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Let Nature Be

Approach to Integrated Sustainability

A **GRIHA Council** Publication

COVER STORY

IN-FOCUS

THANKS TO OUR VALUED PARTNERS

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Message from the **President, GRIHA Council**

> *GRIHA has been conceded as an effectual platform that comprehensively evaluates the environmental performance of buildings over its entire lifecycle. It also guides the stakeholders as well as occupants in adopting efficient strategies and a sustainable lifestyle paving the way for innovation under the gamut of construction, operation, maintenance without compromising the quality of indoor air quality and occupant comfort and wellbeing as well as acting as a tool for improved building performance.*

India, the seventh largest country in the world, is a leading economy and home to over one billion people living in various climatic zones. The country's economy has been growing at a fast pace ever since the process of economic reforms started in 1991. Construction plays a very important role in its economy contributing to growth of the GDP. Commercial and residential sectors continue to be a major market for the construction industry. The sectors consume a lot of energy throughout the life cycle of buildings thus becoming a major contributor to greenhouse gas emissions.

I am pleased to announce that the GRIHA family, in this regard, has been instrumental as a catalyst for environmental upgradation. With pioneering work aimed at a holistic assessment of building resource efficiency, GRIHA continues to develop a myriad of rating variants catering to a wide range of building typologies and scale. It is heartening to see the steady adoption of these variants across the country. Multiple engagements with public and private construction agencies have reinforced GRIHA as a robust and transparent tool to evaluate green development and encouraged the launch of new initiatives by the GRIHA Council in response to the emerging needs of the building industry as well as government goals.

With unprecedented global challenges; climate change, loss of biodiversity and exhaustion of critical natural resources being the most prominent, it is evident that without proactive action and dialogue at a global level, solutions cannot be sought. In order to address the challenges faced by communities at large, it is imperative to strike a balance between social development, sustained economic growth, sustainable management of natural resources and cultural variations.

With its commitment to the sustainable development goals, GRIHA is organizing the '11th edition of GRIHA Summit' to serve as a forum to discuss various environmental challenges. As part of outreach to international academia GRIHA Council is collaborating with the University of New South Wales, Sydney, Australia, to co-create the 11th GRIHA Summit in the week of 'Energy Conservation' day. The theme for this year summit is "Approach to Integrated Sustainability" and will seek integration of solutions across the different parameters of sustainability.

This GRIHA Summit will bring together global leaders on sustainable habitats, experts from industry, government, academia, finance and policy, consumers and numerous international delegates, to discuss and deliberate on furthering the sustainable habitat agenda in India. This summit is interspersed with technical sessions on sustainable building policies, tools and techniques, exhibitions showcasing sustainable building materials construction practices and technologies.

I humbly acknowledge the unending support and trust of our valued partners and their unwithered confidence in GRIHA. Without any apprehension I can proudly say that this progress is the result of continuous commitment of an exuberant team.

Wishing all the best for the forthcoming year, 2020!

Ajay Mathur
President, GRIHA Council and Director General, TERI

GRIHA TIMELINE

2014

❍ GRIHA for day schools rating.

✸ GRIHA projects in MoUD, Delhi Division, Government of India.

Sikkim mandates GRIHA.

2013

❍ GRIHA LD rating, GRIHA app, GRIHA new user-friendly metro design website.

✸ GRIHA projects in Noida, Greater Noida, and Punjab.

PCMC announces premium discounts to developers and property tax rebate for buyers.

2015

✸ GRIHA projects in Rajasthan, Pune, AUDA, and Uttar Pradesh.

✸ GRIHA projects in the Government of West Bengal, Department of Municipal Affairs.

❍ GRIHA V.2015 rating and GRIHA LD rating.

A 25% subsidy on FSI for GRIHA-rated industrial projects in Andhra Pradesh.

2000–08

TERI conducted over 100 building audits.

TERI GRIHA released as an indigenous green building rating in India (2005).

MNRE adopts GRIHA as a National Rating System for Green Buildings (2007).

National Mission on Sustainable Habitat launched (2008).

2012

❍ SVA GRIHA rating

❍ GRIHA Product Catalogue.

SIDBI announces concessional rate of interest for GRIHA projects.

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.

2011

■ CREDAI

PCMC announces discounts on premium charges to developers and property tax rebate for buyers for GRIHA-rated projects.

EC linked to GRIHA precertification.

2010

❍ Evaluators' and Trainers' Programme.

Developed by

The Energy and Resources Institute

Creating Innovative Solutions for a Sustainable Future

Contact Details

GRIHA Council

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Phone: 91.11.46444500, 91.11.24339606-08

Fax: 91.11.24339609 • E-mail: info@grihaindia.org • Website: www.grihaindia.org

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

2019

- ❍ GRIHA for Existing Day Schools rating
- ❍ GRIHA v. 2019
- ■ PWD, Maharashtra
- ■ UNSW, Sydney
- ■ Council of Architecture
- ■ Indian Institute of Architects

2018

- ■ PWD, Maharashtra and Orange County.
- ■ Extended with NASA, India.
- ❍ Paryawaran Rakshak Programme for RWA

GRIHA Council awarded with Green Excellence Award, 2018.

2017

- ❍ GRIHA EB rating, GRIHA for Affordable Housing rating.
- ❍ Revamped evaluators module and exam.
- ■ MPPH&IDC, PMC, BESTECH, Ireo, Vatika, CONSCIENT, ADANI Realty, Vilas Javdekar Developers, and Godrej Properties.
- ■ EESL, NHB, ISHRAE
- ■ Extended with NASA, India

Circular issued to all the State Police Housing Corporations for the incorporation of GRIHA in the ongoing and future projects by the BPRD.

SPARSH installed at the UN office on UN Day 2017.

2016

- ❍ GRIHA Help Centre, Institute membership programme ACE, students membership programme CATALYST.
- ✸ GRIHA projects in Haryana.
- ■ MPPH&IDC, IICCI.

PMC announces discount in premium charges for GRIHA/SVA GRIHA projects.

- ❍ Launch
- ■ Memorandum of understanding (MOU)
- ✸ Floor area ratio (FAR) incentive

GRIHA App on >

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नितिन गडकरी
NITIN GADKARI

सत्यमेव जयते

मंत्री
सड़क परिवहन एवं राजमार्ग;
सूक्ष्म, लघु एवं मध्यम उद्यम
भारत सरकार
Minister
Road Transport and Highways;
Micro, Small and Medium Enterprises
Government of India

MESSAGE

It gives me an immense pleasure to know that GRIHA Council is celebrating the 11th Anniversary of their annual summit on 17th and 18th of December, 2019 with the theme **'Approach to Integrated Sustainability'**.

I deeply appreciated GRIHA Council's mission of integrated development through diverse partnerships. It is also a matter of great pride to know that GRIHA Council is about to launch **'GRIHA v 2019'** – the latest version of GRIHA rating, which was initially designed to assess the environmental performance of buildings over their entire life cycles and has been improved over the years to make it even more relevant to the changing trends and recent Industry standards.

In this context, I wholeheartedly hope that the motives and aspirations of this summit along with the earnest efforts of the experts and stakeholders associated with it bring out a positive outcome for India and its citizens.

I wish GRIHA Council's 11th summit all the success and convey my best wishes to the GRIHA Council in all their future endeavors in the year 2020.

(Nitin Gadkari)

Date: 20th November, 2019
Place: New Delhi

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आर. के. सिंह
R. K. SINGH

सत्यमेव जयते

विद्युत एवं नवीन और नवीकरणीय ऊर्जा
राज्य मंत्री (स्वतंत्र प्रभार) एवं
कौशल विकास और उद्यमशीलता राज्य मंत्री
भारत सरकार
Minister of State (Independent Charge)
for Power and New & Renewable Energy and
Minister of State in the Ministry of Skill Development
and Entrepreneurship
Government of India

Message

I am glad to know that Green Rating for Integrated Habitat Assessment (GRIHA) Council is co-hosting its flagship event, the 11th GRIHA Summit from 17th to 18th December 2019 at New Delhi with the theme "Approach to Integrated Sustainability".

Electricity consumption is a key ingredient to accelerate the economic growth and one of the important indices that is considered vital for the nation's overall development. Providing reliable and quality power supply in an efficient manner is an immediate need of the hour. Owing to the increase in customer base, changes in lifestyle and consumption patterns, there is a consistent growth in electricity demand. However, we have determined that we will also reduce our carbon footprint – without compromising on growth.

Improving energy efficiency meets the objectives of promoting sustainable development making the economy competitive; and reducing the emission intensity of our economy.

Government of India have undertaken a two-pronged approach to cater to the energy demand of its citizens while ensuring minimum growth in CO2 emissions, so that the global emissions do not lead to an irreversible damage to the earth system. On one hand, in the generation side, the Government is promoting greater use of renewable in the energy mix mainly through solar and wind and at the same time shifting towards supercritical technologies for coal-based power plants. On the other hand, efforts are being made to efficiently use energy through various innovative measures under the overall ambit of Energy Conservation Act 2001.

I am delighted to learn that GRIHA Council is organizing its **"11th National Summit"** on the theme **"Approach to Integrated Sustainability"** on 17th and 18th December, 2019. I believe that summit will open doors to deliberate on issues, challenges and the way forward on how to strengthen the approach to integrated sustainability, in the built environment and otherwise. I wish all success for the summit.

(R.K. Singh)

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हरदीप एस पुरी
HARDEEP S PURI

सत्यमेव जयते

आवासन और शहरी कार्य राज्य मंत्री (स्वतंत्र प्रभार)
नागर विमानन राज्य मंत्री (स्वतंत्र प्रभार)
वाणिज्य एवं उद्योग राज्य मंत्री
भारत सरकार
Minister of State (I/C), Housing & Urban Affairs
Minister of State (I/C), Civil Aviation
Minister of State, Commerce & Industry
Government of India

Message

It gives me immense pleasure to know that GRIHA Council is celebrating the 11th Anniversary of their annual summit on 17th and 18th of December, 2019 with the theme 'Approach to Integrated Sustainability'.

Practicing and propagating sustainable development is the most predominant and contemporary process that is prevalent throughout the globe, especially in India. An integrated approach to implement sustainable strategies is required to sustain the brisk growth rate of the economy, and to alleviate the problems arising due to the same.

The Ministry of Housing and Urban Affairs has actively promoted holistic development through integration of various sustainable strategies in the housing and construction industry, to meet the growing demands of urbanization.

I also appreciate GRIHA Council's mission of integrated development through diverse partnerships. I am also pleased to know that GRIHA Council is about to launch 'GRIHA v 2019' – the latest version of the GRIHA rating, which was initially designed to assess the environmental performance of buildings over their entire life cycles and has been improved over the years to make it even more relevant to the changing trends and recent industry standards.

I wish GRIHA's 11th summit all the success and convey my best wishes to the GRIHA Council in all their future endeavors in the year 2020.

(Hardeep S Puri)

New Delhi
11 December 2019

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

संजीव एन. सहाय, भा.प्र.से.
सचिव
भारत सरकार
Sanjiv N. Sahai, I.A.S.
Secretary
Government of India

सत्यमेव जयते

Ministry of Power
Shram Shakti Bhawan
New Delhi - 110001

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December 11, 2019

MESSAGE

I am glad to know that GRIHA Council is hosting its "**11th GRIHA Summit**" on 17th – 18th December, 2019 with the theme "***Approach to Integrated Sustainability***" in New Delhi to mark the adoption of sustainable development and promote, create awareness and ensure positive & affirmative action for conservation of natural resources.

Energy demand owing to the rising population is expected to surge in the coming years resulting in aggravated concerns about climate change. To address this, countries across the globe are modernizing their electricity grids to monitor, measure and control power flows in real-time; and optimize their performance.

The Government of India is committed to supply electricity to each household and improve the quality of life of its citizens by providing reliable and quality power at affordable prices. The 'Power for All' programme is a major step in this direction.

The joint initiative of GRIHA Council with various other organizations aims to align the nation to its global commitments. These efforts have set the country on the low-carbon path and are enabling implementation of sustainable development. It would further encourage environmental as well as socio-economic progress of the country.

I compliment GRIHA Council and wish them all the success for this event.

(Sanjiv Nandan Sahai)

RIGHT TO INFORMATION

स्वच्छ भारत
एक कदम स्वच्छता की ओर

HIGH COMMISSIONER

AUSTRALIAN HIGH COMMISSION
NEW DELHI

I am delighted to see collaboration between the University of New South Wales (UNSW) and the Green Rating for Integrated Habitat Assessment Council (GRIHA) for the second consecutive year for the 11th GRIHA Summit.

The theme of the summit, *Approach to integrated sustainability*, is timely given the increasing focus globally on sustainable and inclusive development of our cities. The theme also acknowledges that sustainability is a cross-disciplinary endeavour that requires coordination across sectors and among myriad stakeholders—business, government, civil society and communities.

Australia and India are experiencing a trend towards increased urbanisation and the challenges that brings. While the scale of both countries is vastly different, nevertheless, the pace and distribution of Australia's population growth has put enormous pressure on the liveability of our big capital cities, as it has in India.

Underpinning all this is the challenge that climate change poses to liveability and livelihoods. Buildings and construction are significant contributors to emissions. I commend the work of the GRIHA Council in focusing on this issue and designing frameworks and solutions to bring down emissions and improve the quality of life for us all.

UNSW is recognised for its expertise in the built environment and the interdisciplinary approach it takes, aimed at creating resilient, connected, sustainable, and smart urban environments. It is wonderful to see Australian and Indian capability being brought together to address such critical issues.

Addressing the complex challenges of rapid urbanisation will require ingenuity, innovation and a long-term perspective. We will require new ways of collaborating and learning from each other to develop environments that are healthy and prosperous. The GRIHA Summit is one great example of that collaboration.

Congratulations on your continued commitment to taking forward this partnership and I wish you every success at the 11th GRIHA Summit.

Harinder Sidhu

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ROYAL DANISH EMBASSY
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Ambassador, The Royal Danish Embassy in New Delhi, India

It is a great honour to be part of the **11th GRIHA Summit**. The summit with the theme "Approach to Integrated Sustainability" will focus on various verticals of growth. Besides striving towards economic growth, the aim of the Summit is also to highlight the importance of balancing social development, sustained economic growth and sustainable management of natural resources and cultural variations. This will result in adhering to the set SDGs and its successful adoption.

Denmark provides a comprehensive approach; whether, it is offering a deep pool of relevant urban solutions, products, services and expertise or providing innovative and sustainable solutions. The inclusive framework is well thought out and is realised through understanding the feedback of various stakeholders.

Denmark is committed to promoting its green ambitions and solutions worldwide, which is why the Royal Danish Embassy in New Delhi has been appointed as a Climate Frontrunner. It will now be our task to bring innovative green solutions from Denmark to India, by linking all areas within foreign, trade, and development policy. In short, Denmark is greening its foreign policy.

Cities like Copenhagen, Aarhus, Vejle, Sonderborg etc., have their story of success in urban planning. District heating due to integration of biomass and wind, using digital technology for improving climate change resilience, strong citizen participations and raising awareness among citizens in spite of rapid urbanization are few strategies that were adopted in these cities.

We are proud to be associated with GRIHA Council as 'Associate Partners' to the Plenary Session "Grand Challenges on Rapid Urbanization" at this year's Summit.

I very much look forward towards an evolving partnership that could strengthen the ties between Denmark – India, which would encourage in facilitating knowledge exchange and deepen research links in addressing the issues of climate change and the effective strategies of mitigation.

I give my best wishes to GRIHA Council for grand success of the Summit.

Ambassador Freddy Svane

दुर्गा शंकर मिश्र
सचिव
Durga Shanker Mishra
Secretary

भारत सरकार
आवासन और शहरी कार्य मंत्रालय
निर्माण भवन, नई दिल्ली–**110011**
Government of India
Ministry of Housing and Urban Affairs
Nirman Bhawan, New Delhi-110011

MESSAGE

Our Country is witnessing an unprecedented development in the urban areas. Various transformatives Missions like Swachh Bharat Mission (Urban) - SBM(U), Atal Mission for Rejuvenation and Urban Transformation - AMRUT, Smart City Mission - SCM, Heritage City Development and Augmentation Yojana - HRIDAY, Pradhan Mantri Awas Yojana (Urban) – PMAY(U), Deendayal Antyodaya Yojana – National Urban Livelihoods Mission – (DAY-NULM) and scheme of Urban Mobility like Metro Rail, Regional Rapid Transport, BRTS, Non-motorised transport etc. are bringing transformation of cities like it has never happened anywhere in the world .

Sensitivity to environment, resource efficiency, reducing wastages, conservations of resources and climate resilient activities should be core to such rapid development. They not only ensure achieving the Sustainable Development Goals (SDGs) but also ensure sustainability in the long run.

GRIHA rating plays a very significant role in addressing our concerns to the environment and green sustainable development. I am happy to learn that GRIHA Council has developed standards for Affordable Housing and the cities and now it has come up with rating for Day-Schools and new version for Urban Habitat. These will help in future development with commitment to the nature and environment.

I wish all the very best to GRIHA Council in their endeavour in making urban habitat better sustainable.

(Durga Shanker Mishra)

New Delhi
02 December,2019

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भारतीय विमानपत्तन प्राधिकरण
AIRPORTS AUTHORITY OF INDIA

Message from Chairman, Airports Authority of India

India is now the third largest, and the fastest growing domestic aviation market in the world in terms of number of domestic tickets sold. In 2017, India registered a growth of 23.5% in domestic passenger departures as compared to 3.3% growth in the US and 10.7% in China. India continues to have among the lowest airfares in the world and, with the airport network growing rapidly, flying has truly become available for all.

In wake of the increasing demand, system capacity is being raised in all areas including airports, skilled staff, aircraft parking and maintenance, air traffic management and financing. Close collaboration with states to ensure equitable land acquisition, integrated urban planning, high speed transportation networks and balanced regional development is being facilitated. The Airports Authority of India aims to achieve, consolidate and strengthen good corporate governance including socially and environmentally responsible business practices that balance financial profit with social well-being.

I am pleased to inform that as a part of the National Civil Aviation Policy (NCAP) 2016, which was a guiding platform to meet our goals, we could successfully implement UDAN (Ude Desh ka Aam Naagrik), which offers affordable flying to masses. UDAN has set the revival tone for most unserved and underserved airports of the country as well as brought in new destinations on the air map. AAI is committed to maintaining and managing the immediate surroundings of new or existing airport which are most affected by such facilities; the district, town or city as a whole where the airport is located; and the country as whole for dealing with emergency situations and achieving higher national goals.

In this regard, it is heartening to see GRIHA's outreach in different parts of the country towards facilitating sustainable practices in the construction industry. GRIHA has been instrumental in the development of an indigenous and holistic rating system for building of different typologies addressing issues on water, waste and energy management which are fundamental in ensuring resilient built environment.

I congratulate the GRIHA team on the launch of its new variants 'GRIHA for Day Schools' and 'GRIHA version 2019'. I wish them success for the 11th GRIHA summit and look forward to the continued adoption of the rating by the AAI.

(Arvind Singh)
Chairman

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PRABHAKAR SINGH
Director General

सत्यमेव जयते

भारत सरकार
Government of India

CPWD

केन्द्रीय लोक निर्माण विभाग
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MESSAGE

It gives me immense pleasure to know that the GRIHA Council is organizing its annual flagship event - **11th GRIHA Summit** in New Delhi from 17th to 18th December, 2019.

The theme chosen for the summit '**Approach to Integrated Sustainability**' is very relevant considering the present scenario of rapid urbanization and need for creation of sustainable, smart, energy efficient and affordable built environment in the country in a holistic manner.

CPWD being a Principal Engineering Organization and Technical Advisor to the Government of India, has always strived to be the front runner in adoption of energy efficient, sustainable, new and innovative technologies in its construction to push its vision of sustainable and inclusive built environment. CPWD is aggressively pursuing its Clients to go for the green buildings and also developed its own Green Rating System.

There are many ways to pursue integrated sustainable development strategies. Some of the effective ways are to adopt a sustainable development pathway by shifting to environmentally sustainable technologies, promotion of energy efficiency, renewable energy, forest conservation, reforestation, water conservation, efficient, fast and reliable public transport system etc.

I take this opportunity to congratulate the efforts put in by the GRIHA Council for the promotion of sustainable buildings in India and also for its collaboration with other countries. I hope that the Summit will bridge the gaps in adoption of sustainable technologies by bringing everyone on the same page.

I wish 11th GRIHA Council Summit a great success.

(Prabhakar Singh)

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ऊर्जा दक्षता ब्यूरो
(भारत सरकार, विद्युत मंत्रालय)
BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

Bureau of Energy Efficiency (BEE) is supporting the Government to adopt measures to reduce the demand side energy consumption, in turn helping to meet commitment made to the UNFCCC to curtail CO_2 emissions. One such BEE's flagship program namely "Energy Conservation Building Code (ECBC)" focuses on energy management in the building sector. ECBC provides basis to benchmark energy consumption of commercial buildings, with the final objective to achieve Net Zero Energy Buildings. GRIHA being the green building rating system has a vital role to play in the implementation of sustainability in the building sector. ECBC and GRIHA go hand in hand as the former serves as the basis/baseline for measurement of energy and material related parameters within the GRIHA rating.

It gives me immense pleasure to learn that the GRIHA Council is organizing the **"11th GRIHA Summit"** in Delhi in the month of December, 2019. The theme **"Approach to Integrated Sustainability"** chosen for the summit is in line with the commitments of GRIHA Council towards fulfilling sustainability across building sector and bridge any gap that might pose hindrance in the implementation of these efforts. I believe that this Summit will serve as a platform to provide integrated solutions to enhance the adoption of energy efficient buildings across the country.

I wish the GRIHA Council all success in their endeavors

N-Delhi 29.11.2019

Abhay Bakre
(Abhay Bakre)

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The Energy and Resources Institute's (TERI) longstanding dedication to advancing the sustainability agenda is a natural partner to UNSW's history of commitment to environmental science, renewable energy and the built environment.

Our combined credentials in these areas have never been more greatly needed than they are today, as our world struggles to reverse decades of inaction on climate change.

The deepening ties between TERI and UNSW reflect great trust in the capability of the partnership and the belief in what we can achieve together.

In the year since the 10th GRIHA summit, Dr Ajay Mathur, Director General TERI, and I signed a Memorandum of Understanding to strengthen existing relationships, and UNSW has hosted a delegation from India municipal government on a knowledge exchange program regarding leading built environment practices.

There have also been developments in a broader collaboration between the PLuS Alliance – comprised of the University of New South Wales, Arizona State University (USA) and Kings College London (UK) – and the Pune Smart City Development Corporation. At this year's GRIHA summit, a Memorandum of Understanding between these partners will be signed to further collaboration on innovative solutions to a rapidly urbanising India.

This is the second year UNSW has had the privilege of co-creating the GRIHA summit and once again we will witness the sharing of knowledge and the ideal of generosity of partnership.

UNSW will lend its expertise to discussion on this year's theme 'Approach to Integrated Sustainability', in particular through our leadership of plenary sessions on water, energy, waste and governance within The Grand Challenge on Rapid Urbanisation.

UNSW sees its role as a servant of society and our partnership with TERI is part of our mission to have a positive global impact, including through education and a commitment to long-term research.

I look forward to the 11th GRIHA Summit being yet another launching pad for productive partnerships and innovative ideas and an opportunity to forge a more closely shared future with our valued Indian counterparts.

Ian Jacobs.

Professor Ian Jacobs
President and Vice-Chancellor of UNSW

Message from the
CEO, GRIHA Council

Dear Friends and Colleagues,

The establishment of mechanisms that ensure successful sustainable solutions calls for effective partnerships across sectors and disciplines. GRIHA has made unprecedented headway in its outreach and collaborative efforts

In the face of ever increasing environmental and climatic concerns, GRIHA Council continues its unwavering commitment towards the promotion and implementation of sustainable habitat. In order to recognize energy-efficient buildings and promote sustainable practices across the construction industry, GRIHA strives constantly to increase its footprint. Over 1733 projects with a footprint of 565 million square feet of built up area comprising of public and private buildings of varying scale and typology – including housing, schools, large developments, healthcare and commercial spaces are currently registered with GRIHA. Together, they span the length and breadth of the country exceeding 565 million square feet in built up area and include landmark projects such as the terminal building in the Kartarpur corridor, the Agartala airport and the headquarters for the UIDAI in New Delhi.

I am proud to announce that the 11th edition of the GRIHA Summit is once again being co-hosted with the UNSW Sydney, Australia. Our theme for the summit - "Approach to Integrated Sustainability", is aligned with the Global Sustainable Development Goals. The Summit will focus on the challenges that rapid urbanization has thrown up in the context of energy, water, waste, socio-economic divide and governance. The discussions over the next 2 days will seek solutions to the most pressing challenges by engaging the best minds across industry, policy makers, academia and think tanks.

