO and Dr Ajay Mathur, DG TERI in presence of Shri N. Chandrababu Naidu, Hon'ble Chief Minister of Andhra Pradesh

Industrial Development Policy (IDP) 2015–20.

Taking forward its association with GRIHA, the Bureau of Police Research & Development (BPRD) issued a circular to the heads of all the State Police Housing Corporations for the incorporation of GRIHA in ongoing and future projects. The Madhya Pradesh Police Housing & Infrastructure Development Corporation (MPH&IDC) has committed 10 upcoming projects to be certified by GRIHA. In line with its intent of implementing best sustainable practices towards reduction in emission levels and in saving fuel, Airports Authority of India (AAI) announced that all proposed airport terminals will have GRIHA ratings. Likewise, as part of environmental initiatives, energy conversation, use of renewable energy and green technology, Military Engineering Services (MES), has mandated GRIHA norms in all projects to ensure environment-friendly buildings in future.

GRIHA rates projects all over the country from its office in Delhi and Mumbai. With an intent to enhance its services in different regions, GRIHA offices have been set-up in Bengaluru and Pune as well. GRIHA Council continues to undertake widespread capacity-building exercises across the country for smooth knowledge transfer and effective implementation of the GRIHA Rating. In addition to the intensive three-day GRIHA Training Programmes, GRIHA Council, in collaboration with Pimpri Chinchwad Municipal Corporation and Tata Capital Housing Finance Limited, also organized a one-day conference on 'GRIHA and Financing Green Buildings' on June 22, 2017 in Pune. Further, the one-day Training Programme on SVAGRIHA rating system conducted on July 29, 2017 along with a site visit to a 5-star SVAGRIHA-rated building in Noida was also appreciated and very well attended by the professionals. This year the certification exams of GRIHA, Certified Professional (CP), that is the replacement of the GRIHA Trainers Scheme and GRIHA Evaluators, were revamped. The evaluator exam and modules were launched at the One Mega Event at Pragati Maidan, New Delhi, on May 11, 2017.

Photograph 3:Sanjay Seth, CEO, GRIHA Council speaking at the One mega event, New Delhi

SPARSH—an integrated, life-size model which endeavours to enhance the user experience of a 'Green Building', conceptualized and developed by the GRIHA Council with support from green building material manufacturers—was re-created at the UN grounds to showcase sustainability on the UN Day 2017.

The past decade has been revolutionary for the green-building sector in India, but the number of certified green buildings in India is still miniscule and there is a long road ahead. Today, we are bearing the brunt of environmental damage more than ever with challenges, such as air pollution and water pollution posing a threat to the people of the country. Sustainability is not an option any more but a necessity for the survival of mankind, and, in the coming time, GRIHA is the right way forward for the building industry.

AIS
Asahi India Glass Ltd.

AIS ecosense
The green standard in glass

Built using AIS Ecosense Enhance – Dawn, Aura & Spring

ENABLING A SMARTER AND SUSTAINABLE FUTURE

AIS Ecosense is a range of energy-efficient glass products designed to achieve the right balance between daylight & energy saving, visual comfort & thermal control and technology & eco-sensitivity.

- **AIS Ecosense Enhance** – Solar Control
- **AIS Ecosense Exceed** – Solar Control Low-E
- **AIS Ecosense Essence** – Low-E
- **AIS Ecosense Edge** – Solar Control Thermal Insulation (Can be used in SGU)
- **AIS Ecosense Excel** – Double Low-E

Asahi India Glass Ltd.
Global Business Park, Tower – B,
8th Floor, Mehrauli – Gurgaon Road
Gurgaon – 122 002, Haryana,
Tel: (0124) 4062212-19
www.aisglass.com

Follow Us
/AsahiIndiaGlassLtd /AsahiIndia
/company/asahi-india-glass-limited

To experience glass like never before, download the **AIS world of glass** app now!

Parryware
always in fashion

SOME THINGS NEVER GO **OUT OF STYLE**

SANWARE / TAPS / WELLNESS / VANITY / ACCESSORIES

Parryware Care – 1800-274-6060 / www.parryware.in