The continued collaboration between GRIHA Council & UNSW provides a platform for knowledge exchange. The outcomes of the 10th GRIHA Summit saw partnerships emerging between The Energy Resources Institute (TERI) and Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) in addition to GRIHA and UNSW which will be formally announced at the 11th GRIHA Summit. This will enable further strengthening of the strategic economic partnership between Australia and India, across government and business.

We are equally delighted to inform that this year, The Royal Danish Embassy in India has joined hands by supporting the GRIHA Summit as an Associate Partner. This partnership will be a stepping stone to cementing our collaboration between Denmark and India in the area of sustainable habitat.

Marking a year of growth, transformation and achievements for GRIHA Council, the 'Regional GRIHA Summit' was organised in Nagpur on 15th June, 2019, in association with Public Works Department, Government of Maharashtra. The summit was graced by Shri Nitin Gadkari, Hon'ble Minister for Road Transport & Highway and MSMEs, Government of India. The Summit centred on the theme 'Transformation Strategies for Built Environment' – a pragmatic approach towards the incorporation of sustainability initiatives in public buildings was the major topic under deliberation. The platform saw a continuation of the agreement between GRIHA & PWD Maharashtra for rating existing government buildings across the state.

The establishment of mechanisms that ensure successful sustainable solutions calls for effective partnerships across sectors and disciplines. GRIHA has made unprecedented headway in its outreach and collaborative efforts. In February 2019, a Memorandum of Understanding (MoU) was signed between the Council of Architecture (CoA) and GRIHA Council for conducting training programmes in architecture colleges across India. These training programmes will facilitate future pathways around sustainable design and construction. Another agreement was signed between Indian Institute of Architects (IIA) – Northern Chapter and GRIHA Council in May, 2019 for conducting awareness and training programmes for members of the IIA. The GRIHA Trophy for National Association of Students of Architecture (NASA) for the year 2019 has been sponsored by the Airport Authority of India.

The 11th GRIHA Summit would see the launch of GRIHA V 2019 keeping abreast the advancements of green construction technologies, materials and practices to responsibly promote resource efficiency throughout the building's life cycle. The 2019 Version would include improved parameters for an array of building typologies such as green infrastructure, life cycle assessment, life cycle cost analysis, materials for external site development, water self-sufficiency and systems commissioning to provide a holistic environmental sustainability.

The achievements during the year would not have been possible without the passion and whole-hearted commitment of the multidisciplinary team at the GRIHA Council. With persistent efforts and growing partnerships, I am certain that we at the GRIHA Council will continue our endeavours to accelerate the greening of upcoming infrastructure while blending modern and innovative green technologies with deep rooted traditional knowledge. I wholeheartedly thank my team at the GRIHA Council.

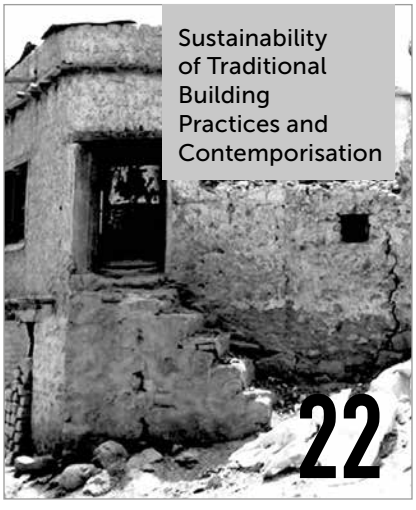
I take this opportunity to acknowledge our esteemed clients and industry associates with whom we have built inclusive partnerships based upon shared principles, values, vision and goals and extend a warm welcome to all the participants at the 11th GRIHA Summit. I am sure that the Summit will provide an enriching experience for everyone with the hope that it would benefit us all to adopt sustainable practices leading to reduced stress on natural resources and improved efficiency.

On behalf of the GRIHA Council and our partners, I welcome you all to the 11th GRIHA Summit.

Wish you all Season's Greetings and a great year ahead.

Sanjay Seth
Chief Executive Officer, GRIHA Council

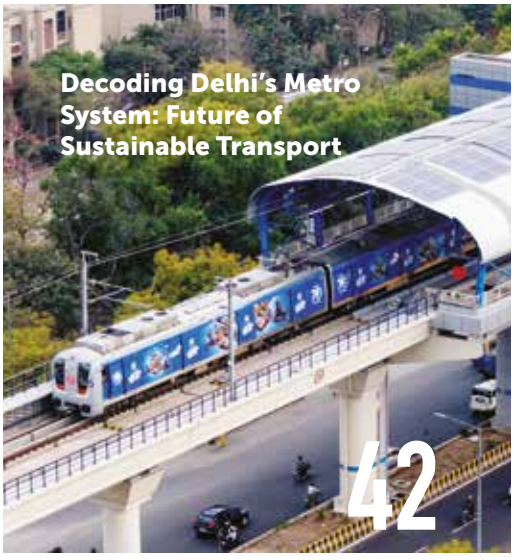
Contents



FEATURES

TESTIMONIALS

IN-FOCUS



IN-FOCUS

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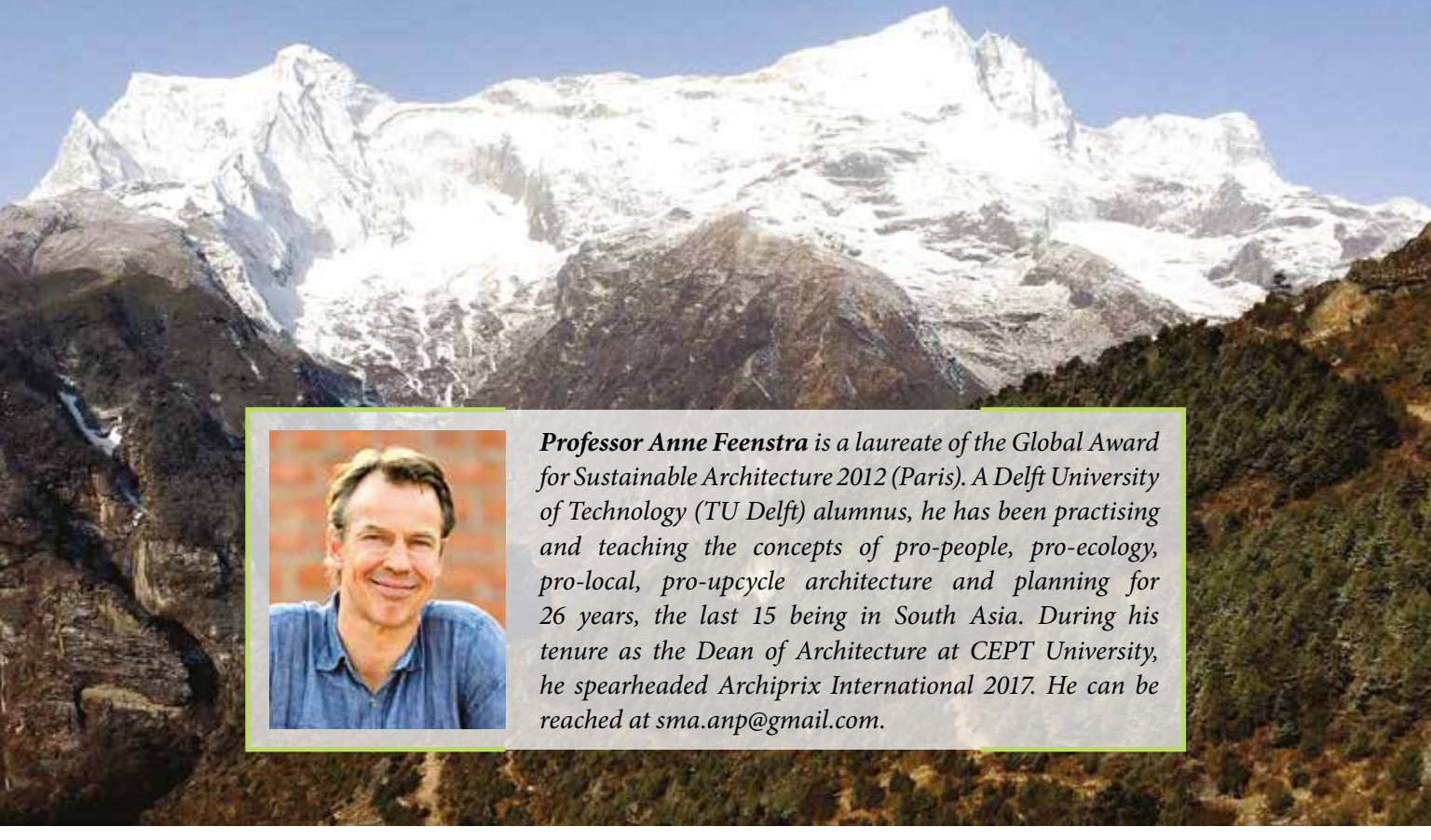
The Magic of Slow Architecture in Sagarmatha

The romance of mountaineering is comforting and adventurous. But, how often do we seriously think about mountain waste and recycling? As much as we are fascinated by the thought of scaling the Everest, seldom do we try to understand the importance of using sustainable ways of preserving the beauty of our mountain ranges. In this article, **Professor Anne Feenstra** discusses the need for sustainable mountain architecture by finding environment-friendly alternatives to non-biodegradable resources like nylon climbing robes, PET bottles, glass bottles, tetrapacks, broken mountaineering equipment, and destroyed tents among others.



Professor Anne Feenstra *is a laureate of the Global Award for Sustainable Architecture 2012 (Paris). A Delft University of Technology (TU Delft) alumnus, he has been practising and teaching the concepts of pro-people, pro-ecology, pro-local, pro-upcycle architecture and planning for 26 years, the last 15 being in South Asia. During his tenure as the Dean of Architecture at CEPT University, he spearheaded Archiprix International 2017. He can be reached at sma.anp@gmail.com.*

Scaling the Everest

The open landscape of turquoise, yellow, and ashen-dotted meadows is mixed with outstretched paws of juniper trees and rhododendron. The scene is picturesque –clouds, raptors glide overhead and yaks roam below, carefully picking out the juiciest grass and tastiest herbs, while petite flower heads sway in the wind. Everything is moving in Syamboche at 3778 m above sea level. It is 300 m above Namche Bazaar, the last town on the way to Mount Everest's base camp.

In May 1953, Edmund Hillary and Tenzing Norgay scaled the summit of Sagarmatha – the Nepali name for Mount Everest. With adventure tourism growing rapidly and improved accessibility to Nepal, thousands of individuals and groups took up the ultimate challenge. On May 19, 2012, a staggering 234 people reached the summit. In 2005, about 20,000 individuals attempted to go to the base camp, and the number has doubled to 40,000 per year, ever since. The total, after including the number of porters and other support staff, reaches one lakh.

Mountains of Waste

Nylon climbing robes, PET bottles, glass bottles, tetrapacks, broken mountaineering equipment, and destroyed tents are not biodegradable, so the quantity of these resources simply grows. Petroleum-based plastics, like PET, will never biodegrade. Scientists predict that the 22 per cent polyethylene in tetrapacks will take about 500 years to photodegrade when exposed to ultraviolet radiation. The 4 per cent aluminium – anti-bacterial 6 micron thick layer on the inside – found in tetrapacks, needs to be separated from the 74 per cent paper, before it can be reused. At high altitudes, even biodegradable materials degrade at a much slower rate. It is clear that individual ambitions have led to an uncontrolled expansion of the underbelly of the mountain ecosystem. Set up in 1991, the Sagarmatha Pollution Control Committee (SPCC) has been active in solid waste collection. A decade ago, it also banned glass beer bottles from the national park. But much more needs to be done.

Sagarmatha Next

In 2015, local Sherpa community members and the Saraf Foundation approached me. At that time, I was the founder of the Kathmandu-based non-profit Sustainable Mountain Architecture (SMA). They asked us to conceptualize and design a centre for the upcycling of mountaineering waste. They strongly believed that the local problem would require a local solution.

With the SMA team, we first studied the slowly developed geo-cultural uniqueness of the area, which is reflected in the tangible and intangible social-cultural heritage of the Sherpas. It was crucial to have ample field observations and conversations with the locals and Sherpa experts like Frances Klätzel. Their stories, observations, and cultural expressions became an inspiration for the architectural micro-narratives that our design team would eventually build. We included all the stakeholders in the process and as a team, we at SMA were confident that this could contribute to the long-term sustainability of the project.

Designing with Nature

The other important step was trying to understand the context followed by the gathering of bioclimatic data, which confirmed extreme conditions. Wind speeds regularly go up to 65 km/h, and winter temperatures drop down as low as -18 °C with up to 40 cm of snowfall. On clear days, there is high UV solar radiation. In order to deal with the wind speed, we carefully studied the contoured land and the protective juniper forest on the northern side of the land. This steered the design towards exploring a series of lower buildings, merging with the existing terrain.

The fine-tuning of the architectural composition happened with architectural scale models. A café gallery was added to the workshop

and the interpretation centre. Visitors would come to see the actual process of locally upcycling the mountain waste in the workshop. Our interactive exhibition explained how one could help reduce the waste inside Sagarmatha National Park. We screened short films and documentaries to create awareness on how the issue of mountain waste is addressed in other places in the world like the Alps, Andes, Mount Kilimanjaro, and Mount Fuji, among others. All the buildings form a compact cluster, grouped around an open public terrace called *Langgang* (extended flat space to the outdoors of a Sherpa house). Architecturally, we designed the Langgang as a

pause point, a place for relaxation and orientation. Protected against the wind, visitors can enjoy the spectacular views of the snow-covered Kongde Ri. Although we used traditional materials, some parts of the building's shapes lean towards the aerodynamic and contemporary. Locally sourced rock stone is used for the walls. Professor Basanta Devkota of Tribhuvan University observed that the rock stone is essentially light grey granite with the occasional quartz vein and darker parts containing iron. The stones can only be taken out in two strictly limited periods of the year, so as to not disrupt the national park's wildlife. Two concrete ring beams, on the floor level and on the roof level, ensure earthquake resistance. The granite stone walls are inserted with horizontal Sal timber ties and vertical micro concrete. This allows movement, but does not cause a complete collapse in case of an earthquake. Structural engineering calculations proved that the curved walls of our design were stable. For long straight walls, a subtle system of supporting buttresses and perpendicular walls were introduced

Creating Energy-Efficient Walls

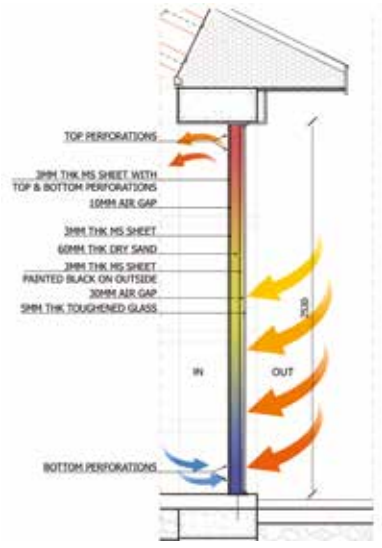
Every single window of the project was carefully designed, be it in the façade or on the roof. To ensure we capture the morning sun, we designed chamfered stone walls right next to the windows. Trombe walls provide natural heating while heat loss is reduced by double glazing units for windows, XPS roof insulation, and mud mortar.

While the present general practice amongst Sherpas is using concrete structures and cement mortars, we resisted this idea. Rapid urbanization in South Asia has resulted in the massive amount of cement usage. It is not based on structural science, or on energy efficiency, and it is certainly not good for interior comfort.

When the soil samples were taken for laboratory tests in Kathmandu, these showed that the site's yellow deep soil did not have enough clay (compared to sand and silt). During one of the site visits in early 2018, I started to work with yak dung and cow dung, to get good quality mud mortar. Both types of dung were collected from a nearby village called Khumjung. The final mixture that performed best, constituted 60 per cent yellow soil, 25 per cent yak dung, 15 per cent cow dung. We also added a little organic mustard oil as I had learned in Afghanistan that it does wonders in binding the silicone molecule structures. Professors Sushil Bajracharya and Prativa Lamsal helped us calculate the energy efficiency of the buildings. Their findings (using Mahoney table) showed that a standard design with single glazing, cement mortar, no Trombe walls, and minimal roof insulation, would need additional space heating for about 10 months (mid Sept–mid June). With the SMA's collaborative design approach, the U-values ($W/m^2.°C$) came down. Ongoing calculations indicated that additional active heating throughout the day will only be needed in the months of January and February.

Time is a Friend

Sitting on a carpet, sipping on green tea in the mountains of Afghanistan in 2004, I started to erase some of the lessons I had learned during my professional working decade in the European continent and London. Unlearning, perhaps, happened to me by default, as I stepped into an utterly different socio-cultural context. It made me reflect on a world that is becoming very impatient and ego-centric, where the sole aim seems to be to go faster for the sake of being faster. It made me ponder how we can be true and better creators. Why should we hurry if we want to be part of creating a long-lasting civilization?



I try to use the unique skills and crafts of South Asia. Not in the classical sense, but in a more innovative manner. When we spend time to listen to people, we understand the conditions of the site, examine the existing local material, gain contemporary knowledge, and accumulate wisdom, which can be used in creating interventions in the built environment. For Sagarmatha Next, we made a vision document and worked on the design between 2015 and 2016. Foundations were made in 2017 and the chiselled granite stone walls came up last year. This year, we aim to complete the timber roofs and the opening is scheduled for 2020. Can we design with the soil, the rain, the sun, and the wind? Are we able to consistently follow design principles that lead to an integrated sustainability? Can we embrace slow-paced yet thoughtfully designed structures that would last long and age well? Now is the time to seriously think and execute environment-friendly techniques in building a better future. ◻

Sustainability of Traditional Building Practices and Contemporization

In India, architectural practices have undergone significant changes due to the effects of modernization and globalization. Traditional housing techniques and design strategies have evolved in the contemporary world and societies are trying to create sustainable environments for posterity. In this article, **Avik Roy** and **Bhagyashri Sharma** argue in favour of preserving our heritage by adopting a mix of traditional and modern practices in the architectural development of a city.

Avik Roy *is an architect and industrial designer. He is an Assistant Professor, KIIT School of Architecture & Planning, Bhubaneswar.*

Bhagyashri Sharma *is an interior designer. She is an Associate Professor, Pearl Academy, Noida*

Introduction

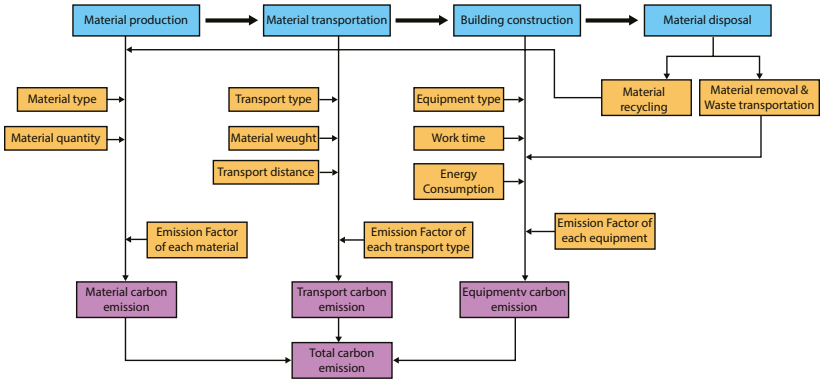
The repository of building practices in India has been developed over thousands of years owing to its diverse climates, demographics, ethnicities, regions, religions, sociocultural practices, etc. The traditional building practices have also aligned and diversified according to local needs. These practices are responsive to climatic[1] conditions and material availability specific to the region. However, due to globalization and modernization, the practices of traditional housing, instead of being refined further, have been replaced with systems that do not have any allegiance to the conditions of the region, thereby making them unsustainable. As a result, different regions and terrains have achieved urbanization without any architectural identity. Due to this unplanned modernization, a huge number of crafts, traditions, arts, and skills, which were based on traditional practices, have been either completely obliterated or are on the verge of it, irrespective of their proven benefits.

Many architectural practices in contemporary times have been limited to a category of the "vernacular building" rather than being treated as mainstream methods of construction. However, a country like India needs to develop a system where such practices are brought to the mainstream and evolved in a manner so that they can incorporate present-day requirements. Modernization should not be an excuse to replace traditional practices.[2] Instead, it should help enhance such practices.

Traditional practices are sustainable in a variety of ways. First, they are based on locally available materials. The easy availability of local materials gives an advantage of low transportation cost, further resulting in minimal carbon emission. According to a research conducted in 2014 by the Intergovernmental Panel on Climate Change (IPCC), building industries cause 36 per cent of carbon emission in developed countries. Hence, the building industry needs to be regulated to reduce carbon emissions.

The overall process through which carbon emission happens in the life cycle of material production is explained in Table 1. The different structures and subsystems are explained in Table 2. The details of expenditure during transportation of materials give clarity on how a building subsystem functions. Research shows that almost 46.6 per cent of carbon emission happens in the substructure by the use of steel and concrete.[3] Bringing in unknown or unfamiliar materials could lead to multiple issues. One such issue can be found in Cyber City, Gurgaon[4] where glass façades and construction work in densely populated areas have resulted in localized heat islands. Glass

» **Table 1** Carbon emission process in production and transportation of material



» **Table 2** Building materials, transport and expenditure

Building subsystem	Material	Quantity	Transport distance (km)	Transport type (road/rail/ocean)	Cost (EK)
Substructure	Concrete Steel Plywood Block Bricks	95 13.4 3.3 20.2 9.6	60 140 100 100 100	Road Road Road Road Road	9.5 0.4 5.3 3 3
Roof	Steel Timber Waterborne paint Polystyrene	10.1 4 0.6 0.02	140 80 70 70	Road Road Road Road	12.3 6.6 1 0.4
Walls	Steel Timber Plasterboard Plaster Bricks Paint	1.2 1.3 2 0.3 62.7 34.5 1.8	140 80 90 160 80 100 60	Road Road Road Road Road Road Road	5.5 2 1.3 0.7 12.2 10.7 2.4
Windows and doors	Glass Timber Paint	1 1.2 0.3	70 80 60	Road Road Road	11.9 14.5 0.4
Ceiling	Plater	0.4	160	Road	0.8

[1] Singh, M., S. Mahapatra, S. and Atreya, 2009. Bioclimatism and vernacular architecture of north-east India. *Building and Environment,* 44(**5**): 878-888.

[2] Foruzanmehr, A. and M. Vellinga, 2011. Vernacular architecture: questions of comfort and practicability. *Building Research & Information,* 39(**3**): 274-285.

[3] Fu, F., Luo, H., Zhong, H. and Hill, A. 2014. Development of a Carbon Emission. 'Calculations System for Optimizing Building Plan Based on the LCA Framework. Mathematical Problems in Engineering': p. 1–13.

[4] Singh, M. 2015. Urban development patterns and entrenched heat island: A distinctive approach to study heat island intensity. 14th International Conference of IBPSA- Building Simulation 2015: p. 1047–1053.

» Corrugated metal sheet used in roof

converts buildings into greenhouses which consume large amounts of energy to keep them habitable. Such a scenario creates adverse conditions and then technological assistance is required for necessary solutions. Due to an increase of materials like steel, concrete and glass, we have become prone to numerous issues ranging from environmental, economic and cultural. However, vernacular architecture not only supports the environment of the region but also sustains the cultural and hereditary roots including local crafts.

Crafts of the region are intertwined with local culture and religious practices. The modern building methodologies are devoid of cultural sensitivities, thus rendering traditional skills redundant.

However, there are various examples where traditional building practices have been successfully incorporated into the present building systems. A few such examples and experiments are explained below.

The Ladakh Experiment

Ladakh is the highest plateau of the country with temperatures varying from -14.2 °C to 24.5 °C.[5] Owing to extreme weather conditions that last for most part of the year, traditional architectural practices have evolved as well. However, modernization has started affecting this region adversely. In one such experiment of studying traditional architecture, we participated in a renovation exercise by Root Collective, an organization, which is involved in the conservation of vernacular structures. This gave us the opportunity to understand the construction practices that use locally available materials to combat harsh climates. During the exercise, we had to use only the locally available materials to reconstruct a dilapidated 300-year-old house in Leh. Due to the unavailability of other resources, we used natural and local materials to build the houses. We re-plastered the walls of the house with clay, sand and certain additives. The process of plastering the walls and its cracks was done by using a mixture of paneer ka pani (cottage cheese water), maida solution (refined flour and water), clay and sand in the ratio of 3:3:1:2.

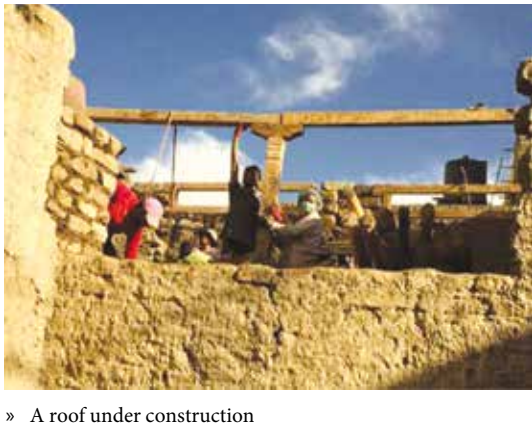
For the roofs, they use poplar beams and willow twigs also known as talu, straw, clay etc. With the mainframes made from poplar wood, talu is used to form the intermediate skeleton or reinforcement base. Layers of mud are placed over this base to form the finished roof.

Bhutanese Building Practices

Thimpu, Bhutan's capital, leads by example. Heritage conservation is practiced as an essential part of the city's development. The implementation of their traditional designs is highly impressive that reflects the architectural identity of the city and the country as a whole. Their design strategies showcase how traditional architecture can be seamlessly amalgamated with modern amenities. In 2014, comprehensive guidelines were formulated by Bhutan's Ministry of Works and Human Settlement (MoWHS). The guidelines' main aim was to build a harmonious relationship between modern needs and traditional practices. Instead of replacing, the older guidelines on traditional Bhutanese architecture were revised. A sustainable

» An Under construction site

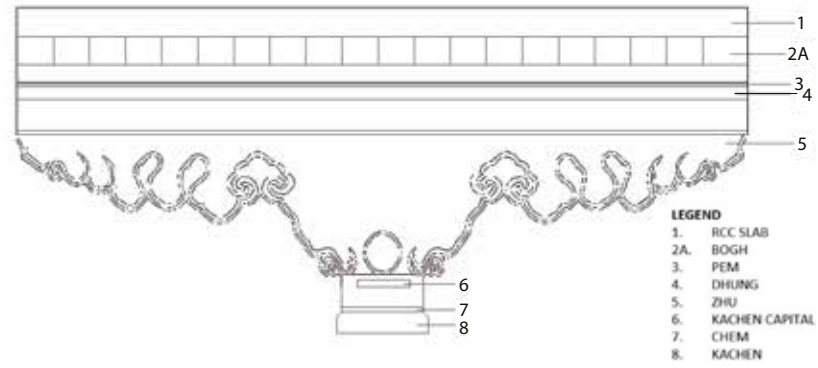
» Re-plastering the wall



» A roof under construction

[5] Kashmir, J., Leh, C. and Leh, a. 2019. Leh climate: Average temperature, weather by month, Leh weather averages: Retrieved from https://en.climate-data.org/asia/india/jammu-and-kashmir/leh-24802/; last accessed on September 25, 2019.

» **Figure 1** Zhu or Capital Element



» **Figure 2** Columns with RCC slab

environment was created without negating the centuries old heritage. The objective was to create a detailed handbook for the stakeholders like architects, builders, engineers, etc.[6]

Some of the important architectural features of Bhutan are:

- Tapering walls made of stone or rammed earth
- Gable roofs made of wood
- Elaborate framing of windows with multi-layered trefoil
- Vibrant lintels and cornices called "Bogh". It marks the level and head of each storey, window and door
- Embellishment of the interiors and exteriors with spiritual and iconographic references
- Natural resources like earth, stone, timber, wood, etc. are used as the basic building materials

Some of the main architectural elements are:

- Kachen or Column
- Jadhang Tazi
- Zhu or Capital (seen in Figure 1)
- Payab gochu or the windows
- Rabsel
- Roof

In Figure 2, we notice that the RCC slab has been incorporated in the structure whereas the original structure as per the vernacular tradition would have used wood. Similarly, certain materials like reflective glass are not allowed. In the ministry's guidelines, the minimum architectural features to be used for a single or/and for two or more storeys are clearly indicated.

Conclusion

It is evident that traditional building practices are being made relevant to the needs of contemporary times. Vernacular practices have been developed over centuries through trial and error. They give instructional solutions to the issues of sustainability in a built form specific to a region. However, the world is undergoing massive changes in the way human beings are responding to their surroundings. To accommodate these needs, we have to change the vernacular practices in a manner that we do not lose out on the advantages of such structures while integrating modern ideas and values. For conserving monuments, building practices should evolve and not be limited to archaic methods. Thus, instead of considering traditional designs as an antonym of modern ideas, we must strive to grow and strike a balance between the two. There needs to be a two-way movement between adaptability of modern ideas and sustainability of traditional building practices.[7] □

[6] Ministry of Works and Human Settlement. 2014. 'Bhutanese Architecture Guidelines'. Thimpu: Royal Government of Bhutan.

[7] Rashid, M. and Ara, D. 2015. Modernity in tradition: Reflections on building design and technology in the Asian vernacular. Frontiers of Architectural Research, 4(1): 46-55.

MAKE IN INDIA

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Resilience and Adaptation Through Multi-use Spaces

It is time we move from sustainability and mitigation to resilience and adaptation. **V. A. Valaikodi** and **Dr Srimurali Sampath** emphasize on the need to build spaces that will go beyond serving the basic necessity of shelters and help establish deep social bonds between people in a post-modern world, where we have forgotten the benefits of communication. While social media has opened up a world of options for different communities, it has also encouraged extreme dependence on virtual reality, leading to a lack in the spirit of co existence. Creating sustainable and efficient spatial temporal spaces is essential in envisaging a better future.

V. A. Valaikodi *is an Assistant Professor at Mohamed Sathak AJ Academy of Architecture, Chennai. With seven years of professional experience as a practicing architect and two years of academic experience, she completed her BArch from Anna University. She works on green-gifting ideas and is a GRIHA certified professional.*

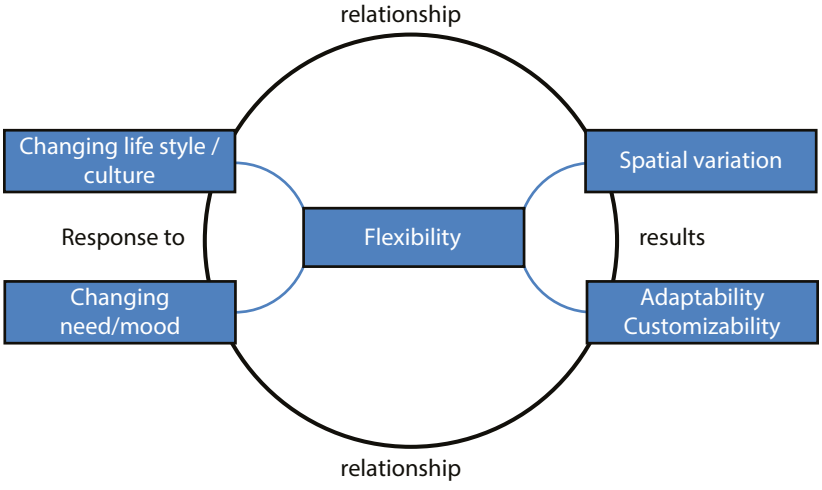
Dr Srimurali Sampath *is a Research Associate at ICMR–National Institute of Nutrition, Hyderabad. He has a PhD from the Department of Environmental Biotechnology, Bharathidasan University, Tiruchirappalli, Tamil Nadu. He also has a Post-doc from SRM Institute of Science and Technology. Additionally, he has 11 years of research experience in endocrine–disrupting chemicals in different environmental compartments and associated health risks.*

Mankind has always lived in shelter and developed deep social bonds. Even the complex cave systems have paved the way for man to associate with others to a great extent. Early civilizations like the Harappa and Mohenjo-daro had rectilinear buildings and complex superstructures. The Romans, influenced by Greek architecture, built large multi-use complexes as well. Even as trade started becoming a major occupation during the medieval era, people used to manufacture, sell, and live together.

With the industrial revolution, trade and home became defined spaces and gradually, people got drifted apart. As a result, cities around the world began to segregate uses, by either locating different functions in separate buildings, or through the regulatory zoning of land.[1] Over the years, we have tried many combinations in building spaces where infrastructure, technology, transport, etc., have played a major role. Social changes have led to various transitions in the way people live, work, and interact. Social media, virtual reality, and wide global communication networks are connecting people around the world but along the process, we have begun to get detached from our dear ones. We build elaborate private spaces for every individual in a unit, and lose out on interaction. Should not resilience begin at home?

Today, we are facing the biggest challenge of evolution – the dearth of spaces for habitation. We live in a society symbolized by change, uncertainty and unpredictability, depleting resources, excessive marketing, and poor interpersonal skills. Now, and in the coming days, social sustainability has become

[1] Ketchell, Misha. 2017. A place to live, work and play: Why mixed-use developments are making a comeback. The Conversation. Details available at https://theconversation.com/a-place-to-live-work-and-play-why-mixed-use-developments-are-making-a-comeback-73142; last accessed on October 11, 2019.



» **Figure 1** Schematic representation of changing lifestyle/culture, needs, flexibility, spatial variations, and adaptability

Source Iasef Md Rian, 2014[3]

all about people choosing a certain standard of living and quality of life. It describes the extent to which a well-designed neighbourhood supports individual and collective well-being. A physical environment creates community resilience through diverse, adaptable, and multi-use spaces that capitalize on the active use of spaces and boost reduction of carbon footprint, thus addressing sustainability at different layers.[2]

"Densely populated mixed-use spaces promote effective functioning of all types of social, cultural, and commercial activities and have low energy impact in comparison with single-use spaces."

Flexible spaces are of various types and degrees, and are achieved by:

- **Permeability:** between space and surroundings
- **Variety:** a mix of activities or uses
- **Legibility:** of space in surroundings
- **Flexibility:** at both micro and macro scale

Such diverse, flexible, and mixed-use spaces encourage community interaction. Adaptability is the potential of a system to harmonize with the environment. In fact, the mixed nature of development will allow individuals and families to avoid the need for motorized transport, create community bonds, and deepen citizenship, along with ensuring better mental and physical health. While designing and constructing spaces, it is necessary that we understand the potential of the space to adjust and respond to the changing environment, accordingly.

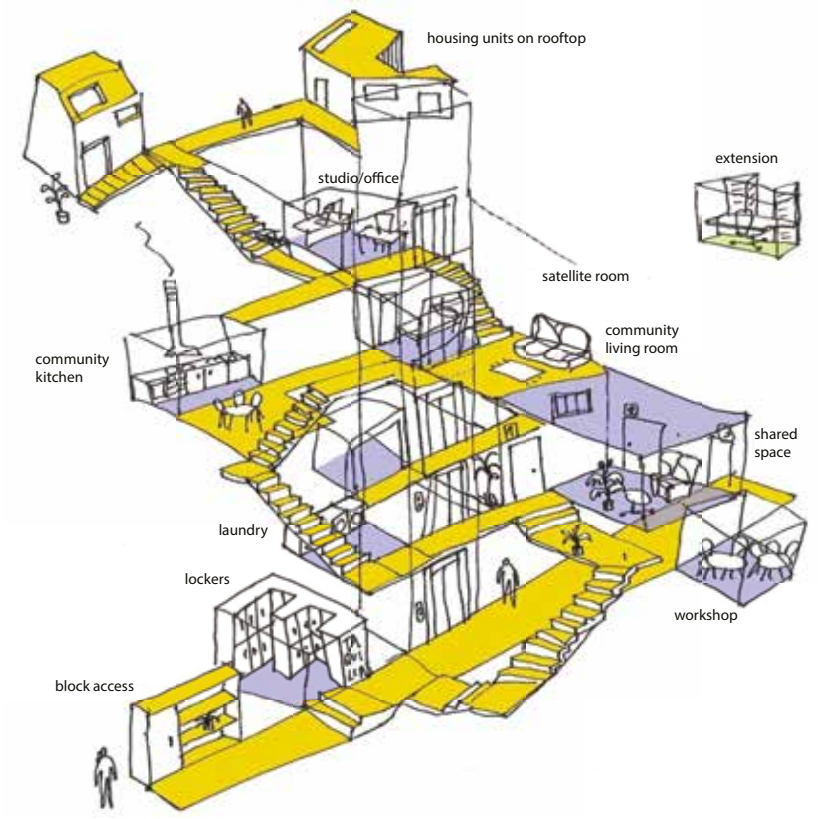
It is time we move from sustainability and mitigation to resilience and adaptation. The best example is to take a leaf from our vernacular way of life, where the *thinnai* (raised seat), verandah, *aangan* (courtyard), etc., were spaces that transformed according to the needs of the users and their demands. They helped people establish a connect with their surroundings, added character to their overall interaction space, and were climate responsive as well. Some of these spaces were also incremental in nature; you could alter them as the family needs grow. These were predominant spaces where the inmates met and interacted. In case of a *thinnai* or a backyard, such spaces helped people communicate with the neighbourhood. Evidently, these were never single-use spaces.

The future of housing is co-living and coexistence. There is a growing need for multi-use and interactive spaces, which will eventually help create lasting social bonding. A sense of community and family can be made, even between strangers, through a good design of interactive spaces. High energy-consuming fields like transportation have already started working on options like group riding, carpooling, and shuttle services. In densely populated cities like Ahmedabad, for instance, parking lots in offices are being used as pop-up markets and eateries, and sometimes, they even double up as play areas and car-free zones during nights and weekends, along major destinations like Pondicherry and Besant Nagar. We must build spaces that are designed efficiently to accommodate a wide mix of people, are adaptable with the changing times, and can create more efficient spatial temporal spaces in future.

Spaces that are highly efficient and can be used at all times, need to be designed, instead of leaving our homes empty for 12 hours in a day or keeping our office spaces vacant for a number of hours. Co-living communities can

[2] Abhilaash, 2016. Against the forces of nature: tackling floods with resilient vernacular architecture in Chikwawa. GoUNESCO. Details available at https://www.gounesco.com/against-the-forces-of-nature-tackling-floods-with-resilient-vernacular-architecture-in-chikwawa/; last accessed on October 11, 2019.

[3] Iasef Md Rian. 2014. 'Multicultural flexible housing: addressing the need and scope of flexible housing in cosmopolitan indian cities." 5th International Conference & Workshop on Built Environment In Developing Countries, Penang'. Details available at https://www.researchgate.net/publication/235754363_Multicultural_Flexible_Housing_Addressing_the_Need_and_Scope_of_Flexible_Housing_In_Cosmopolitan_Indian_ Cities; last accessed on October 11, 2019.



» **Figure 2** Understanding new-age housing needs
Source NPR (www.npr.org)[4]

establish a balance between work, live, and play in an efficient manner. Larger spaces can be partitioned into smaller spaces, based on the needs of the inmates, where the core can be a constant, for instance, rice/paper walls are used as movable partitions in traditional Japanese houses.

We have always considered space in relation to different dimensions like structural, experiential, functional, and architectural features. Modern architecture taught us function-based spatial zoning to avoid confusion and chaos. But, with the present-day need for diversity of space, spatial planning cannot be based only on functionality. In fact, different functions and inclusion of thoughtful architectural/ structural flexibilities can create different experiential qualities. With change in function, the active use of a space, its circulation pattern creates a varied experiential quality.

Versatile space can serve diverse functions instead of a singular one. Viral Chhajer, Co-founder of StayAbode, states that a modern-day man typically spends more than nine hours a day in the bedroom and bathroom, areas that occupy about 40 per cent of the total apartment space, while the hall, kitchen, and utility areas – that constitute 60 per cent of the apartment space and cost – are utilized for less than three hours per day. He proposes a cost-effective and sustainable solution for the challenges of the present-day urban scenario by promoting the use of limited private space and shareable common space.[5]

Adaptability of a space means the potential of a spatial system to harmonize with the environment and community. It can adjust and respond to environmental, socio-economic and cultural changes. Let's solve this land crunch collectively, and address it at every level. After all, resilience must begin at home. ◻

[4] Frayer, Lauren and Ari Shapiro. 2015. Not A Group House, Not A Commune: Europe Experiments With Co-Housing. NPR. Details available at https://www.npr.org/sections/parallels/2015/02/16/385528919/not-a-group-house-not-a-commune-europe-experiments-with-co-housing; last accessed on October 11, 2019.

[5] Chhajer, Viral. 2019. Why co-living spaces are the future for millennials in India. Details available at https://yourstory.com/2019/03/why-co-living-spaces-are-the-future-for-millennial-jjxhd6red5; last accessed on October 11, 2019.

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Impact of Extensive Usage of Air Conditioners on UHIE

There is an unprecedented rise in global temperature, which needs to be controlled immediately. Extreme changes in weather patterns and erratic climate behaviour have contributed to global warming. During hot and unbearable summer months, human beings rely on air-conditioning systems without realizing their harmful effects on our environment. In this thought-provoking article, **Prashansa Singh** elaborates on the types of air conditioning systems that affect urban heating islands, and she further argues why passive cooling techniques have been rendered ineffective.

Global Warming and Climate Change

Our planet is undergoing a massive change in the weather patterns and the climate has started to behave in an unpredictable manner. Every day, we come across one or two climate-related news on such erratic patterns across the globe. The cyclonic storms and flash floods have become common and frequent. Researches show that our planet is becoming warmer with each passing season and year. The recent weather-related calamities in Odisha, Mumbai, Chennai, and Washington DC are a few examples of this trend, which is growing exponentially.

It is evident that the global temperature rise is a consequence of uncontrolled human activities. The temperature rise is non-uniform and certain pockets on our landmass are heating at a higher rate than the rest of the planet. These are majorly known as the urban heat islands (UHI). Further, other heat pockets have been formed due to rural activities like stubble burning and deforestation. However, the UHI have become significant and they have started impacting the overall health of the residents of urban areas. The temperature of these UHI of Delhi has been around 3.8 °C to 7.8 °C higher at 3:00 pm and around 2.8 °C to 8.3 °C higher at 9:00 pm and between 4.1 °C and 5.6 °C in early mornings.[1]

Urban Heat Island Effect

A UHI is found in urban areas showing a significant rise in temperature as compared to the surrounding landmass. It is a proven fact that urban expansion, when done in an unplanned manner, leads to a local rise in temperatures because the heat production is more than the

[1] Kikegawa, Yukihiro, B. R. Gurjar, Shweta Bhati, Anurag Kandya, Koichi Ogawa & Manju Mohan. March 2012. Atmospheric and Climate Sciences, Urban Heat Island Assessment for a Tropical Urban Airshed in India.

Prashansa Singh *has done her Bachelor's in Archaeology from MANIT, Bhopal, and holds a Master's Degree in building engineering and management from SPA, New Delhi. She has eight years of experience in projects and mentoring students of architecture. She is a GRIHA Certified Professional (CP) and IGBC Accredited Professional (AP). Presently, she is a faculty member at Sushant School of Art and Architecture, Ansal University, Gurugram. She has introduced sustainable practices in teaching building services to her students. She can be reached at Prashansa.manit@gmail.com.*

heat sink (passive heat exchanger). These areas are indicated by closed isotherms. The warming trend in Delhi National Capital Region has been observed over the past few decades.[2] Such a trend is noticeable during the night-time temperatures, which is again a reflection of change in land-use pattern and additional heat source that may enhance the overall urban heat.[3] The heating is anthropogenic in nature, which includes fuel burning, industrial activities, indoor cooling, human metabolism, vehicle exhaust, etc. Increased levels of CO_2 and aerosols in the air trap the heat and do not allow any cooling to happen, thus making the area a perpetual greenhouse.

Factors Contributing to Urban Heat Island Effect

1. Air pollutants present in urban concrete masses have major ingredients like aerosols and CO_2 that absorb infrared radiations and re-radiate the long wave radiations, thus trapping the heat waves near the earth's surface, leading to a rise in temperature
2. Large concrete built masses form a major heat production zone with very little or no heat sink areas like waterbodies, green covers, etc.
3. Traffic conditions affect the urban heat islands severely
4. Industrial activities and factories emit pollutants that contribute to a rise in local temperatures

Air-conditioning systems used in buildings in urban areas reject a substantial amount of heat. Other pollutants, with the help of sunlight, warm the earth's surface, whereas air conditioners operating during night time further add heat to the outdoor surroundings, thus significantly increasing the night-time local temperature. The direct effect of air-conditioning systems used in urban areas is discussed in detail in the later sections of this article.

HVAC and Enthalpy

The air-conditioning equipment works on the principle of the first law of thermodynamics (law of conservation of energy). The total heat "enthalpy" is the sum of sensible and latent heat. The enthalpy of air leaving the system is less than entering air, indicating the removal of total heat. There is a common phenomenon of experiencing a warmer temperature outside unitized air conditioners, near outdoor units. This indicates the rejected heat of the systems. The air-conditioning equipment collects all the heat from indoors and directly throws out the heat back to the atmosphere, thus making it warmer.

Removal of Heat Gain

The heat gain in the indoor spaces includes both sensible and the latent components. The factors that affect the sensible heat gain are solar radiation, conduction from outside to inside during hot weather, warm ventilation air, lighting, machineries, equipment, people, manufacturing processes, etc. Such heat gains increase the indoor temperature. The latent heat gains are from exhalation, perspiration, industrial sources, and humidity content of the air. To control the room temperature, the sensible heat is removed by cooling the ventilation supply air and increasing the air changes.[4]

The supply air volume is Q m^3/s, the temperature of supply air is t_s°C, and the absolute humidity of supply air is g_s g/kg. The air enters the closed air-conditioned space and the air which is rejected from the room has t_r°C temperature and g_r absolute humidity.

For summer cooling, t_r is greater than t_s It is governed by the following equation: $Q = SH$ kW/$(t_r - t_s)$ x $(273 + t_s)$/357 m^3/s, where SH is the sensible heat flow.[5]

[2] Mohan, Manju, Anurag Kandya, Arunachalam Battiprolu. April 2011. *Journal of Environmental Protection, Urban Heat Island Effect over National Capital Region of India*: A Study Using the Temperature Trends.

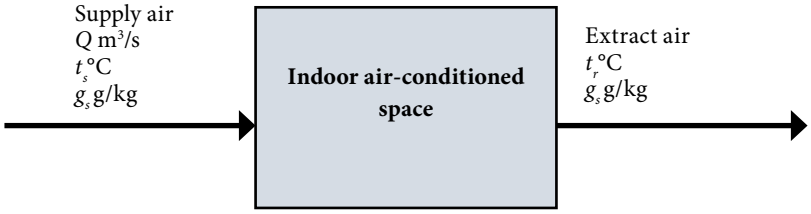
[3] Ref. footnote 2.

[4] V. Chadderon, David. 2013. *Building Services Engineering*, p. 94.

[5] V. Chadderon, David. 2013. *Building Services Engineering*, p. 95.

It is a vicious cycle where, in order to escape the warm outdoors, we tend to use air conditioners that in turn end up warming the outdoors even more.

» **Figure 1** Potential urban heat islands, Gurugram



» **Figure 2** Air-conditioned indoor spaces, temperatures, and humidity control

Quantification of the Total Heat Rejected

The amount of heat rejected by a one tonne air conditioner = 5.25 kilowatt, and for a duration of 8 hours, the total heat rejected = 5.25 kW x 8 h x 3600 = 151,200 kJ/day (1 kW= 3600 kJ/h).[6]

Let us assume there is a housing society of 6 acres with 300 dwelling units and each of them owns a one tonne air conditioner, which is operated overnight.

For 300 one tonne air-conditioning units, the heat rejected = Q = (151200 x 300) kJ/day.

Let us assume the volume of air affected 1000 m above the surface level (assuming no wind movement).

Total affected volume of air = 6 acres x 4046.86 x 1000 m (1 acre = 4046.86 m^2) = 24,281.16 x 1000 m^3

Specific heat capacity of air = c = 1.006 kJ/kg °C

Density of air = 1.14 kg/m^3 at 35 °C

Mass of air = M = 1.14 kg/m^3 x 24281.16 x 1000 m^3

Quantitative relationship between heat transfer and temperature change is given by the formula mentioned below:

$Q = Mc\ \Delta T$

Where Q is the symbol for heat transfer, M is the mass of the substance, and ΔT indicates the change in temperature. The symbol c stands for specific heat and depends on the material and phase.

Therefore, ΔT = (151,200 x 300) kJ/day/(1.14 kg/m^3 x 24,281.16 x 1000 m^3 x 1.006 kJ/kg °C) = 1.08 °C

Result: The above calculation shows that there is a rise in temperature by 1.08 °C for 1 km height for the spread of a 6-acre land when subjected to the running of 300 air-conditioning units of one tonne capacity each, overnight, without considering heat sink through trees, waterbodies, movement of air, etc.

Types of Air-conditioning Systems and Their Impacts on UHIE

- **All air system:** This is a type of centralized air-conditioning system, which uses air to pick up the heat and then that air is used for circulation within the building. It has two variations – constant air volume and variable air volume. The excess heat is directly removed through air in the outer atmosphere. The installation of heat recovery wheel at the exhaust side of the air-conditioning system reduces the direct throw of the heat into the atmosphere, thus reducing the urban heat island impact. This type of air-conditioning system is used in a centralized commercial building.
- **Air and water systems:** This is a type of air-conditioning system that uses both air and water for circulation and rejection of heat. The cooling towers bring down the energy consumption of the chillers, and the installation of heat recovery wheels at the exhaust side reduces the direct heat rejection, thus limiting the urban heat island impact. This system is also used in a large-scale cooling requirement, preferably for a commercial building.
- **Unitary air-conditioning systems:** These are the spilt and window ACs used in residential areas. These systems have no check over the heat rejection. These are the most commonly used air conditioners in urban areas, which adversely affect the UHIs.

Conclusion

The usage of air conditioners can considerably contribute to the UHI effect. The rise in temperature is significant and it can be easily observed during the morning hours. The drop in temperature during early morning is considerably lesser in urban areas as compared to a rural area, which is not dependent on air conditioners. Thus, the purpose of having a thermal lag to cool the structure (building) overnight through a passive cooling technique is completely defeated. This study clearly quantifies the amount of heating propelled by the use of air conditioners alone. Apart from air conditioners, there are many factors that contribute to UHIE, making the magnitude of the problem higher and multidimensional.

A few recommendations and suggestions to control the effect of using air conditioners are:

- The findings of the article show the rise in 1.5 °C temperature of air volume by air conditioners. In an urban scenario, the density of the built mass can be checked by controlling the construction density.
- It is important to have a sensible city planning with a lot of heat sinks such as waterbodies, plants, and vegetation.
- Centralized air-conditioning systems with a proper check on heat-rejection system in residential projects should be promoted.
- Intense research is required for ways of utilizing the heat energy rejected by the air-conditioning systems. □

[6] Joseph Stalin, M., S. Mathana Krishnan, G. Vinoth Kumar. 2012. 'Efficient Usage of Waste Heat from Air Conditioner', *International Journal of Advances in Engineering & Technology.*

THE ECOINDIAN STORY

The urge to break free from ruthless consumerism, lifestyle change, and negative effect on environment has been the core thought behind just-born and evolving Ecoindian, the zero-waste grocery store. As a small step towards curiosity in sustainability, **Prem Antony**, a banker turned event manager started an amateur forum ecoindian.com in 2009 that published events and articles on eco-friendly lifestyle. In early 2016, he shared the common idea with his childhood friend **Pradeep Kumar** to get their hands on. Instantly, they started to explore organic farmers, farming workshops, and exhibitions across Tamil Nadu and Karnataka.

In March 2018, the duo started Ecoindian organic store in Chennai sighting the need and potential in retailing organic farm produce and market local artisanal products. The Ecoindian team started purchasing from fresh farm produce directly from organic farmers, artisans, self-help groups and farmers' associations after thorough understanding of their farming practices and production process. Bulk groceries procured were repacked for retail sales in plastic covers like any other conventional store. They realized that their convenience store was soon heading towards being inconvenient to the environment. The intention towards spreading healthy food and positive environment was getting crushed due to single-use plastic packing of organic products.

Chennai contributes 0.07 kg per capita waste, the highest in India and Ecoindian became part of the garbage contributor to the existing humongous landfill problem. The major part of the dumped single-use plastic is from toxic pouches used for packing products that travel from shop to kitchen. The partners tried to address this issue, but they could not find any better alternative to replace retail packaging.

The Idea

The brooding guilt prompted to launch plastic-free, package-free retail store. After an initial research from various zero-waste stores in Singapore and Hong Kong, Prem and Pradeep decided to make Ecoindian a non-mass produced, zero-waste organic retail store in April 2019. The concept facilitated them to find various solutions for reducing landfill. The groceries were made package-free or minimally packed. It encouraged its customers to consciously buy any quantity as per their requirement, thereby reducing food waste. Since there is no packing cost for the products, customers were given 5–7 per cent cost benefit on their shopping bill. Also, customers are incentivized with cash discount, if they bring their own containers for shopping.

There was some initial ambiguity whether the customers would appreciate extra effort in zero-waste shopping and change their entire buying pattern. But the customers' response was surprisingly overwhelming. There is an intense participation and increasing conversations among the enthusiasts about plastic-free lifestyle all across India and overseas.

The Next Step

Ecoindian aims to create an ecosystem through guilt-free retail and knowledge sharing on sustainable practices to strengthen the conscious consumerism that restores us back in the eco-life cycle. The team will continuously study to find sustainable alternatives to reduce landfill. As a first step, Ecoindian will be creating a cutlery bank for community use from this festive season to replace disposable cutleries. Ecoindian will soon launch a zero-waste ecommerce site, www.ecoindian.com, and plans to open their next store in Bengaluru. □

Store address
Ecoindian, The Zero Waste Store
No 19, Dr Ranga Rd, Mylapore,
Chennai, Tamil Nadu 600004

Contact
Prem Antony
prem@ecoindian.com
+91 9884488458

Construction and Demolition Waste Management for Sustainability

In India, construction and demolition waste poses a serious challenge to the construction and building industry, which is expanding at an alarming rate. With an ever-growing population, rise in infrastructural activities and an increasing demand in modern construction practices and materials, the building sector has considerably contributed to the depletion of natural resources. In this article, **Dr Parveen Dhamija** expresses concern over the lack of effective management of construction waste that has significantly contributed to erratic climatic patterns. The author explains why Indian housing and building agencies should use recyclable and cost-effective materials in their construction practices to ensure sustainability.

Dr Parveen Dhamija *is working as an advisor in New Delhi's Skill Council for Green Jobs (SCGJ), in the field of skill development in renewable energy and sustainable development. Previously, she worked in the Ministry of New and Renewable Energy (MNRE) for planning and execution of national programmes related to biogas, improved chulhas, women and renewable energy, and promotion of new technologies. As head of Delhi's nodal agency, she also coordinated many activities related to renewable energy, improving energy efficiency, and climate change. She has authored books on environmental education and was an Intergovernmental Panel on Climate Change (IPCC) expert in bioenergy for the special report on 'Renewable Energy Sources and Climate Change Mitigation'. In addition to being a member of many BIS committees and ISO/TC 28, she is currently the chairperson of core group on services of the CII task force on bioenergy.*

The construction industry is a significant contributor in the infrastructural development process, especially for developing countries. It not only provides important finished products useful in many activities such as services, commerce, utilities, and others, it also assures employment opportunities to a large number of people, thereby impacting a country's economy. In addition to many other human activities, construction impacts the environment and contributes enormously to climate change through greenhouse gas (GHG) emissions. In recent years, the construction industry has grown rapidly due to an increase in the population, industrialization, and new infrastructure projects. With a rise in the demand for construction materials, there has also been a generation of huge amounts of construction and demolition (C&D) waste. Increasing quantities of C&D waste can be a threat to our environment and therefore, an efficient system of management is the need of the hour. 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 to 590 million in India by 2030,[2] creating a direct demand for new construction and infrastructure in the country. The current trend in population growth and the relative demand for construction foresee a huge potential in the construction industry. Rapid growth in construction activities will lead to a generation of large quantities of C&D waste that needs to be handled effectively to develop accurate data and establish sustainable methods to manage this waste.

Skill Council for Green Jobs along with KPMG carried out a study to undertake sector analysis, skill gap studies, occupational mapping, and

[1] UNEP, SBCI. 2009. 'United Nations Environment Programme, Sustainable Buildings & Climate Initiatives', Buildings and Climate Change, Summary for Decision-Makers.

[2] Global Construction Perspectives and Oxford Economics. 2013.

process flow along with identification of job roles in the domain of C&D waste management in India. As per the study, the construction industry in India is expanding at an exorbitant rate. This has led to an increase in the demand for construction materials, subsequently resulting in the generation of huge amounts of construction-related waste. It is observed that the production of waste due to the demolition of structures is more than the amounts generated during construction of structures. As a result, the management of C&D waste becomes essential in the contemporary Indian landscape.

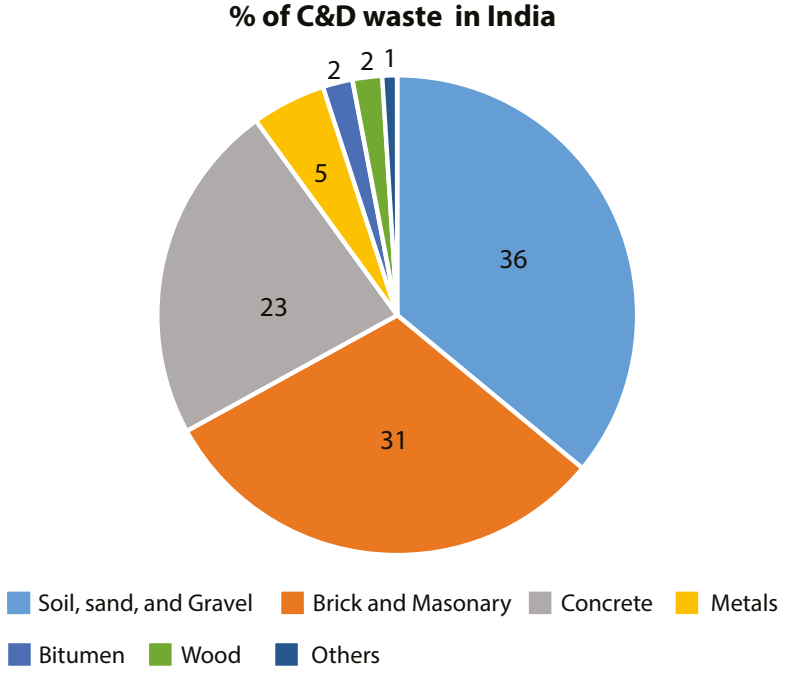
C&D waste is composed of elements such as concrete, soil, sand, gravel, bitumen, glass, plastic, metals, wood, and other materials. Recyclables such as metals, plastic, and glass find use in respective recycling industries for reprocessing into new products, whereas, sand is segregated from the C&D waste and either sold to builders or more commonly dumped in open areas, indiscriminately. Figure 1 shows the typical C&D waste composition seen in India.

Under Indian regulations, as per construction agencies like Central Public Works Department (CPWD), Indian law permits the use of only naturally sourced building materials. The IS: 323-1970 Indian Standard specification related to aggregates for concrete, laid down by the Bureau of Indian Standards (BIS), stipulates that concrete can be made only with naturally accessed materials. Though a number of innovative cost-effective recycled building materials, components, and construction techniques have been developed and are available, Indian housing and building agencies have not adopted them in their construction practices. Lack of standardization, absence of a list of techniques and materials within the purview of the Indian Standard Codes and/or the Schedule of Rates (SoR), poor policy push, and little or no awareness are some of the key barriers.

The Government of India notified the "Construction & Demolition Waste Management Rules 2016" on March 29, 2016. According to these rules, the local bodies will have to utilize 10–20 per cent material from construction and demolition waste in municipal and government contracts. These rules also indicate that cities with a population of more than one million will commission processing and disposal facility within 18 months from the date of final notification of these rules, while cities with a population of 0.5 to 1 million and those with a population of less than 0.5 million, will have to provide these facilities within two and three years, respectively. Large generators of waste will have to pay relevant charges for collection, transportation, processing, and disposal, as notified by the ruling authorities. These rules are aimed at addressing the indiscriminate disposal of C&D waste and enabling channelization of the waste for reuse and recycling in a gainful manner. These rules have been premised on the concept of "Extended Producer Responsibility", with a vision of putting in place an institutional framework for C&D waste management system.

As per the "Guidelines on Environmental Management of C&D Wastes–CPCB 2017", there are a lot of uncertainties in analysing the quantum of C&D waste generation in India due to reasons like different methods adopted to estimate quantum of generated C&D waste, varying pace of developmental activities in cities, redevelopment of cities due to rapid urbanization where demolition activities become necessary, and so on. Surveys also indicated that the quantum and composition of C&D waste is project specific and could vary to a considerable extent. However, it is estimated to account for approximately 25–30 per cent of total generated solid waste.

As per Central Pollution Control Board (CPCB), the quantum of generation of C&D waste estimates available from other sources was 12 million tonnes in 2013. Additionally, it is assumed by Technology Information Forecasting and Assessment Council



» **Figure 1** Utilization of waste from construction industry
Source Technology Information, Forecasting and Assessment Council (TIFAC), 2001

(TIFAC) 2013, that 50 kg of C&D waste is generated in India m^2 of new construction. Adding this number to the CPCB estimate gives an approximation of the total C&D waste generation in India. Corresponding to the growth in built-up area to 9.65 billion m^2 by 2030, it is estimated that the overall generation of C&D waste will go up to over 65.54 million metric tonnes by 2030.

Year	Built up area (Billion sq. m)	C&D waste generated-CPCB (million MT)	C&D waste generated from new construction (million MT)	Total C&D waste generated (million MT)
2020	5.09	18.78	15.77	34.55
2030	9.65	35.62	29.92	64.54

Therefore, C&D waste management requires a trained workforce for collection, transportation, processing/recycling, and disposal. As per *What a Waste: A Global Review of Solid Waste Management*, World Bank 2012, it is assumed that only 5.24 per cent of construction waste was recycled in 2011 in India. However, owing to enactment of stringent legislation, active participation of citizens, and enhancement of C&D waste processing technology, it is assumed that the effective utilization of C&D would increase gradually to 20 per cent by 2030. This will generate a large number of jobs, especially in the area of processing/recycling C&D waste.

C&D waste generation is thus expected to increase in India in the future and hence there is a need for minimizing and handling it efficiently. More detailed data are needed for running rigorous assessments to manage C&D waste, effectively. To complete the waste management plan for any construction activity, there should be an estimation of the amount and type of recyclable and non-recyclable waste materials that are expected to be generated on site. A list of all the expected quantities of each type of waste indicates what kinds of management activities are appropriate for the specified waste. At each stage of construction, there should be specific ways to reduce, reuse and recycle the wastes which may be produced. The use of recycled and recyclable materials should be included in the initial design of the structure. Storage methods should be carefully examined to prevent damage from mishandling and adverse weather

conditions. Additionally, the ordering of materials should be made just before the construction work commences. Finally, government policies and laws that have been enacted should be enforced, and C&D waste management must be made mandatory for all types of construction activities. ◻

Innovative steps taken in Guajarat for C&D waste reuse

Architects in India have already taken steps to reuse waste in their buildings. There is an example of a school building in Rajkot designed by Ahmedabad-based architect Surya Kakani that has been built from the debris of Bhuj earthquake. The institute of Rural Research and Development (IRRAD) building in Gurugram has innovatively recycled and utilized its own construction waste in the building. But these are limited steps and they will have to be encouraged with policy and fiscal support. This is particularly relevant for the infrastructure necessary for development such as roads, flyovers, pavements, etc. In fact, the attempt to use recycled material from the Burari centre in New Delhi during the Commonwealth Games faced opposition as these materials were not backed by stipulated standards.

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"Real change will only happen when we fall in love with our planet. Only love can show us how to live in harmony with nature and with each other and save us from the devastating effects of environmental destruction and climate change."

–Thich Nhat Hanh

Absolute minimum damages to natural features of the land area, measuring approximately 250 hectares allotted to IIT Gandhinagar for establishment of a permanent campus, has been the cardinal principle of the institute while planning and executing the project. Having this objective in mind, the requirements of the institute are met by adopting the following guidelines:

a) To protect natural soil other than that covered by built environment - ensuring preservation of soil by preventing erosion

b) Least number of trees were cut for accommodating built environment maximizing transplantation of existing trees and planting new ones in large numbers

c) Efficient water management is practiced by having in place the institute's own water treatment plant and water harvesting system. This aids in meeting the partial demands through harvested water and full utilization of recycled water for irrigation. This has further reduced the institute's dependency on supply of water from the municipality.

d) No dependency on local bodies for liquid and solid waste disposal by installing and operating institute's own Sewage treatment plant and solid waste treatment plant

e) Optimizing the power requirement - both supply side and demand side energy management by installing solar PV panels and solar water heating units, and using energy-efficient plants, machines, light fittings, etc.

f) Enhancing the overall standard of construction process by adopting various measures for labour safety and welfare

While translating the provisions of the "Master Plan" on ground, the GRIHA team played an important role by providing us with a clear insight on the rating parameters and helped us to take corrective measures wherever needed. With the help and guidance from GRIHA Council, the institute was able to surpass the targets set in the master plan. We could confidently say, "Here, the realities are more beautiful than dreams".

Decoding Delhi's Metro System: Future of Sustainable Transport

A functional transportation system is the spine of a city because without movement, there would be no development. A smart city adopts greener ways of modifying rules of commute, encourages reduction of greenhouse gas emissions and implements ideas to tackle environmental issues to reduce dust and smoke pollution, created at the hotspots of traffic congestion in cities. In this article, **Mridul Pareek** describes how the Delhi Metro has eased the life of a city dweller while catering to the goal of sustainability at the same time.

Mridul Pareek *has a Bachelor's degree from IIT Gandhinagar, and has completed his MSc in environmental sciences and policy from Central European University, Budapest. He has worked on areas like climate finance, energy data management and smart cities with different stakeholders such as the UN-FAO, private sectors and academia. He has been instrumental in leading environmental clubs and organizing events for community awareness. In his most recent project, he investigated the challenges to energy data management in India.*

Transportation has been rightly called the "lifeline" of our nation. A quick glance at common links between the most prosperous regions reveals our excellent network of connectivity.

New Delhi has witnessed one of the highest urbanization rates, globally, and is expected to surpass Tokyo as the most populous city by 2028. Rapid urbanization can have both positive and negative consequences.[1] In such a densely packed society, it becomes essential to keep the citizens on the move. This article introduces a brief historical setting, and then moves on to discuss various challenges and opportunities in the later sections.

Successful civilizations have controlled the influx and outflux of traffic, be it with reference to human beings or transportation of goods. As much as global connectivity is important, the local network also plays a key role in seamlessly helping the lifeline of city to thrive. A robust transportation system in a city facilitates events ranging from daily trade of goods to local job commute. However, local transportation in most urban centres around the world is rapidly deteriorating, and one of the reasons for this trend is increase in demand. Needless to say, a transport system that shapes the backbone of a society needs to be sustainable in every aspect. With massive capital involved, it is imperative to realize its effectiveness. In this article, we focus on the metro system in the Indian capital city of New Delhi, and gauge its prospects as the future of sustainable transport.

Shaping the Current Network

Historical events, both socially and politically motived, have been instrumental in shaping the transport system as it runs presently. Prior to India's Independence, it was mostly informal and non-regulated. Several studies during the 1970s advocated establishing a multi-modal system with the construction of a metro (subway) and replacing gasoline-run buses with natural gas-operated buses. It was during the Delhi Commonwealth Games in 2010 that drastic improvements in the city infrastructure were introduced. This single event played a pivotal role in formalizing and framing of the city's urban planning department.[2]

The Delhi Metro Rail Corporation, or DMRC, is a company, which was set up in 1995 and is responsible for the implementation of metro operations in Delhi and NCR. The metro network from December 2002 till August 2019 comprises of 271 stations spread over 373 km with over 300 trains joining the capital city with nearby major corporate hubs in NCR. In addition, development schemes are still being carried out in phases. DMRC has always been eager to start a new line given the immense enthusiasm that the metro has received from both public and political parties.[3]

[1] Kumar, Megha, Seema Singh, Akshima T. Ghate, Sarbojit Pal & Sangeetha Ann Wilson. 2016. Informal public transport modes in India: A case study of five city regions. IATSS Research, p. 102–109.

[2] Kassens-Noor, Eva & Priyamvada Kayal. 2016. India's new globalization strategy and its consequences for urban development: the impact of the 2010 Commonwealth Games on Delhi's transport system. *International Planning Studies*, p. 34–49.

[3] Goel, Deepti & Sonam Gupta. 2015. 'Delhi Metro and Air Pollution'. Centre for Development Economics, Delhi.

What About the Air Quality?

The metro is often considered a viable solution to the emission problems, because it is electricity driven. The Delhi Metro is the first rail project in the world to earn carbon credits for offsetting carbon emissions. The United Nations (UN) certified DMRC for reducing greenhouse gas levels by 6.3 lakh tonnes, annually, although the numbers vary every year. However, some quantitative studies have shown that the impact has not been quite significant considering the growth of the city. For example, a study[4] concludes that the impact is not visible because of the pollution levels, possibly getting offset by the increasing influx of vehicles on the road. Hence, the problem of bad air quality, for which Delhi is infamous, has not been solved with the operation of emission-less metro. Even the World Bank called it a short-term impact in one of their study reports.

Such a large-scale operation of the metro rail is also energy intensive. The system requires over 700 million kWh of electricity per annum, which has been mostly obtained from conventional grid. The abundance of rooftop space on stations and rapidly fallen costs of renewables (solar PVs) cater to a large potential for cutting down emissions as well as reducing operational costs. DMRC started its pilot project by installing 50 megawatt of solar capacity, which is estimated to cut 70,000 tonnes of greenhouse gas emissions, every year.[5] Another study found co-benefit of job creation for 34 people per MW of solar capacity installed. Switching to renewable energy sources for its operations would also accelerate the ambitious "green buildings" initiative of the DMRC. However, these emission values reflect only the operational aspect without considering other significant emissions during vehicle manufacturing, construction of stations and tracks, etc.

As a consequence of rapid urbanization, development of infrastructure such as streets, parking lots, buildings, etc., have paid the price of diminishing vegetated lands. Concrete structures are a known cause for increasing the average local temperature, thereby creating an urban heat island effect. Ideas to tackle such issues at micro-level, like introducing vertical gardens on station pillars, have been welcomed by the authorities. These can be effective in lowering dust and smoke pollution, created at the hotspots of traffic congestion in the city but their efficacy still remains debatable.

A Congested City

Another issue that the metro aimed at solving was traffic congestion in the city, which has, however, proven to be the opposite. Instead of lowering the congestion, some metro stations have become hotspots of heavy traffic due to inefficient parking infrastructure. Although there have been limited studies on congestion, its impact can be easily estimated due to a sudden change in air pollution levels at certain hours of the day. The huge rush experienced during peak hours leads to no-movement zones for extended periods of time. These externalities of the metro system demonstrate the importance of urban planning, innovation, and learning from past experiences.

New initiatives to tackle these issues have been brought in, like expansion of parking space, introduction of separate lanes for buses, and so on. Similar issues were faced in London and use of congestion pricing and parking policies were deemed effective. There are other negative externalities that are often not mentioned when conceiving a holistic picture of a project, for instance, congestion created during the construction phase, in addition to fatalities such as accidents and displacement of households. Majority of areas experienced increase in land value by 11–18 per cent within 500 m of the metro lines.[6] It is possible that higher demands and more earning potential in the vicinity of such metro lines affected the traffic density in the area.

[4] Sharma, Niraj, Anil Singh, Rajni Dhyani & Shweta Gaur. 2014. Emission reduction from MRTS projects – A case study of Delhi Metro. *Atmospheric Pollution Research*, p. 721–728.

[5] *IRENA Quarterly*. IRENA. 2019.

[6] Goel, Rahul and Geetam Tiwari. 2014. Case Study of Metro Rails in Indian Cities. UNEP, New Delhi.

Engaging More Ridership

A brief look at the revenue stream of DMRC suggests almost 80 per cent is earned from traffic ridership. An increase in ridership could directly impact profit stream. One of the principal factors encouraging usage of public transportation is how densely it is networked in the city, also known as "last-mile connectivity". The narrow size of streets in many parts of the city makes it impossible for public buses to navigate. Therefore, informal mobility solutions like tuk-tuks (autorickshaws) and innovative services like taxi applications, ride-sharing and so on, have undergone rapid growth. Increasing parking space, introduction of electric tuk-tuks and electric bus fleet would take substantial time to show improvement in the quality of riding.

Creating bicycle lanes could be another solution, but the feasibility of high ridership is uncertain and depends on weather, air quality, and distance covered. The success of bicycle platforms would also rely on the safety of riding in city traffic, which is controlled only in patches. A survey undertaken by UNEP (sample size ~ 1100) suggests, only 7–12 per cent of metro riders use private cars for last-mile connectivity (to and from metro stations) while less than 1 per cent use bicycles.[7] These data sets suggest a rather doubtful situation for the investment in separate bicycle lanes.

Another reason for unequal distribution of ridership across the city is that commuters with private vehicles are considered superior than those who travel by public transport. Due to disparate social and economic strata across the city, some of the metro stations experience significant ridership while others do not, making the existing infrastructure less profitable.[8] In order to cope with this issue, urban bodies have made significant efforts in making the metro system comfortable and aesthetically pleasing. Many stations have displayed graffiti art, and some have been even tailored to host contemporary art exhibitions in the premises, generating more public attention.

Untapped Potential of Travel Data

The potential of smart card is multi-dimensional. Introduction of payment via smart card for the Delhi Metro expedited the overall commute, in addition to convincing office-goers, who preferred driving, to switch their mode of commute. The switch, no matter how small, would result in lowering the carbon footprint of the city. Further, the travel data collected from such systems could be used for studying travel behaviours, and later, in policymaking by the city council.[9] Newer methods like big data analytics could be implemented for traffic prediction, regulation, and so on.

The presence of a strong watchdog NGO to critically analyse the policies and decisions of urban development bodies is indispensable. These organizations improve citizens' participation, resulting in consideration by the decision-makers for a better development. Moreover, it would strengthen dissemination of information to the public and make the system more transparent. For example, a non-profit organization called Transit Alliance runs many campaigns in Miami (Florida) to improve the public transit of the city. Their initiative of introducing a mobility scorecard to gauge the health and performance of the city's transit system gained huge popularity among the residents. Their system has been

described as "a combination of data, analysis and recommendation to guide elected officials, community leaders and transportation planners to move Miami forward, together."

Conclusion

The mere availability of public transportation is not enough to realize the goal of a sustainable transport system. Factors such as inclusiveness – both in the form of accessibility and affordabilityt are important to paint a complete picture of sustainable urban transportation. This article highlights many context-specific challenges that the metro system in Delhi face, along with some solutions at multiple levels. The important lesson learnt is that how externalities can change from positive to negative due to lack of systemic thinking in urban planning process. As urban areas in India, and elsewhere, grapple with growing urbanization, climate change, and pollution, sustainable and innovative transportation planning can reduce adverse environmental impacts while enhancing socio-economic sustainability. The list of challenges for any metro system, presented through this article, is not limited to the discussed subjects, and invites further quantitative and qualitative research and analysis for better perspective. ◻

[7] Refer to Footnote 6.

[8] Malhotra, Ashish. 2017. Can the Affluent Be Convinced to Ride Transit in Delhi? Available online at https://www.citylab.com/transportation/2017/12/can-the-affluent-be-convinced-to-ride-transit-in-delhi/547775/; last accessed on October 11, 2019.

[9] Bagchi, M., P.R. White. 2005. The potential of public transport smart card data. *Transport Policy*, p. 464–474.

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AIR: The Invisible Killer

Are we inhaling pure air? **Sunanda Satwah,** in this eye-opening article, shares her concern over the rising levels of air pollution in Indian cities. Anthropogenic activities have an adverse effect on the health of our planet and its inhabitants, and if stringent measures to control greenhouse gas emissions and carbon footprint are not implemented soon, the debilitating air quality could claim many lives. Whether it's about adhering to dust-preventive guidelines, covering up construction materials during transportation, or understanding the importance of waste segregation, the idea is to work towards a future where the air that we breathe doesn't turn poisonous and fatal.

Sunanda Satwah *is an environmental architect, educator and a writer with 17 years' experience in the field of architecture and healthcare design. She is a GRIHA certified professional, GRIHA evaluator (architect) and an IGBC accredited professional. She is an associate professor at CTES College of Architecture; heads the green design consultancy "sunarcs", and has over 60 published articles and academic papers. She can be reached at satwah1@rediffmail.com.*

According to a report by The Lancet Commission on pollution and health, India ranks number one in deaths related to air pollution, across the globe. The causes of pollution include vehicles burning fossil fuels, exhausts from factories, mining and agricultural activities, and construction sites. Construction activities like demolition, transportation of raw material, land clearing, and usage of diesel generators contribute to about 30 per cent of particulate emissions, as per Delhi Pollution Control Committee. Dust emissions are a major pollutant in cement industries, and manufacture of cement contributes to greenhouse gas emissions and climate change. Kiln-burnt clay bricks too have a much higher carbon footprint as compared to compressed stabilized earth block (CSEB). On construction sites, precautionary dust-preventive guidelines mandate covering up of construction materials in vehicles, keeping the ground wet, setting up 3m high barriers on the periphery to avoid particulate dust from spreading, yet it is an ill-contained issue, and construction sites are often blamed for the deteriorating air quality in cities, especially during winters.

Trees were levelled, tarmac was poured, roads were laid and the pedestrian city made way for asphalt nation. Cities should be designed for people, and not for cars.

Greenpeace India reports that among the world's most polluted cities, top 15 out of 20 are in India. The data are derived from 3000 cities across the globe by comparing their respective PM2.5 concentrations. Gurugram topped the list with an average of annual particulate matter of 135 µg/m^3, followed by Ghaziabad as the second most polluted city. The US Environmental Protection Agency (EPA) specifies in National Ambient Air Quality Standards (NAAQS) the levels for particulate matter or fine particles less than or equal to 2.5 µm in diameter (PM2.5) as 35 µg/m^3 per 24 hours, and 15 µg/m^3 per year.[1] In India, the annual guidelines range between 40 and 60 µg/m^3, depending on the location being either industrial or residential.[2]

A report on air quality, prepared by The Energy and Resources Institute (TERI), for the Central Pollution Control Board (CPCB)

[1] Environmental Protection Agency. 2017. *Particulate Matter (PM) Pollution*. Retrieved from A United States Environmental Protection Agency: https://www.epa.gov/pm-pollution/2006-national-ambient-air-quality-standards-naaqs-particulate-matter-pm25; last accessed on October 14, 2019.

[2] Koshy, J. 2019. Retrieved from The Hindu: https://www.thehindu.com/sci-tech/energy-and-environment/fifteen-of-the-20-most-polluted-cities-in-the-world-are-in-india/article26440603.ece; last accessed on October 14, 2019.

and Maharashtra Pollution Control Board (MPCB), specifies that air pollution in the state is on the rise due to unplanned development and rising vehicular emissions. The annual permissible limit for respirable suspended particulate matter is specified as 60 µg/m^3, and permissible limit for oxides of nitrogen (NO_X) is 40 µg/m^3 and sulphur dioxide (SO_2) is 50 µg/m^3. In most cities of India, the actual levels far exceed the permissible limits. Mortality rates due to respiratory ailments have gone up; the number of patients suffering from asthma, bronchitis, lung cancer, and acute cases of respiratory infections is rising; as are premature deaths due to air pollution.[3]

What does one do when the air one breathes becomes poisonous?

The London smog in the December of 1952 that claimed more than 12,000 lives, and shrouded the city in darkness for four days, became the poster image for industrialization, development, and urbanization. Ground-level ozone, also known as "bad" ozone, has been rising ever since the machine age advanced and cities embraced vehicles, and replicated Le Corbusier's popular philosophy that, "the house is a machine for living in".

And yet, more and more cities across the globe push for roadways; mass transport routes cut through the heart of forests and pierce mountains in the name of connectivity and progress. The coastal road project proposed, disputed, and debated in Mumbai, is one such example that demands careful attention. More than 3000 trees were proposed to be cut down for the Metro 3 car shed project, and less than 50 per cent of trees survived the tree transplantation.[4] It makes one wonder if we would ever take that 50–50 chance with human life. In fact, we do! Every day, citizens are exposed to harmful vehicular fumes that are considered equivalent of smoking 10 cigarettes a day. Researchers at UC Berkeley, who have devised an equation that translates Air Quality Index (AQI) into cigarettes, claim that breathing in polluted air with a PM2.5 level of 22 µg/m^3 is equivalent to smoking one cigarette per day, and the harmful effects are similar.

Vehicular fumes are an indisputable source of outdoor air pollution. Some of the harmful effects include industrial emissions carried far and wide by winds, thus contributing to acid rains; transfer of dangerous persistent organic pollutants (POPs) through winds, adversely affecting human health and environment; festivals and celebrations that encourage bursting of firecrackers; unregulated burning of waste in landfill sites; and, cold climatic inversions causing potentially fatal visual and respiratory conditions such as smog, which are further worsened by stubble burning in the agriculture fields of North India during winters.

Innovative Solutions to Combat Air Pollution

"Necessity is the mother of invention," said the Greek philosopher Plato. Propelled by the need to tackle anthropogenic problems, innovators and visionaries across the globe are devising strategies to deal with the vagaries of air pollution. Where Elon Musk's SpaceX is an attempt to reduce space travel cost and colonize Mars, and while other visionaries seek alternate planets, there are innovations galore that are being explored to help make our planet more liveable and less polluted.

In 2007, Italcementi, an Italian Cement Company, developed smog-eating concrete (or photocatalytic concrete) that claims to reduce the harmful effects of certain pollutants by 20–70 per cent. Titanium dioxide in the concrete, when exposed to natural sunlight, was found to trigger a chemical reaction that self-cleans, and clears up smog to 2.5 m above ground. It is able to reduce NO_x and ground ozone, released by vehicles, by 25–45 per cent.[5]

Straw-bale construction has been practiced in many parts of the world, for years. There are many examples in straw-bale construction from Germany, Northern Europe, and parts of Asia. This type of construction practice could be the answer to control agricultural waste across the globe, as could wattle and daub, and cob methods of construction. It is estimated that about one-third of the global population lives in either mud or earth houses. Shredded straw is known to add strength and stability to the soil mix and hold it together, resisting cracks and crumbling. Several

[3] Behl, M. 2019. 'Mumbai's air's toxicity worst in Maharashtra, Bandra and Sion are choking: Study'. The Times of India, p. 5.

[4] Jadhav, R. 2018. 'Mumbai: Over 50 percent trees transplanted at Aarey for Metro work dead'. Mid-Day.

[5] Lee, C. 2013. Smog-Eating Concrete. Retrieved from smogeatingconcrete.weebly.com: https://smogeatingconcrete.weebly.com/; last accessed on October 14, 2019.

self-sufficient zero waste houses are being built across the globe.

Waste segregation through composting organic wet waste, recycling paper, plastic, and glass, leaves very little waste for landfills or incinerators, thereby reducing the level of air pollution.

Berlin architects Allison Dring and Daniel Schwaag have devised an external smog-eating façade system that reduces pollution, in response to the ever-rising number of polluting vehicles. The façade affixed to Hospital Gonzales in Mexico City, and designed in a Swiss-cheese pattern to increase the surface area, is made of titanium dioxide pigment, which, in the presence of ample sunlight, neutralizes the emissions of 1,000 vehicles per day. As per reports, each square metre of the façade module removes 0.26 g of NO_x per day.[6]

Where Delhi dealt with the rising pollution levels in the past few years, by bringing into action the policy of allowing odd and even numbered vehicles to operate on alternate days; China has built a 328ft tall anti-smog tower that claims to produce 10 million m^3 of fresh air every day, and is considered the world's largest-constructed air purifier; and, the city of Tel Aviv facilitates pedestrian movement and encourages its citizens to ride bicycles as their daily mode of transport.

Materials make 50 per cent of a building's carbon, while cement produces more pollution than all the trucks in the world. The manufacturing of cement is responsible for 7 per cent of global CO_2 emissions. There is a pressing need for decarbonization within the environment in general, and the construction industry in particular.

To achieve the carbon-neutral goal, there are many initiatives being taken by individuals, organizations, and countries. While architect Michael Green feels that planks from responsibly harvested forests and wooden skyscrapers provide an effective answer to the natural carbon sequestering of trees; Ferdinand Ludwig's "Baubotanik" construction technique integrates building with trees, and uses the natural sequestering of carbon by trees for structural strengthening. David Benjamin's "Hy-Fi" biodegradable tower employed "Ecovative" mushroom bricks to build the 12m tall tower using zero carbon building blocks. Tel Aviv's Porter School of Environmental Studies is a carbon-neutral building, aimed towards carbon positivity. It generates its own electricity by using building components like the "EcoWall" that keeps the building thermally comfortable throughout the year. The city of Barcelona has embraced the superblock model and walkability concept; and, Europe has a vision towards achieving net zero status for the continent by 2050.

Innovations inspired by nature and technology are being developed to reduce the carbon footprint of materials and buildings, and thereby, control the levels of air, water, and material waste pollution.

Conclusion

The dilemma surrounding our planet's fragile balance, global warming, and air pollution concerns is manifold. There is no one-size-fits-all solution to the gamut of problems that arise from any single system. It is an interwoven predicament. For instance, vehicles release toxic gases that cause air pollution, respiratory illnesses, add SO_x and NO_x gases generating bad ozone, release carbon monoxides and carbon dioxide, which have a high global warming potential, contribute to the urban heat island effect, initiate laying of asphalt roads, deforestation, and much more. While all these issues cannot be resolved with a magic wand, innovators and environmental visionaries have now begun the clean-up act. There is a long way to go, but this could be a good start. □

[6] Herwig, O. 2015. 'Smog-eating façades'. Available online at http://offline.smart-magazine.com/en/smog-eating-facades/; last accessed on October 14, 2019.

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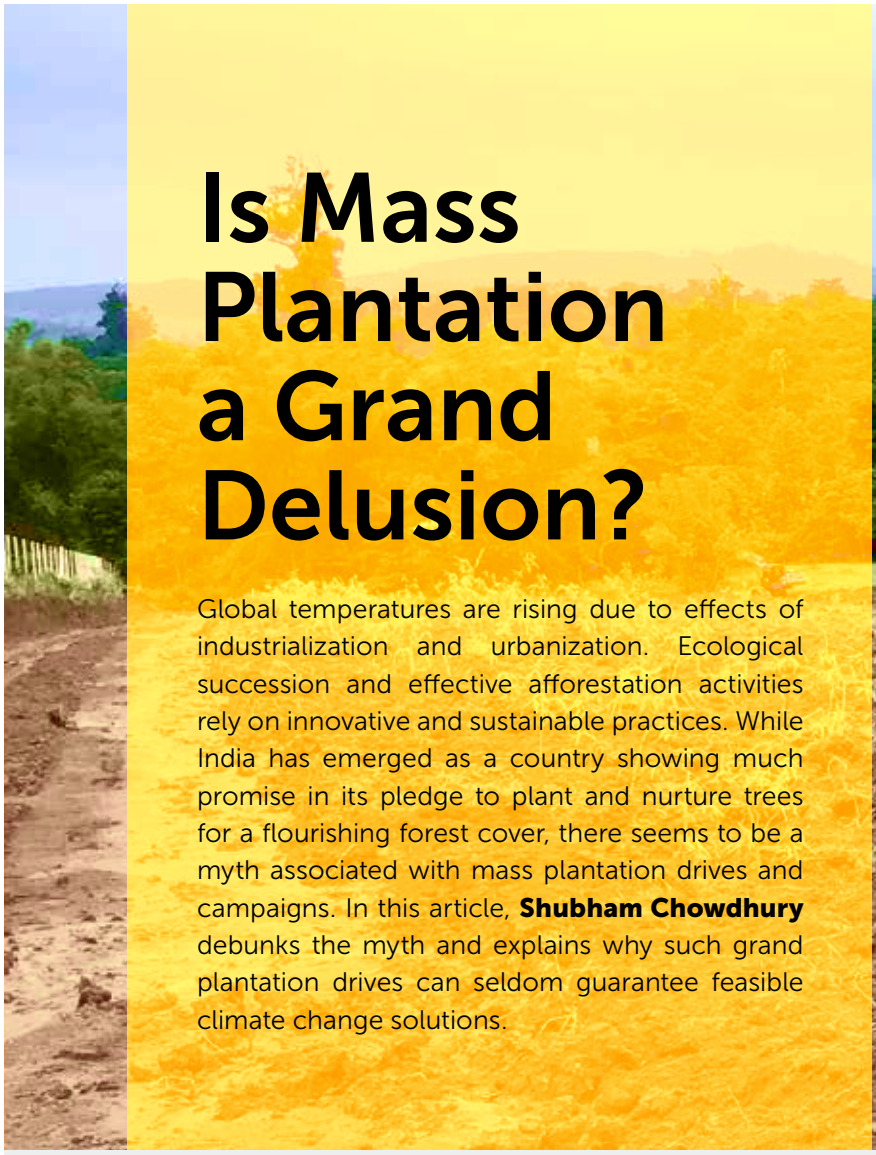


Is Mass Plantation a Grand Delusion?

Global temperatures are rising due to effects of industrialization and urbanization. Ecological succession and effective afforestation activities rely on innovative and sustainable practices. While India has emerged as a country showing much promise in its pledge to plant and nurture trees for a flourishing forest cover, there seems to be a myth associated with mass plantation drives and campaigns. In this article, **Shubham Chowdhury** debunks the myth and explains why such grand plantation drives can seldom guarantee feasible climate change solutions.

There is no denying that trees play an instrumental role in keeping carbon out of the atmosphere and maintaining the stability of global climate patterns. In 2018, the United Nations' Intergovernmental Panel on Climate Change (IPCC) estimated that a billion hectares of forest would need to be planted by 2050 in order to keep global temperatures from rising by a full 1.5 °C over pre-industrial levels. The authors of the study considered the figure "undoubtedly achievable", and even went so far as to state that global tree restoration is "our most effective climate change solution to date". There is certainly no shortage of space on the planet – another recent study[1] has discovered that there exists the potential for an extra 900 million hectares of canopy cover to be planted, translating to storage capability for 205 gigatonnes of carbon. To get a sense of what that means, our entire species emits about 10 gigatonnes of carbon from burning fossil fuels annually, according to Richard Houghton, a senior scientist at the Woods Hole Research Center (WHRC). There are now about 850 gigatonnes of carbon in the atmosphere; a plantation effort on such a scale could, theoretically, reduce that by about 25 per cent.

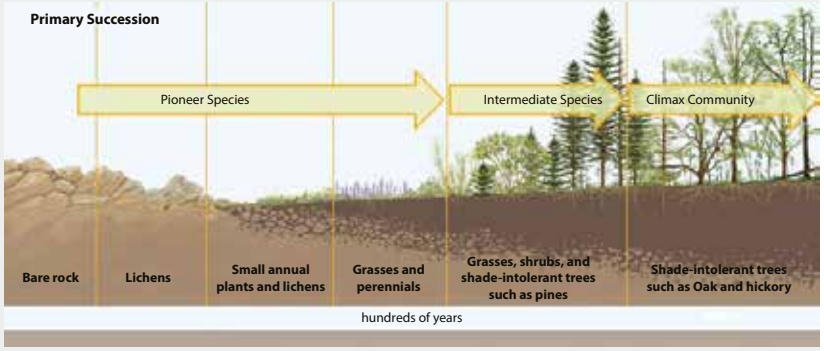
Prime Minister Narendra Modi has repeatedly highlighted India's commitment to the Paris Climate Agreement. The third largest carbon emitter in the world, India has pledged to increase its forest cover by five million hectares before 2030. Mass plantation drives are being carried out on a record-breaking scale. In

[1] Bastin, Jean-Francois, Yelena Finegold, Claude Garcia, Danilo Mollicone, Marcelo Rezende, Devin Routh, Constantin M. Zohner & Thomas W. Crowther. July 2019. *The global tree restoration potential. Science.*

Shubham Chowdhury *is an architect currently working as a Project Officer with GRIHA Council. Perpetually enthralled by the natural world, he is a biomimetic, cradle-to-cradle and environment responsive design enthusiast and amateur naturalist. He may be reached at shubham.chowdhury@grihaindia.org.*

2017, Madhya Pradesh claimed to have planted 6 crore seedlings in one day, while Uttar Pradesh apparently planted 9 crore seedlings in 2018, and 22 crore seedlings in July 2019, both within a span of a single day. With action on such a massive scale, why are not our worries about the climate melting away into oblivion?

A 2017 plantation drive in Nagpur, on a scale impressive enough to be registered in the Limca Book of Records, was considered an excellent example of citizen participation and government involvement in environmental preservation. The efficiency and success of these movements can, however, only be determined by the final outcome. Three months after the plantation drive, The Times of India published a report claiming that 90 per cent of the saplings, planted as part of the green Maharashtra campaign called Mission Plantation, were nowhere to be seen. Those tasked with



ensuring the survival of the saplings declined to take the responsibility when questioned. Plantations require long-term maintenance, and political hype surrounding a particular phase of such an activity only lasts for so long. With the public eye wandering elsewhere, the enthusiasm and flow of funds to plant and nurture thousands of trees slowly waned. The alarming and consistent failure of such enterprises compels us to question the possible ill effects of other recent changes in the government policies – the new directive put forward by the Ministry of Environment, Forest and Climate Change, that allows states to clear forest land for non-forestry projects by carrying out compensatory afforestation in other states, being a case in point.

But, why would trees that had already been around for over 380 million years by the time the first human walked the Earth, suddenly require such intensive human care in order to survive?

The answer lies, as it does often, in our failure to understand and appreciate the ecological

Learn how to see. Realize that everything connects to everything else.

—Leonardo Da Vinci

interconnections that hold our planet together. Accustomed to viewing the world through the materialistic lens of man-made "things", we assume that the functions of a single tree may easily be replaced by "installing" another one elsewhere. Once planted, the new tree is expected to commence operation as a standalone air purifier, the whole process seemingly akin to selling your vehicle in your hometown and purchasing another one of similar make and model when you move to a different city. But trees are not products, and nature does not work that way.

In 1987, Hugh Wilson acquired several hectares of degraded marginal hill country in New Zealand. His plan was to allow native gorse to grow naturally over the terrain. Alarmed by his intention to allow what is widely considered a weed to proliferate, a resident farmer penned these lines that were later published by a local newspaper – "I am all for saving

patches of bush, but the thought of starting from scratch on land, that is clear enough to be used productively, frankly appalls me. As for shutting up a whole valley, heaven help us from fools and dreamers!" This farmer, who had spent all his life fighting for the gorse, feared that allowing it to spread unchecked could only ruin the surrounding landscape. But Hugh, with his background in botany, foresaw something quite different. At first, the gorse did indeed expand profusely – it is an opportunistic plant that takes advantage of cleared ground and grows well when exposed to direct sunlight. But in doing so, it provided just the right amount of shade underneath to nurture the saplings of bigger trees. With time, sans human intervention, these trees grew taller and spread their canopies. In their shadow, blocked from direct access to sunlight, the gorse gradually died out. A natural forest steadily replaced a weed-infested landscape, and with it came all the advantages of extensive native tree cover – reduced erosion, increased soil fertility and better water retention. Now considered a local hero, Hugh oversees 1500 hectares resplendent in native forest, where birds and other wildlife are abundant and 47 waterfalls flow permanently. He has proven without doubt that nature knows best and that he is certainly no fool. This phenomenon is an example of what is called "ecological succession". Every species has a set of environmental conditions under which it can grow and reproduce optimally. Under an ecosystem's unique set of conditions, species that can grow most efficiently and produce the most viable offspring quickly becomes abundant. As long as these prevalent conditions remain constant, those optimally adapted to them will flourish. The engine of succession that causes ecosystems to change, however, is the impact established species have on their own environments. A consequence of simply being alive is exerting influence over one's own environment – the gorse grows best in direct sunlight but the gorse itself creates shade as well. The original environment may have been optimal for the first species, but the altered environment is often optimal for some other species. Under the new circumstances, the hitherto dominant species may fail and another may ascend in its place. This is how forests naturally come into existence, and this is why random plantation of individual saplings, even native ones, rarely yields desired results. The support systems and ecological conditions are not in place for them to thrive – it is merely attempting to start a process midway.

You don't just plant exotic forests (on denuded land). For carbon sequestration, that is just replacing one ridiculous folly with another ridiculous folly.

— Hugh Wilson

This is not new knowledge. Our ancestors were aware of this, as is evidenced by the recent discovery that the Amazon rainforest is not untouched wilderness at all – most of the food-producing plants in the rainforest were planted by humans about 4,500 years ago. "Ancient communities likely did clear some understory trees and weeds for farming, but they maintained a closed canopy forest, enriched in edible plants which could bring them food," said Amazonian paleoecologist Dr Yoshi Maezumi, who led the study.[2] This understanding of ecological interactions will also play a vital role in the shift from our currently unsustainable chemical-based agriculture to permaculture, the process of growing naturally regenerative "food forests". What we see above the surface of the earth is only a fraction of the story. Natural forests nurture a whole world of creatures that in turn feed and protect the trees. It is a subterranean community including fungi, worms, arthropods, and protozoa that transfers nutrients and even information between plants. These organisms are beneficial in other ways, increasing the size of soil particles and improving the ability of the soil to hold water and air.[3] Before it is too late, an understanding of ecological succession and interactions is essential in ensuring the success of any afforestation activity. Otherwise, we will continue to destroy our existing life support systems in the name of economic development and nothing to replace it with except misplaced hope and shrivelled saplings. □

[2] Maezumi, S. Yoshi, Daiana Alves, Mark Robinson, Jonas Gregorio de Souza, Carolina Levis, Robert L. Barnett, Edemar Almeida de Oliveira, Dunia Urrego, Denise Schaan & José Iriarte. 2018. The legacy of 4,500 years of polyculture agroforestry in the eastern Amazon. Nature Plants (4); p. 540–547.

[3] Ramirez, Kelly S., Jonathan W. Leff, Albert Barberán, Scott Thomas Bates, Jason Betley, Thomas W. Crowther, Eugene F. Kelly, Emily E. Oldfield, E. Ashley Shaw, Christopher Steenbock, Mark A. Bradford, Diana H. Wall & Noah Fierer. 2014. 'Biogeographic patterns in below-ground diversity in New York City's Central Park are similar to those observed globally'. Royal Society.

Future Shift, a set of policies framed for PWD, GoM, by GRIHA Council, pertaining to environment friendly procurement and waste & water management was officially launched at the event.

Cultural performance at 10th Regional GRIHA Summit

10TH REGIONAL GRIHA SUMMIT 2019

TRANSFORMATION STRATEGIES FOR BUILT ENVIRONMENT

Bamboo Workshop_Mumbai Regional Summit

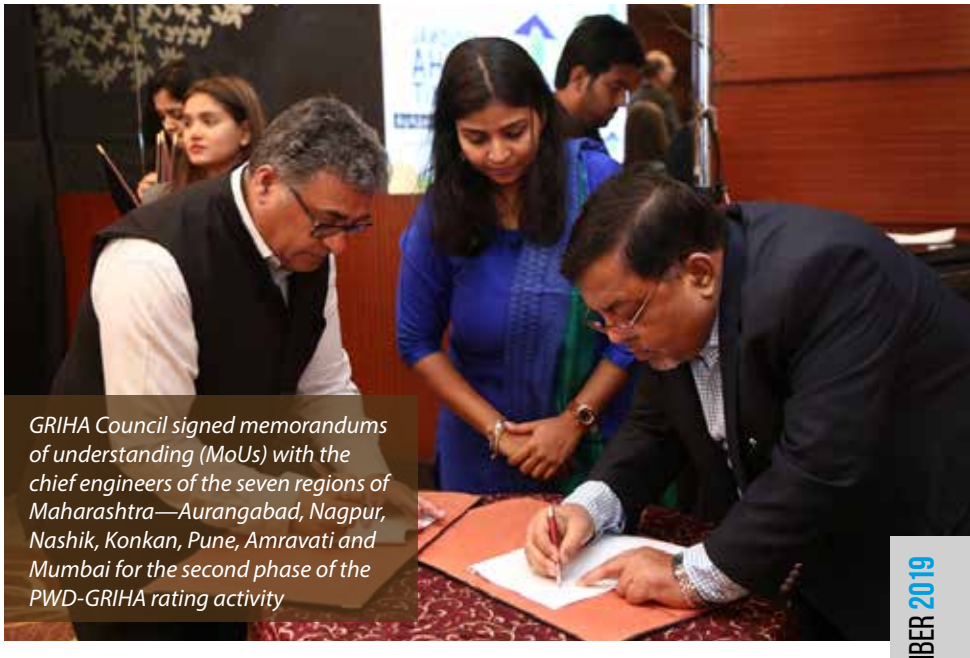
GRIHA officials along with hon'ble Shri Nitin Gadkari and CEO GRIHA Council at the Summit

Mr Sanjay Seth, CEO GRIHA Council felicitating Shri Nitin Gadkari, MoRTH, MSME, GOI.JPG

The presidential address was delivered by Shri Nitin Gadkari, Hon'ble Union Minister for Road Transportation and Highways and Minister of Micro, Small and Medium Enterprises, Government of India

Ms Jahnavi Parab
Senior Manager- Sustainability, Mahindra Lifespace Developers Ltd.

The meeting was presided over by Mr Ajit Sagane and Mr Sanjay Seth and included the seven Chief Engineers, senior officials from PWD & GRIHA Council and the GRIHA evaluators



GRIHA Council signed memorandums of understanding (MoUs) with the chief engineers of the seven regions of Maharashtra—Aurangabad, Nagpur, Nashik, Konkan, Pune, Amravati and Mumbai for the second phase of the PWD-GRIHA rating activity

Nimai Lila Das

In today's urbanized world, the role of an ecovillage is instrumental in envisioning a sustainable future. An ecovillage is a community that works towards the goal of becoming more socially, economically, culturally, and ecologically sustainable. One of the pioneering ecovillagers, who has been working relentlessly for the cause of regenerating and restoring social and natural environments through participatory processes, is **Nimai Lila Das**. In this conversation with GRIHA Council, **Nimai Lila Das**, Chief Sustainability Officer, Govardhan Ecovillage, formed by International Society for Krishna Consciousness (ISKCON), reflects on his extraordinary journey in expanding the ecovillage's spectrum in the fields of water conservation, waste management, use of alternative energy, adoption of green building concept, implementing organic farming, thrusting on rural empowerment, and enhancing global outreach.

How was your experience of transitioning from a tough corporate life to the "Chief Sustainability Officer" at Govardhan Ecovillage?

In one simple word – Profound! For a person who lived only in the hustle and bustle of the city, it was quite a challenge to make this huge leap towards an alternative way of working and living in a remote village. I have had my moments of doubts and second thoughts before I actually moved to the Govardhan Ecovillage (GEV). When I first moved here in 2010, it was as rustic as any other village would be. There were frequent power outages, poor mobile network connectivity, bad roads, etc. But somehow, during the very first week of my stay here, I fell in love with this place and perfectly adjusted to the setup, despite the infrastructural shortcomings. That brought about a deep and profound understanding in me that it is easy to adjust with anything that is natural. And anything that is artificial will always be a struggle! So, in a sense, I felt at ease in my role at GEV.

What inspired you to take on this role?

Before moving to GEV, I was working for a top defence electronics company, on indigenous missile launchers development. Coming from a background of system science and power electronics, my role was designing the control mechanism of the unit. After the successful completion of one project, I asked myself "my control engineering skills can control the launching angles of a missile, but can it control the direction in which our society was moving?" My inner engineer and spiritualist were engaged in a debate. Eventually, the spiritualist won!

What sustainability measures have been implemented at Govardhan Ecovillage?

The development model we adopted at GEV is called "Symbiotic Development". You may draw parallels with C2C systems or circular economy models. The essential difference is that along with the ecological, economic, and social dimensions, we have also worked on sustainability of the cultural dimension. All these four dimensions form the core of the fundamental human needs. Eventually, a holistic model of village development, based on organic farming, animal care, water conservation, integrated waste management, green building technologies, alternative energy, rural development, women empowerment, rural education, and geotourism, was designed and implemented at GEV over a period of 10 years.

What positive impact does the holistic environment at Govardhan Ecovillage have on its occupants/ guests?

For the residents at GEV, it is more than just a village. The strong cultural base here makes eco-centric values a part of the very fabric of their daily life. And the years of experience we have gained by working here, have been translated into a vibrant rural development programme, which has been impacting lives of nearby villagers by enhancing their livelihood, education, health, and sanitation, thus bringing about greater

social equity while ensuring ecological sustainability. Another major activity is in ecotourism. In 2017, one of our projects won the coveted United Nations World Tourism Organization (UNWTO) award, for showing how ecotourism can be a catalyst for rural development. The idea is to make our guests realize that the responsibility of environment conservation does not rest with the government alone. As an individual and as a collective, much can be done. Not only do we showcase an alternative eco-centric lifestyle, we also run various courses that can bridge the gap between the complex high embodied energy lifestyles and simpler low carbon footprint lifestyles.

How can some of these sustainability measures be implemented in larger metropolises where there is a major space constraint?

An interesting aspect of the GEV model is decentralization. Some of the technologies and methodologies we have showcased here are perfect examples of how decentralized management can be done in urban spaces. For instance, our multi-award winning soil biotechnology-based wastewater treatment plant is a good example of decentralized wastewater management that needs to be urgently implemented in metropolises today. Rather than pumping the entire city's wastewater to a remote sewage treatment plant, why not have multiple decentralized units across various city blocks?

We have also implemented a low-cost pyrolysis plant that effectively converts all the plastic collected in the village into useful diesel-grade polyol, which can be further used to produce electricity. Decentralized energy production through solar energy is already a tried-and-tested concept. So I think, the future of these large metropolises is in decentralization and that is what we have demonstrated at GEV.

What learnings can one imbibe from ancient scriptures and implement them in modern-day lifestyle?

A fundamental difference between the ancient and modern worldview is in the way we define and implement sustainability. The modern approach towards sustainability is all about sustaining/controlling nature to meet our ever-increasing needs. So if you analyse carefully, what we are essentially doing is not sustaining nature, but sustaining our own demands. The ancient worldview is a total contrast. It defines nature as something that will always be in a state of flux. The real challenge is to figure out how we can learn to sustain ourselves in this dynamically changing nature. This is not an anthropocentric view, rather, it is a worldview that puts the onus on human management, rather than nature management. It is about time we realize our responsibility and start working towards more sustainable lifestyles.

What is your message to the youth struggling to find a balance between financial growth and sustainable living?

I personally feel the youth today is more ecologically sensitive than ever before. And, the world today, is one big global knowledge village. Youngsters are well exposed to various sustainable technologies. I feel there is no shortage of "skill" to balance financial growth and sustainable living. If there is a shortage of anything, it is the "will". So I will request all like-minded eco-sensitive youth to come together and inspire each other. The power of collective strength is extraordinary and the youth must discover this synergy among themselves to strengthen their will. And I do see it happening in small, isolated pockets already. It is just a matter of time before it reaches a tipping point.

What keeps you motivated towards propagating sustainable lifestyles?

Do we have another option? The impending ecological crisis is roaring at a higher pitch every day. If there is any generation that needs to really make a concerted effort, that is us. For me, it is more of a spiritual goal that derives from the Vedic worldview I have been trying to internalize for many years now.

What is the "Vedic perspective" towards climate change adaptations for sustainable development?

I briefly touched upon this aspect in my previous reply. As a famous environmental advocate once said, "...to deal with the top environmental problems, we need a spiritual and cultural transformation." The fundamental problem we are dealing with is our own worldview. New technologies come from ideas and our ideas are limited by our worldview. The worldview we carry today is something that was shaped at the time of the Industrial Revolution, when the fundamental design premise was that the planet is an infinite source of energy and is an infinite sink for wastes. So, there was no need to consider either resource optimization or waste minimization. Unfortunately, we subtly carry the same exploitative premises in our worldview, and consequently, are unable to come up with sustainable solutions. To solve the sustainability puzzle, we need to reshape our worldview that is not based on exploitation of nature but that of consideration, if not veneration. And I think that is exactly what the Vedic perspective is all about. We call this "simple living and high thinking". It is more about working on our inner ecology and lifestyle that will pave the way for better solutions to tackle the challenges of outer ecology.

What are some of the highlights in your journey towards sustainability?

Personally, one of the biggest highlights has been discovering the connection between spirituality and ecology. Sustainability is applied spirituality and spirituality is the foundation of sustainability. To realize how the Vedic worldview can be so well integrated with modern technologies to create a relevant model has been a thrilling feeling. And the fact that GEV has won more than 35 awards in the last six years is a testimony to this.

What is your vision towards replicating this ideology of sustainability to other ISKCON campuses?

Sustainability is as spiritual a goal as it gets. In the Vedic narrative, Lord Krishna has always been described as a nature and animal lover. His village Vrindavan can be called the original ecovillage. His cleaning of River Yamuna from the poison of serpent Kalia can be perceived as the original river rejuvenation project. During the torrential rains, the way he provided shelter to the distressed by lifting the Govardhan Mountain can be considered one of the first adaptation techniques towards climate change. Ecology and sustainability are integral to the Vedic practice. And more so in ISKCON, thanks to the definitive directives given by our Founder Acharya Srila A. C. Bhaktivedanta Swami Prabhupada. He defined one of the purposes of this movement as, "to bring the members closer together for the purpose of teaching a simpler, more natural way of life." As recognition of this principle, we have set up many eco-sustainable farm communities all across the world. Secondly, there is a "Green Temple" initiative, where the best green practices are shared with our centres to increase the overall sustainability practices across all ISKCON campuses. The ISKCON Chowpatty, Mumbai campus, which works very closely with GEV, has received explicit recognition in the field of sustainability. So yes, slowly and steadily, there is a massive shift towards extending the sustainability ideology beyond the ISKCON GEV campus.

Innovative Futuristic Building Solutions: A Case Study at SAC, ISRO

Residential and commercial complexes consume more than one-third of the global energy. Besides energy-efficient measures, the need for reduction in CO_2 and greenhouse gas emissions is essential. In this article, **Rakesh Jain, Ar. Nidhi Mishra** and **Pramod Behera** discuss effective ways of achieving green building solutions through reduction of solar heat gain and enhancement of thermal comfort with specific reference to a case study at SAC, ISRO. The emerging technology of solar photovoltaic (PV) facilitates implementation of building-integrated PV (BIPV) that could be a giant leap towards making more energy-efficient sustainable buildings by generating renewable energy.

Rakesh Jain *is a senior scientist and the group head, Construction and Maintenance Group (CMG) at Space Applications Centre (SAC), ISRO. He has done his BTech (Hons) in civil engineering from Harcourt Butler Technological University, Kanpur, and has completed his ME (Hons) in highways from Punjab Engineering College, Chandigarh. He has over 32 years' experience in execution and project management of micro-electronic labs, auditoriums, etc., and planning of high-end civil infrastructure for ISRO. He has a keen interest in the concept of green building, latest technology in construction, and innovative interior design. He can be reached at rsjain7@gmail.com.*

Ar. Nidhi Mishra *completed her MUDP (Hons) from Maulana Azad National Institute of Technology, Bhopal, and did her BArch (Hons) from Madhav Institute of Technology and Science, Gwalior. She has worked as a scientific officer (C) in Bharatiya Nabhikiya Vidyut Nigam Ltd (BHAVINI), in the Department of Atomic Energy (DAE), Kalpakkam. Since 2008, she has been serving as a scientist/engineer SE in Space Applications Centre (SAC), ISRO, in Ahmedabad. Her area of interest is in development of sustainable green buildings for the future. She can be reached at nidhimishra.htc@gmail.com.*

Pramod Behera *has completed his BTech in electrical engineering from Biju Patnaik University of Technology, Odisha. Since December 2011, he has been with the Construction & Maintenance Group, SAC, ISRO, Ahmedabad, where he began as a scientist/engineer (SC), and later became scientist/engineer (SD) in 2016. His current research interests include renewable energy, energy conservation, high-voltage substation engineering and power quality. He can be reached at pramod@sac.isro.gov.in.*

Abstract

In developed cities, particularly high-density habitats in metros with high-rise commercial and residential complexes, it is not feasible to generate solar power by installation of rooftop solar panels (PV) due to lack of adequate roof space, resulting in non-utilization of renewable energy. Rooftop areas of these high-rise complexes are occupied for installation of building services like water tanks, chillers, antennas, VRV/AHU/outdoor AC plants, etc. Moreover, there is further reduction in roof space due to shadow effect of the aforementioned elements on PV installation. The emerging technology of solar PV facilitates implementation of BIPV as a key technology, which could be a giant leap towards making more energy-efficient sustainable buildings by generating renewable energy in the range of 5–20 per cent. Adding BIPV to the façade/roof results in live energy generators by tapping solar power available abundantly in India. In high-rise buildings, energy could be harvested at a large extent by the application of BIPV on the wall areas as compared to that of the roof. This article elaborates on the customized solution with the real BIPV, and its thermal analysis for the project executed at SAC/ISRO. Based on the results from the technical data available for U-values of different construction materials and BIPV, thermal data have been derived from energy simulation softwares. The customized solution using BIPV is found to be the most suited to the Indian climatic conditions where the need of more insulation and reduced light is required inside the habitats.

Introduction

It is a fact that buildings of residential and commercial usages are responsible for consumption of more than one-third of the global energy. Besides energy-efficient measures, the need for reduction in CO_2 and greenhouse gas emissions, the major electricity demand has to be fullfilled by renewable sources of energy through incorporating novel solar technologies in building with explicit use of BIPV/PV. An innovative trend to harvest the green energy and reduce greenhouse gas emissions is to replace conventional construction materials in the building envelope with BIPV as part of the external building façade. This is a turning point in achieving green building solutions not only by on-site energy generation but also, through reduction of solar heat gain

into the building (thus reducing air-conditioning loads) and can assist in enhancement of thermal comfort. BIPV systems must not only fulfil the requirement of the building envelope for water tightness, reliability, heat protection, etc., but also comply with local building codes and regulations.

Mega facility buildings allied service buildings and related infrastructure are being established at the new SAC (Space Applications Centre) campus of ISRO. In this campus, an administrative building provides office space for support services groups. This building had been planned to incorporate most of the green building features and usage of innovative green building materials to enhance the overall thermal performance of the building, and also reduce the energy consumption by integration of BIPV into the external building façade.

Model Conceptualization

The front elevation of the building faces south, which is a critical direction as per the solar path analysis, gaining maximum heat through the building façade. In India's tropical regions, it is the most crucial direction to deal with, as it receives longer duration of sun exposure with intense sunlight for most part of the year. In this building, the less utilized spaces like panel rooms, storages, lobbies, etc. have been placed in the front of the building with least occupancy to create a buffer zone. The idea of utilizing the direction to harness the sunlight from the vertical façade, in a more efficient way, without compromising on the basic functionalities and its properties, was conceived during the planning stage.

The innovative thought of using BIPV was perceived by the architect at the initial stage of the project itself, as it was to curtail and utilize the exposure to sun efficiently. After rounds of market survey, interactive discussions and brainstorming sessions with technocrats, field experts, engineers and manufacturers, the customization of the installation of BIPV modules amenable to the Indian climate was worked out.

All major usable spaces were planned in the north and east directions. Spaces located in the north are provided with plain glass to take the maximum advantage of the daylight (95 per cent) in regularly occupied areas, thereby, reducing the artificial lighting load of the area. Further, artificial lighting load is reduced by increasing the WWR ratio to more than 40 per cent. Due to meticulous planning of the building envelop and usage of BIPV panels in proposed modules, the thermal heat load of the air-conditioning system was reduced by 20 per cent over ASHRAE standard 90.1-2010 base case.

The BIPV panels fixed at human eye level are double-glazed units (DGU) with solar glass panel on the outer face and low SHGC (solar heat gain coefficient) glass on the inner face with solar factor–0.24, visible light transmission - 18 per cent and U-value–3.9 W/m^{2}K. The DGUs have gaps filled with argon gas between the two glasses which acts as thermal insulator. The inert gas filled in the gap of DGU and low SHGC glass on the inner face, considerably reduces the heat load and also curtails the solar glare, thus allowing only cool daylight to enter the building. This increases the daylight factor of the building without increasing its heat load.

The proposal of using BIPV to generate renewable energy was also sent for evaluation and confirmation to the Gujarat Energy Research and Management Institute (GERMI).

Terraces were proposed to be equipped with terrace gardens to reduce the heat load gained through the roof, achieving a U-value of 0.5 W/m^{2}K. These terraces also help improve the indoor air quality of the rooms at both ground and first floors. Further, the heat load inside the building is reduced due to usage of few electrical fixtures, which in turn, reduces on the air conditioning load of the building.

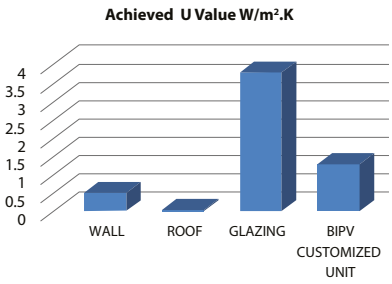
Thermal Analysis

The thermal conductivity (U-value) of different building components has been studied in detail, and after significant efforts, it has been considerably reduced. To calculate the thermal efficiency, appropriate energy simulation tools were used. These tools reduce the thermal heat gain inside the building, thereby, decreasing the cooling load of HVAC system.

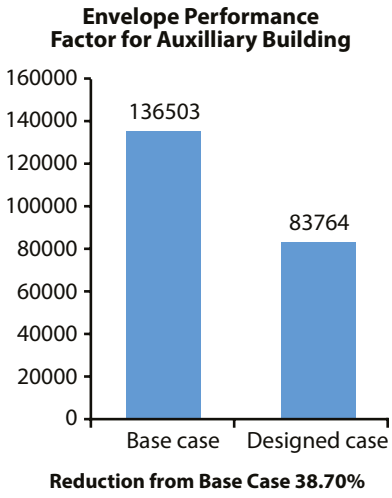
Evolution and Development of Form

Analysis of thermal efficiency

No.	Specification	Achieved U-value (W/m^{2}K)
1	Wall	0.498
2	Roof	0.36
3	High-performance glazing	3.8
4	BIPV customized unit	1.28



» **Figure 1** U-value of different building components [1-3]



» **Figure 2** From ECBC base case

Summary

The concept of having a landscape-interactive green building, which

is functionally and aesthetically appealing, and has been complemented with the use of BIPV in vertical façade, terrace gardens, climatological design, along with all green building parameters, was quite challenging. The concept has been materialised with continuous efforts. The results of review and analysis done by GERMI were found to be overwhelming, particularly the energy generation. The data analysis carried out for daylight factor, thermal conductance of building materials, indoor air quality, energy performance index, and renewable power generation on site and gained carbon credits, shows encouraging results. Further, there is incremental decrease in HVAC heat load and lighting power density.

The developed environment inside the building has increased the performance output of the occupants as the building gained an extended landscape environment inside it.

Reduction in Envelope Performance Factor (EPF) for the building: 38.70 %

Total Building Envelope Performance Factor										
EPI for Design Case						**EPI for ECBC Base Case**				
EPF_{Total}	=	EPF for fenestrations	=	66,162.05		EPF_{Total}	=	EPF for fenestrations	=	89,599.05
		+		+				+		+
		EPF for walls	=	1851.974				EPF for walls	=	4292.426
		+		+				+		+
		EPF for roofs	=	15,660.9				EPF for roofs	=	42,610.46
	83,674.92754						136,503.9435			
Percentage reduction from ECBC Base Case =						38.70%				

[1] Aelenei, Laura & Pereira, Ricardo. 2013. Innovative Solutions for Net Zero-Energy Building: BIPV-PCM System – Modeling, Design and Thermal Performance. IYCE 2013, 4th International Youth Conference on Energy. p. 1-6. Available online at https://ieeexplore.ieee.org/document/6604162; last accessed on October 14, 2019.

[2] Shabunko, Veronika, Monika Bieri, & Thomas Reindl. 2018. Building Integrated Photovoltaic Facades in Singapore: Online BIPV LCC Calculator. Available online at https://www.ieee-pvsc.org/PVSC40/; last accessed on October 14, 2019.

[3] Misara, S., N. Henze & A. Sidelev. 2011. Thermal characteristics of BIPV (U-value and g-value). 30th ISES Biennial Solar World Congress 2011, SWC 2011. Available online at http://publica.fraunhofer.de/documents/N-253992.html; last accessed on October 14, 2019.v

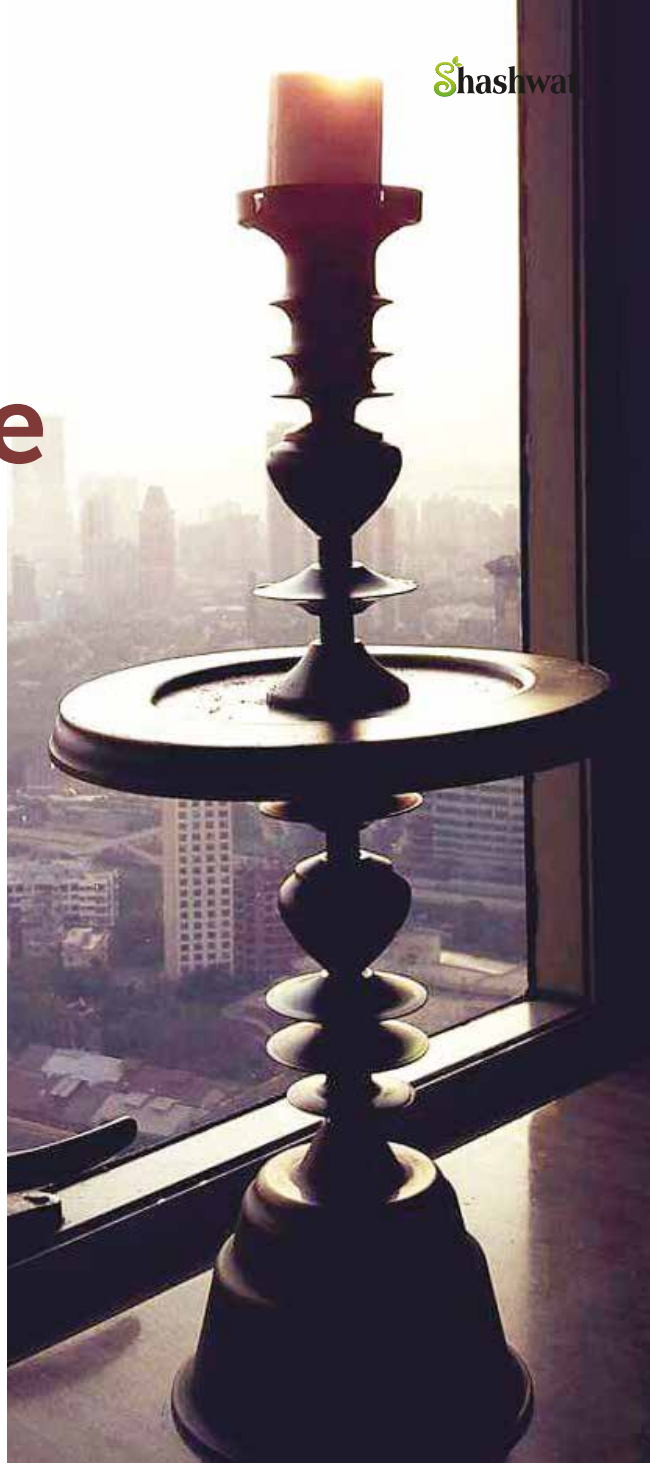
No.	Detail	Base case	Unit	Designed case	Energy saved / generated in units	Saving in cost per annum (INR)	Per cent reduction from base case	Carbon credits in tonnes
1 (i)	Power generation by BIPV over façade				157,465	1,025,000		142
(ii)	Payback period		Year	7.5				
2	Reduction in heat load in HVAC system	160	TR	118	196,560	1,277,640	26	177
3	Reduction in LPD (lighting power density)	22,150	Watt	15,500	17,290	112,385	30	16
4	Recurring cost towards AMC HVAC					115,000		
	TOTAL				**371,315**	**2,530,025**		**34**

Saving in capital cost and recurring cost due to building envelope design			
5	Reduction in tonnage of HVAC system by 42 TR	42 TR x 55,000/-	INR 2,310,000
6	30 % reduction in lighting power density (interior, exterior and use of occupancy sensor) by 6650 W of lighting fixtures	6650 W x 220 /-	INR 1,463,000
	Total Cost Saving in Rupees		**3,773,000**

	Energy Performance Factor	
7	EPF improved by selection/modification in the specification of construction material used for walls	56.9
8	EPF improved by selecting most-suited glazing	26.2
9	EPF improved by selection/modification in specification of construction material used for roof	63.2
Total EPF has been improved for the building		38.5
Daylight factor in regularly occupied areas		95 %

Results show that the system using BIPV-customized modules decreases the temperature inside the building, and makes the building envelop more stable and amenable to Indian climatic conditions. This could be an advantage for the solar energy conversion efficiency of PV module, which could then be optimally utilized in other regions. □

Fostering Partnerships for Sustainable Habitat



The manner in which we approach construction is responsible for how much of an ecological impact it has on the environment. **Nilesh Gandhi** explains in this article that for achieving sustainable goals in the field of construction, all-round efforts and collaborations are necessary. He talks about "construction management", which primarily deals with time, cost, and architecture, as a field that can help the world in achieving carbon neutrality.

"Time, Cost, and Architecture", as a thesis topic sowed the first seed for construction project management, as I graduated from school. The growth of the seed as a shoot at the Master's course in construction project management at CEPT, helped me deep dive into several aspects, giving me a broader perspective on architecture and projects. As we explore ways and means to steer forward the sustainability movement, we disastrously lag behind in reaping the benefits of the low-hanging fruits that "construction management" as a faculty can offer. The development over the past few decades seems that we have been just pushed to swim in this ocean and find out our ways and means, at times even experiment with no assured end in mind, for sustainable solutions. To achieve sustainability, all-round

*An architect working for a sustainable habitat, **Nilesh Gandhi** is the founder director at Metadesign (India) Pvt. Ltd. He completed his MArch in project management from CEPT University. A chance encounter introduced him to environmental sustainability and he pursued his doctorate at IIT Bombay. His professional practice is based in Mumbai, and he is grateful to all the stakeholders for having contributed to his projects that span geographies. His areas of interest include landscape and green building projects; he has been felicitated across events as a speaker, panelist, and a moderator. He can be reached at nilesh.g@metadesign.co.in*

efforts and collaborations are required. Opportunities in construction management deserve due attention, which this article tries to elaborate on. This would need forging key partnerships with project managers, timekeepers, schedulers, cost controllers, and the likes, and seeking their involvement in early stages of the projects for optimized gains.

Time as a Sustainable Resource

We are obsessed with sustainability of natural resources like coal, fuel, water, and gas, and many times rightfully so, however, we ought to consider "time" as a natural resource as well. Just because every day we wake up with our quota of 24 hours, does not mean that it is an infinite resource. Our productivities are at the lowest end of the performance spectrum, since we do not value our own time, let alone considering the loss of opportunity costs on projects that get delayed on account of improper planning. We are comfortable in accepting "years" as the unit of project completion duration, so much so that similar projects that we take years to build are executed in months or days overseas, and we restrict our appreciation to astonishment rather than adaptation. Developers resist time-saving construction techniques for their initial extra costs, also because, we are unsure of effectively utilizing our saved time. Over 90 per cent of the projects are delayed anywhere from 1 month to 60 months, according to the Ministry of Statistics and Programme Implementation (MoSPI), while 70 per cent of the projects fail.[1] Parkinson's Law states that work expands to the time available, for it is time we start monitoring the carbon footprint of delay. It is imperative to have a planned project schedule and monitoring mechanism. Project delays further add a risk of litigation, with client expectations not being adhered to and valuable judiciary resources consumed to settle lawsuits. While a delay in a private project burns a hole in the developer's pocket, in public projects, it is the taxpayers' money, which is essentially ours, that goes down the drain. Our money can be better allocated. Delays are a global phenomenon, however, they are more common in India. While global initiatives are being taken in this regard, we need a more vigorous approach, since we lag substantially in on-time project completion.

Cost

Delayed projects have cost us more than Rs 2 lakh crores in only about 360 projects being monitored by MoSPI. With the inflation factor into play, the cost of construction materials goes up with time, reducing the purchasing capacity, thereby leading to a delay in projects, and in turn, incremental construction cost escalations. Effective time-bound planning also helps avoid waste generation. A better planning, for material deliveries at the required construction stage, will not only save time and cost, but also on-site storage spaces and wastages in damages.

Rework should be avoided under all circumstances as it costs money, wastes time, and consumes material. As per the report by The Boston Consulting Group, 60 per cent of the project

[1] Retrieved from https://4pm.com/; last accessed on October 16, 2019.

cost overrun has been on account of delay, while revisions, changes in schedules, account for the rest. Almost 25 per cent of the projects do not meet owner or client expectations, leading to enhanced costs in rectifications and damage control. Technological innovations on the other hand stand to contribute to substantial savings in construction.

Design

Design is at the heart of achieving sustainable goals. The way projects are designed and planned define the extent to which any project shall be sustainable or low on carbon emissions. Modularity in construction, with an eye on the aforementioned aspects of time and cost, goes a long way in achieving project efficiency. Lean construction is possible with designs being replicated, which in no way means any compromise in creativity. It is about constructing efficiently and effectively, that is, doing things right and doing the right things.

Sustainability in construction management is of critical importance. For the manner in which we approach construction is responsible for how much of an ecological impact it has on the environment. Sustainability of a construction project can be enhanced by efficient planning, synchronization of all the elements, of services, vendors, products, and prior resolution of interdependencies to avoid last-minute and on-site surprises. A good approach is to have a detailed physical on-site verification survey, which shall majorly capture the nitty-gritty, and solutions for those can be envisaged in advance. The process of construction, when the actual work is done, also has a substantial impact on the micro environment, which can be mitigated by adequate easy-to-implement measures. These could be as simple as dust, sound, and space management, and can be facilitated by sheer awareness. Another aspect is residual waste, or leftovers once the project construction is over, which need to form the cradle for integration in manufacturing, thereby ensuring minimal or zero landfill contribution.

Other aspects include quality in construction, which also has a substantial ecological footprint; and things done right at the first time eliminate the need for re-doing things, which put valuable resources to good use, enhancing overall sustainability. Quality control and inspection, total quality management, and quality assurance, are much-ignored aspects in constructions, where the industry substantially lacks in competent quality-monitoring professionals. Even if we have the required professionals, the demand for their services from the developer community needs to be created by bringing about awareness for overall benefits towards achieving good quality in construction.

All these elements of time, cost, design, quality, and value engineering in architecture projects are to be looked at not in isolation, but holistically, with a perspective of sustainability. A holistic approach will go a long way in achieving carbon neutrality, in addition to the active/passive strategies or energy conservation methods being adopted. Construction project management offers us a very crucial and important key to achieve higher goals of project efficiency, while releasing enormous amounts of material, labour, time, and cost resources to be utilized effectively, for a sustainable future. ◻

SALE – Shopping Adds to Landfills Everywhere

THINK BEFORE YOU BUY

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Does every occasion deserve a new dress? Or is it just some ritual we, as adults, have introduced to change something in our otherwise monotonous life? As a child, I remember waiting for Diwali more than any other festival, because other than the lights and cracker fights, Diwali meant buying new clothes. Being brought up in a middle-class family, new clothes were considered as sacred things that were only bought during some festival or a close relative's wedding. As I grew up, and the world changed around me, it became evident that clothes were no more considered as sacred, but a part of the regular shopping list. The MBAs who had studied behavioural economics in college, brought in the "SALE" concept to attract unwilling customers, thereby boosting the sale of their company. Moreover, with the introduction of the magical world of online shopping, we did not even have to wait for "SALE" anymore. After all, who has the time to go store hopping when a few clicks on our mobile while travelling by a metro can get us any merchandise delivered to our doorstep, before we can even think if we actually want that item or not? But with all this happening, it was time to deal with rejections too. Discarding clothes just because "it does not give me a good vibe anymore" began trending among the youth. Suddenly, the culture of fast fashion, where companies produce cheap clothes rapidly to meet the most recent fashion trends, became mainstream. Studies reveal that globally, we now own 60 per cent more clothing items than what we used to a decade ago, while wearing them for only half as long.[1]

[1] Retrieved from https://www.ekoenergy.org/how-polluting-is-the-fashion-industry/; last accessed on October 17, 2019.

The revolution did not come without hidden consequences. As companies focused on making the same customer buy more clothes, they had to drastically lower their prices to attract their clientele, and they found a simple formula to achieve their goal: Cheap Labour + Cheap Material = Cheap Clothes. While the former part was covered by producing majority of the world's clothing in developing countries (where it is much cheaper and labour laws are far more relaxed), companies started focusing on the latter variable of the equation by using cheap material, which is harmful for the environment. Fast fashion paved the way for the use of polyester in clothing, which requires eight-times more energy than linen for manufacturing, and takes 20 to 200 years to break down, unlike natural textiles like silk, cotton, wool that take only a year to break down.[2] Polyester is also infamous for its microplastic fibres which keep shedding from the clothes with every wash. It is estimated that a single polyester garment can shed more than 1,900 microplastic fibres per wash, which enter the water system and ultimately travel into the marine ecosystem. A recent study found that one out of four fish sold in a fish market in California contains harmful microplastics. That was just about the fabric, but the world needed more colours to brighten up people's otherwise dull and boring wardrobes. Every possible

[2] Retrieved from https://www.greenmatch.co.uk/blog/2016/08/fast-fashion-the-second-largest-polluter-in-the-world; last accessed on October 17, 2019.

permutation and combination was tried with all colours of dyes to produce a new shade each time – a shade that inspires (air quotes). It is no surprise that dyes have become one of the largest water polluters in the world, as 90 per cent of the dye houses and textile factories release their waste directly into local freshwater supplies in developing countries. So much so, that it has given birth to a not-so-popular saying that you can see which colour will be in fashion next year from the colour of the river in China.

Apart from the fact that the textile industry contributes a lot to the global water pollution, it has a significant role to play in carbon emissions and land pollution as well. On one hand, 10 per cent of the global carbon emission comes from the fashion industry, while on the other hand, discarding fresh-like clothes puts a load on landfill sites as there is very little recycling done in the fashion industry. When the USA alone trashes 14 million tonnes of textile each year, and 85 per cent of the discarded clothes find their way into landfills,[3] it would not be incorrect to say that the world is literally covered in fashion waste. Recycling seems to have become a lost ancient culture, which is strange, because I remember when I was growing up, clothes used to have a fixed life pattern decided for them. There were party clothes that would later become regular home clothes, then they

[3] Retrieved from https://www.wradliving.com/why/; last accessed on October 17, 2019.

would be passed on to a younger sibling before re-identifying them as nightwear and finally tearing and shape-shifting them into mopping clothes, thus using them in every way possible and giving meaning to their lives. Of course, some special ones (preferably light-coloured) would be kept aside for festivals like Holi, where they would get relieved of any interim duties and attain moksha directly. But today, the culture of fast fashion has made discarding clothes look trendy and recycling look less cool. Did you know that 1 tonne of recycled clothing is equivalent to 20 tonnes less of CO_2 in the atmosphere? [4] Weighing the benefits, a reduction in fast consumption and a proper upcycling programme would go a long way in achieving the goal of sustainability.

[4] Retrieved from https://www.wradliving.com/why/; last accessed on October 17, 2019.

I recently came across a garment exchange programme initiated by a fashion brand where you can exchange your old clothes for discount coupons, which in turn can be used to buy new clothes, obviously from the same brand – another marketing strategy by another MBA to boost sales, but at least, an environmentally responsible one. However, with such a plethora of factors contributing to environmental degradation, the problem seems so big that it is difficult to know how to even begin addressing it.

Let us at least try to find solutions for some of these problems. For starters, the textile industry should take initiatives for recycling and promote this culture among their consumers too. Additionally, every merchandise could carry a label indicating its water footprint to help customers take a sustainable step. To address the throwaway culture, a rental model of clothes could be encouraged, along with easily accessible donation points, so that the discarded clothes can find a new home in someone else's wardrobe. Additional measures could be taken by the government and fashion companies to keep a check on the level of pollution caused during the manufacturing process. Stringent laws by the government may force the industry to ring the bells of their R&D department and come up with innovative solutions to reduce their impact on nature.

Meanwhile, what about you? Well, you should rethink before adding that pair of jeans to your cart, and ask yourself: "Do I really need them?" Is celebrating the four-month anniversary of your first coffee date worth adding a tonne of of carbon footprint to the atmosphere by buying a new outfit?

Think before you buy!

Combating Water Crises through 'Wise Strategies'

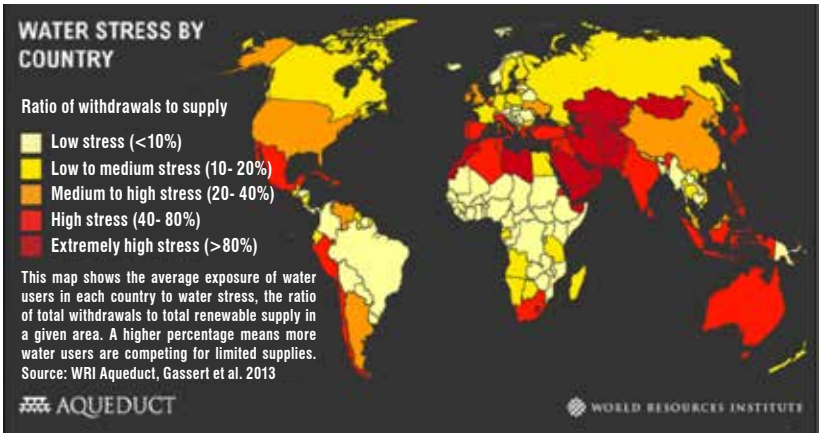
Life exists because there is water. Today, world's megacities are facing a global water crisis. Accessibility to clean water for drinking, bathing, cooking, and washing has become extremely difficult. With increased urbanization and industrialization, clean water supplies, sanitation facilities, and construction of sewage treatment plants have been severely affected. In this article, **Prachi Ghatwani** explains the woes of chronic water scarcity, and discusses how sustainable access to potable water can be achieved through irrigation efficiencies, shifting agricultural production towards less water-using crop and improving soil infiltration.

Prachi Ghatwani *is a green building analyst with Environmental Design Solutions (EDS). She has expertise in developing learning tools, tutorials, and content for students and professionals, focused on design, strategies, and policies for sustainable built environment. Her courses and articles feature on several reputed educational portal and other platforms.*

We are facing a global water crisis. Fourteen of the world's twenty megacities are experiencing water scarcity or drought-like conditions.[1] As many as four billion people already live in regions that experience severe water stress for at least one month of the year.[2] Majority of diseases in the developing countries are caused due to lack of clean water. Interstate water conflicts are common in many countries such as the USA and India, including many regions of the Middle East. In the arid regions of western India, predominantly in the state of Maharashtra, farmers are fighting with the beverage companies and bottled water giants to protect groundwater from contamination. Water conservation means using less water, using it efficiently, polluting lesser water resources, and recycling dirty water after treatment. The major goals of water conservation are sustainability, energy conservation, and habitat conservation. Sustainable Development Goal No. 6 – Clean Water and Sanitation – recognizes it as a priority at all stages of resource planning from supply to end-user management. International agencies, local communities as well as citizens

[1] 'Global Risks'. 2018. World Economic Forum.

[2] Mekonnen, Mesfin M. 2016. 'Four billion people facing severe water scarcity'. Science Advances 2 (2).



» **Figure 1** Water stress by country wise
Source Francis Gassert 2013[3]

are coming together to help realize the goal of universal access to water. Let us look at some successful strategies and programmes from across the world.

Resource Planning and Management

Water resource planning and management consist of judicious sourcing and assessment of long-term environmental impact. Some strategies to ensure judicious management of water resources include harvesting rainwater and reusing wastewater, which can further reduce depletion of water resources. Additionally, it also calls for a fair distribution of water for domestic purposes, agriculture, and industrial use.

There are many other issues involved in resource planning, for instance, maintaining political and social peace, which calls for discouraging private ownership of water resources.

Public Ownership of Water Resources

There are cases of limited access to water even in regions bestowed with abundant fresh water. These often stem from the involvement of the private sector in the water supply. Governments collaborate with private organizations, anticipating increased investments, improved system efficiency, and better accessibility. However, private sector participation usually leads to increased water tariffs, with public facilities turning into profit-making commodities. This has been observed in the privatization of water systems in cities like Jakarta and Berlin. Privatization of water supply is incompatible with ensuring the international human right to water, since it is the poor who suffer most. This was the reason privatizations in Cochabamba (Bolivia) and Dar es Salaam (Tanzania), were aborted.

Watershed Management

The Rio Grande Water Fund aims to protect the Rio Grande River in New Mexico, USA – the most important river in the region – from post-fire flooding and contamination. It seeks to protect and restore vital forests upstream in order to ensure a continuous supply of clean water downstream. The whole community contributes towards building greater water security including business people, water conservationists, and local citizens.[4]

Efficient Irrigation

Since agriculture has a 70 per cent share of water use across sectors, it offers the greatest potential for water conservation. Strategies like increased irrigation efficiencies, shifting agricultural production towards less water-using crop, and improving soil infiltration, can help achieve enormous water savings. One way to push for water-efficient agriculture could be rolling back subsidies given to farmers.

These measures can prove profitable to farmers too. After farmers in the drought-affected Flint River Basin in Georgia, USA, retrofitted their irrigation systems with high-efficiency sprinkler heads and real-time soil moisture monitors, they were able to achieve reduced operational costs along with increased water saving. Even as Arizona reels under a 15-year drought, farmers in Yuma have successfully implemented irrigation techniques, which cut their water usage by about 20 per cent over the last 20 years, while increasing crop production by 30 per cent.

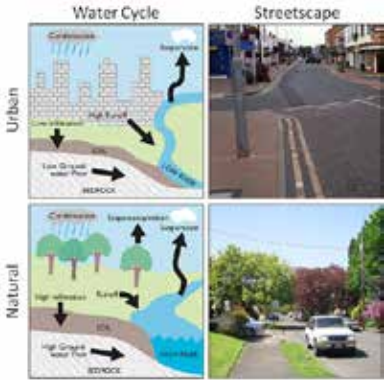
Green Infrastructure

Green infrastructure can help improve water quality as well as prevent floods. For example, after a disastrous flood hit Beijing in 2012, the Chinese government launched a mission called 'Sponge City' initiative to reverse the deleterious effects of rapid construction on stormwater flow. Under this, 30 Chinese cities are adopting bioswales, rain gardens, roof gardens, permeable pavements, and other green infrastructure to infiltrate, capture or reuse at least 70 per cent stormwater. These cities are aiming for 80 per cent of their built-up area to be able to manage stormwater by 2030.[5]

[3] Gassert, Francis, Paul Reig, Tianyi Luo & Andrew Maddocks. 2013. 'Aqueduct Country and River Basin Rankings'. World Resources Institute. Details available at https://www.wri.org/resources/charts-graphs/water-stress-country; last accessed on October 10, 2019.

[4] 'Comprehensive Plan for Wildfire and Water Source Protection'. 2014. Rio Grande Water Fund.

[5] Faith Ka Shun Chan, James A.Griffiths, DavidHiggitt, ShuyangXu, FangfangZhu, Yu-TingTang, YuyaoXu, YuyaoXu. 2019. 'Sponge City in China – A breakthrough of planning and flood risk management in the urban context'. Land Use Policy (Elsevier) 76, p. 772–778.



Blue–Green Infrastructure

» **Figure 2** Cities with blue-green infrastructure mimic hydrology of natural environments

Source EmilyBlueGreen

Infrastructure should also be provided for communal harvesting of rainwater, and recycling or reusing it appropriately. For example, in Chandigarh, India, public parks are irrigated using rainwater collected from the roads via stormwater pipes. In many other cities of India, public buildings have been mandated to practise rooftop rainwater harvesting.

Many other innovative ways can help cities harness stormwater depending on their geography and the needs of the residents.

Recycle and Reuse

There needs to be a greater focus on the use of recycled water. In water-scarce countries like Israel, water supply and conservation are a matter of national security. Israel's water treatment captures nearly 90 per cent of wastewater. The Shafdan Wastewater Treatment Plant near Tel Aviv serves a major portion of the nation's agricultural water needs by covering over 50,000 acres of land.

Water is essential to architecture and built infrastructure, giving us immense scope for practising water conservation during the building design and execution stages. Some buildings like Microsoft's upcoming campus in Silicon Valley are targeting zero water. A net zero water building (or campus) completely offsets its water uses with alternative water, and water returned to the original water source. Wastewater, like grey water, air-cooling condensate, rejected water from water purification systems, etc., can be treated and recharged. Stormwater can also recharge the original water source through green infrastructure.

Toilet-to-Tap: Recycle Blackwater

Water agencies can reuse highly treated effluent from municipal wastewater or resource recovery plants as a reliable, drought-proof drinking water source. Advanced purification processes allow wastewater to be treated to meet all applicable drinking water standards. Singapore's stringent policies encourage national-level conservation measures, including recycling blackwater to potable standards under the NEWater programme.

Supply Management

Proper supply planning and management involve planning water allocation for industry, farms, and domestic uses such that the domestic user is not water stressed.

Water supply should be made available at nominal charges but it must be metered too, so that water consumption patterns can be tracked and allocations revised, if necessary.

Australia follows a system of water pricing. This has helped implement measures that have drastically reduced business and residential water use. It has been observed that metering water usage encourages people to use it judiciously. Supply lines should be frequently checked for leaks or faults and rectified immediately, if needed.

Covered water supply and storage systems would lessen water wastage via evaporation. During the 1980s, the Massachusetts Water Resources Authority (MWRA) took active steps to fix leaking pipelines to reduce the water supply losses in Boston. These

» **Figure 3** Singapore ensures reclaimed water meets potable standards

Source Chris Hamby

early efforts paid off over the long run too, and despite a rising population, the city's water supply has stayed significantly low ever since.[6]

California, for instance, has mandated the use of low-flow fixtures in buildings. Some states have even adopted outdoor water-scheduling methods. City councils can also offer rebates and other incentives for replacing lawns with water-efficient landscaping to cut down on outdoor water use. For example, Dallas permits two watering days in a week.

Conclusion

Water binds all aspects of life. With its supply facing a crisis of epic proportion, governments, international agencies, local communities, and citizens must work together to help realize the goal of universal access to water. There is a growing need for sensitizing everyone on the need for water conservation so that our successive generations have access to adequate resources of clean water. □

[6] Laskey, Frederick A. 2014. 'A History of Boston's Water System'. Massachusetts Water Resources Authority (MWRA).

SUPER SPECIALTY BLOCK ANNEX AND SCREENING OPD BLOCK,

JIPMER HOSPITAL CAMPUS

PUDUCHERRY

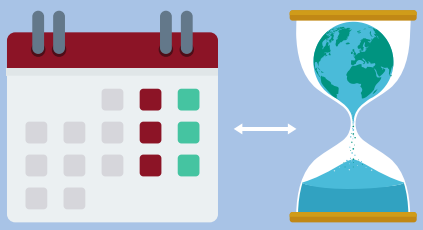
It was a delightful experience to get associated with the GRIHA team for our prestigious Government Hospital project in JIPMER Campus, Puducherry. Under the guidance of the GRIHA Council's officials and our expertise in the field of green building consultancy, we were able to achieve 64 per cent energy savings from the benchmark and 62 per cent reduction in potable water consumption.

With the expert advice from the GRIHA Council and the integrated approach adopted by our design team, we were able to achieve a landmark milestone of a provisional "4-star" rating against the targeted provisional "3-star" rating. Unlike other rating systems, the GRIHA rating prescribes three mandatory site visits by the GRIHA team, during which it really handholds the project team to weigh the sustainability quotient at each stage of construction. The GRIHA team took on an important role in explaining the benefits of implementing cost-effective sustainable measures on-site, and the expertise of Common Entrance Examination for Design (CEED) helped to take a lot of proactive decisions in resolving the design and construction-related challenges. We are indeed very proud to say that our project, Super Specialty Block Annex and Screening OPD Block, JIPMER Hospital Campus, has received a provisional "4-star" GRIHA rating.

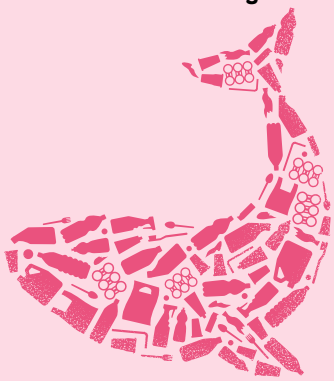
Shashwat

INFO-BYTES

If earth's history is compared to a calendar year, we, the humans have existed for 23 minutes and have used 33 per cent of earth's natural resources in the last 0.2 seconds



90 per cent of plastic polluting our oceans is carried by just 10 rivers. Eight of these rivers are in Asia: the Yangtze, Indus, Yellow, Hai He, Ganges, Pearl, Amur, and Mekong. Two of the rivers can be found in Africa: the Nile and the Niger



Every year we dump a massive 2.12 billion tonnes of waste. If all this waste was put on trucks they would go around the world 24 times

Switching from font

'Arial' to

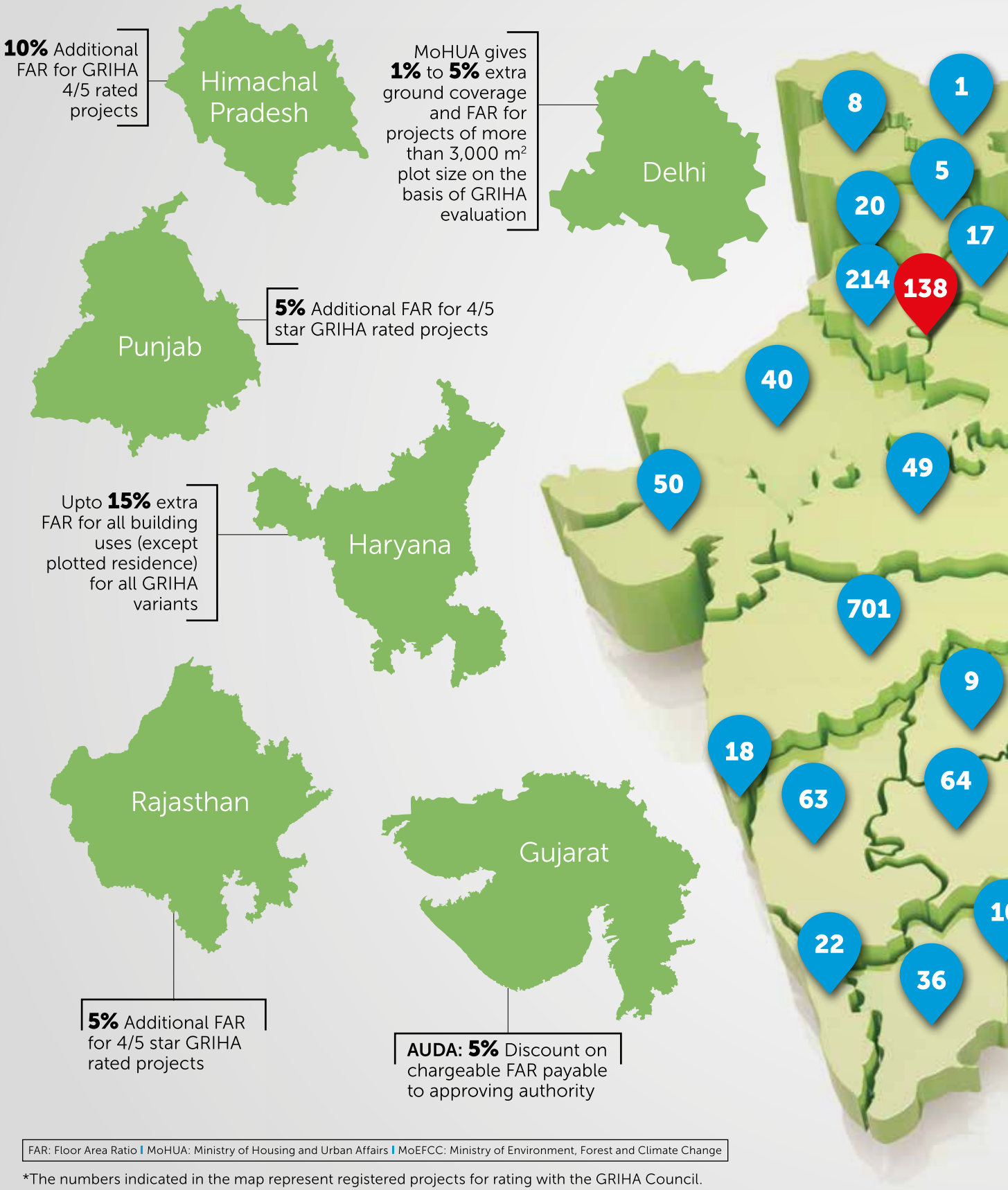
'century gothic'

Saves 30% ink on printing.

It takes more energy to make 1 kg of paper than 1 kg of steel

Up to 90 per cent of the materials used in a mobile phone can be recycled

GRIHA PROJECTS' UPDA

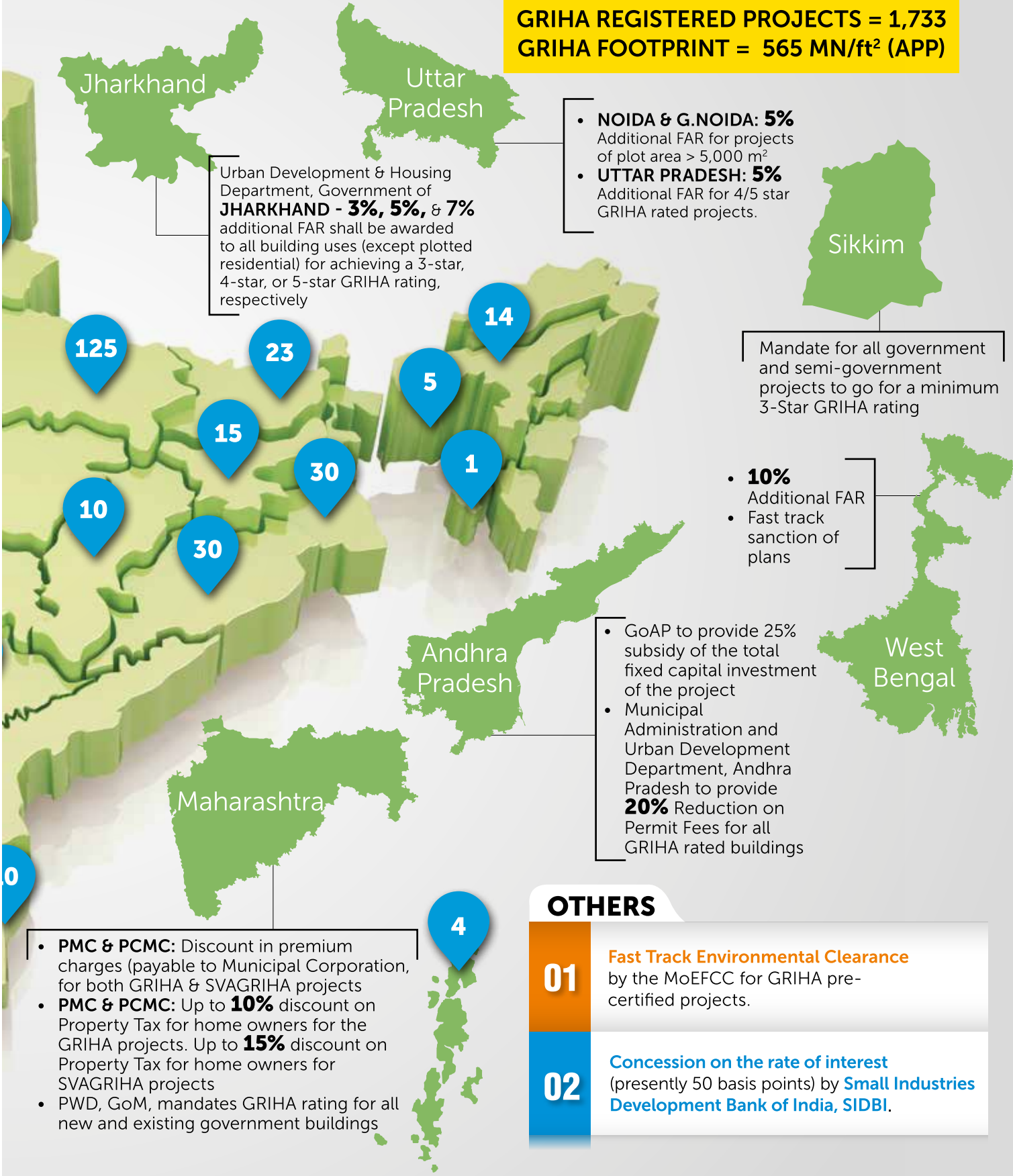


FAR: Floor Area Ratio | MoHUA: Ministry of Housing and Urban Affairs | MoEFCC: Ministry of Environment, Forest and Climate Change

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

TE & LINKED INCENTIVES

GRIHA REGISTERED PROJECTS = 1,733
GRIHA FOOTPRINT = 565 MN/ft² (APP)



Urban Development & Housing Department, Government of **JHARKHAND - 3%, 5%,** & **7%** additional FAR shall be awarded to all building uses (except plotted residential) for achieving a 3-star, 4-star, or 5-star GRIHA rating, respectively

- **NOIDA & G.NOIDA: 5%** Additional FAR for projects of plot area > 5,000 m²
- **UTTAR PRADESH: 5%** Additional FAR for 4/5 star GRIHA rated projects.

Mandate for all government and semi-government projects to go for a 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
- Municipal Administration and Urban Development Department, Andhra Pradesh to provide **20%** Reduction on Permit Fees for all GRIHA rated buildings

- **PMC & PCMC:** Discount in premium charges (payable to Municipal Corporation, for both GRIHA & SVAGRIHA projects
- **PMC & PCMC:** Up to **10%** discount on Property Tax for home owners for the GRIHA projects. Up to **15%** discount on Property Tax for home owners for SVAGRIHA projects
- PWD, GoM, mandates GRIHA rating for all new and existing government buildings

OTHERS

01 **Fast Track Environmental Clearance** by the MoEFCC for GRIHA pre-certified projects.

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

Revolutionary Eco-friendly Solutions for Affordable and Sustainable Houses

Globalization and modernization have serious effects on our environment. The construction sector, which is the backbone of housing societies, is undergoing significant changes and adopting sustainable ways of creating housing options. An energy-efficient initiative that has worked towards contributing to green buildings is APNA GHAR. In this article, **Prakash Jaiswal, Vikas Thakur,** and **Surbhi Sumedh Tankhiwale** discuss the ways that models like APNA GHAR adopt to build affordable, comfortable, and safer houses through innovative architectural practices for the economically weaker sections in the society.

Prakash Jaiswal *is the innovator and founder of APNA GHAR, a start-up, that provides innovative architectural services and housing facilities to people belonging to the economically weaker sections. He has a vast experience in the field of constructing green buildings. He can be reached at apnaghar1963@gmail.com.*

Vikas Thakur *is a structural consultant with APNA GHAR. He is pursuing a PhD from Visvesvaraya National Institute of Technology (VNIT), Nagpur, in earthquake resistance techniques. He did his Master's in structural engineering and psychology (counselling). He has a work experience of more than 10 years. Earlier, he has worked as the head of the department and assistant professor in engineering colleges in Nagpur. He can be reached at vikasmsthakur@gmail.com.*

Surbhi Sumedh Tankhiwale *is a civil engineer, who works as a project coordinator with APNA GHAR. She has done her Master's in construction technology and management from Rajiv Gandhi Technical University, Bhopal. She has trained with GRIHA, and is passionate about working in the field of green and sustainable development. She can be reached at surbhitankhiwale1102@gmail.com.*

Introduction

With the rapid development of the human race, our environment seems to be the first recipient of all its good and bad effects. In many cases, it is evident that the negative effects outweigh the positive ones. Due to modernization, construction work has increased manifold leading to tremendous progress in human comforts, safety, and indoor surroundings. The primary raw material used in construction is concrete. Cement is a non-biodegradable and fine material, which is consistently polluting the environment and its disposal poses a serious challenge. Urban heat island effect (UHIE) is an additional bad effect of concrete, which is common in cities. Cement has a tendency to release heat (from a heated construction system) to its surroundings.

In a conventional method of construction, water requirement is another big challenge. Globally, 50 per cent of fresh water is consumed by the construction sector. Approximately, one tonne of steel uses one–two lakh litres of fresh water. Hence, green buildings or sustainable or high-performance buildings were introduced to mitigate such problems of pollution and generate innovative solutions to save the environment. A lot of technological advancements have been introduced in the field of housing market, and substantial expenditure has been done for improvements but nothing seems to have fixed the housing crisis and the basic problem of affordability yet. APNA GHAR is a construction firm, which is continuously trying to provide eco-friendly, sustainable, and cost-effective houses.

APNA GHAR: Towards a Sustainable Approach

APNA GHAR is a Nagpur-based construction company, a start-up, which has taken an initiative to create eco-friendly, sustainable, and affordable houses for societies, without any negative impacts on the surroundings, under PMAY (Pradhan Mantri Awas Yojana). Such a construction system is a load-bearing structure in which only approximately 20 per cent concrete and steel are used. This construction system is primarily made up of Porotherm (clay) bricks and ISMB (Indian Standard Medium Weight Beams) that have a lifespan of close to 150 years. Porotherm blocks are hollow and thermally insulated, with a compressive strength of more than 12 MPa. These are lightweight with a weight density of 10.5 kN/m^3. With this green building material, (G+3), floors can be made easily and can be reached up to (G+4) level structures.

The main objectives of APNA GHAR are:

- Provide affordable and sustainable houses, which are eco-friendly and easy to construct, to the financially poor sections who cannot afford professional services
- Save environment by conserving natural resources

The design solutions adopted by APNA GHAR are:

- Sustainable, eco-friendly, locally available, cost effective, less time consuming, less skilled labour use
- Provide thermal and acoustic comforts
- Pocket friendly (post occupancy)
- Contribute to reduced emission of CO_2 and carbon footprint to control global warming
- Has a provision of earthquake resistance

APNA GHAR's Innovative Construction System

This construction system is significantly different from the conventional construction system. Here, Porotherm blocks are used for masonry works, ISMB sections for filler slabs, reinforced concrete (RC) bands for earthquake resistance, and gypsum punning, among others. The construction system is broadly explained in the later segments.

Foundation

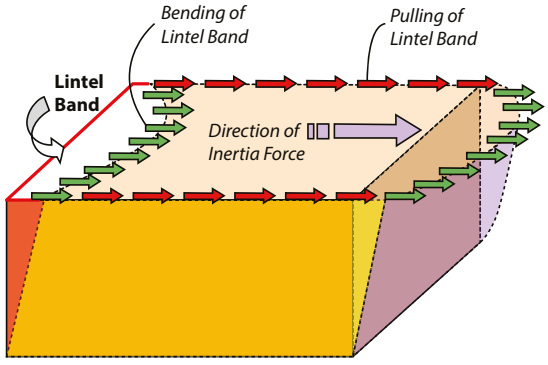
The foundation of any building should be strong and in order to support the superstructure, an appropriate type of foundation must be selected. Figure 1 shows how the foundation is similar to, yet different from, the conventional building system.

» **Figure 1** Foundation work of APNA GHAR construction system

Brickwork and Columns

Special HP (horizontally perforated) blocks which are made up of pure clay, are used to construct columns. Figure 2 shows how these columns are reinforced with four steel bars. Reinforcement is not required for static gravity loads but offers resistance against the possibility of lateral earthquakes and wind forces. The column extended above the ground level from foundation is surrounded by brickwork of vertically perforated Porotherm blocks. Since the appearance of these blocks is beautiful, these are not plastered.

» **Figure 2** Brickwork and columns of APNA GHAR construction system



» **Figure 3** Reinforced concrete bands at lintel level for earthquake resistance

RC Bands at Lintel Level for Earthquake Resistance

The continuous horizontal RC (reinforced concrete) bands are provided at the lintel level over inner and outer walls to offer resistance against dynamic loads, as seen in Figure 3. They protect the building against the threat of an earthquake. RC bands run all over the periphery of the house at a lintel level.

Staircase

The staircase is designed in a manner that it does not require Reinforced Cement Concrete and shuttering. The steps are made up of well-dressed kadappa stones of appropriate size. These stones as shown in Figure 4 are supported by the help of ISA (Indian Standard Angle) of appropriately designed property on masonry. It is durable, non-slippery, has an attractive look, fine finish, can be cleaned easily, is smooth textured, and its maintenance is easy as well. Moreover, such a staircase is an economical option over the conventional one.

Slabs

Porotherm bricks of 4″ x 8″ x 16″ size are used as filler and the upper layer of the slab (2.5″) uses RCC material in order to make it watertight and to offer a wearing coat. As shown in Figure 5, ISMB (sizes are selected as per design calculations) sections are used

» **Figure 4** Staircase made up of kadappa stones

» **Figure 5** Slab work with ISMB and Porotherm bricks

for supporting these slabs. The Porotherm blocks make them thermally insulated. Use of these slabs in a building gives respite to those living in hot regions where temperatures reach 50°C. Figure 6 shows some finished houses by APNA GHAR.

Cost, Construction, and Duration

It is a very cost-effective construction system (1 BHK configuration of 321 ft^2 costs around 3.25 lakh). This system is used to construct houses according to the affordability of EWS (economically

weaker sections). Models like APNA GHAR have shown their keenness to cater to the needs of those belonging to the weaker economic sections. For example, if one has a budget of two lakh rupees, the organization will customize and try to construct the house within an area of 200 ft^2.

As shuttering is not required and there are no conventional RCC members, the time required in such a construction system is very less. For instance, a flat with a 2 BHK configuration can be completed within 40 working days.

Salient Features of APNA GHAR Construction System

1. Expensive building materials like cement, sand, and steel are used in a limited quantity, only up to 20 per cent. Since shuttering is not required, the total construction cost is cheaper than the conventional construction system, ensuring affordable houses for EWS
2. Uses low embodied energy, fire-resistive and low-cost green building material called Porotherm blocks (terracotta clay blocks), which reduce UHIE from all five sides of the structure
3. Since no curing is required and only 20 per cent RCC is used, water required for concrete is saved, resulting in considerably less water consumption.
4. No waste production
5. No cement pollution
6. No noise pollution
7. Provides thermal comfort to occupants.
8. Eliminates dependency on air conditioners and coolers, which in turn reduces electricity cost considerably. Hence, this system is energy efficient
9. For earthquake resistance, a continuous RC band is provided at a lintel level. Lightweight hollow blocks are used to attract less inertia force and prevent loss of lives
10. Less duration and skilled labour are required in constructing this system

» **Figure 6** Finished houses by APNA GHAR

Affordable Housing for South Asian Countries: An Eye-Opener

This study attempts to provide dignified and most eco-friendly houses to poor and marginal people of not only India but also across other South Asian countries grappling with the same problem. If we do not take this seriously, by 2040, 60 per cent population of India will live without their own houses. Mainstream construction professionals have still not taken any positive and effective initiatives towards EWS. This technique is simple, modular, and unbelievably fast that it can be replicated in large numbers. This technology reduces the consumption of natural resources including sand, cement, steel, and most importantly, water. The conventional construction system consumes 50 per cent fresh water and it contributes to releasing CO_2 in the environment. It is a bitter truth and an eye-opener that our rivers are in danger. If proper measures are not taken to keep the threat of sand mafia under check, successive generations will struggle to get drinking water. Through this system, excellent thermal insulation can be achieved; it reduces electric consumption by 30–40 per cent and results in less dependency on air conditioners and coolers.

It is an appeal to our government that we should work towards making this construction system popular among societies, especially among EWS and financially less stable groups, for a better housing future. □

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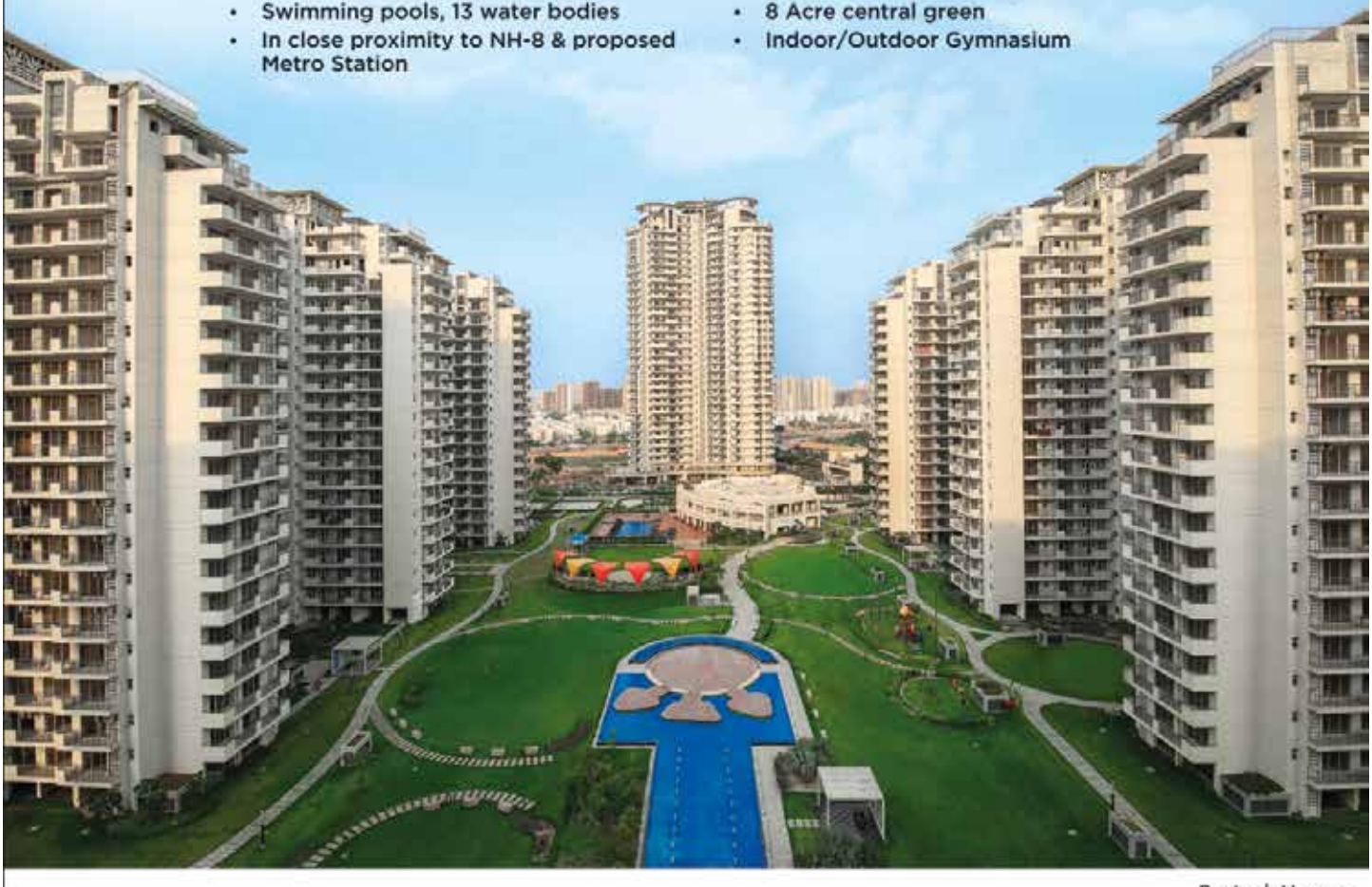

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Green Revolution 2.0: Aspiring for a Greener Future

Climate change is a global challenge that poses a serious threat to our environment. Food wastage is one of the daunting concerns that India is battling today. The level of carbon in the atmosphere is rising, and we must adopt sustainable ways to combat the ill effects of carbon footprint and waste generation. **Abhishek Pathade** and **Rupak Bose** discuss how important it is to start taking baby steps towards meeting the holistic goal of a greener future instead of depending only on the government, and its policies.

Abhishek Pathade *is a civil engineer and has a postgraduate degree in advance construction management from National Institute of Construction Management and Research, Pune. He is currently working with GRIHA Council as a project officer in the western regional office.*

Rupak Bose *has a BTech from Visvesvaraya National Institute of Technology (VNIT), Nagpur, and is currently pursuing a Master's degree at Centre of Studies in Resources Engineering, Indian Institute of Technology, Bombay. His areas of interests include sustainable development, mineral economics, and tool development for pattern recognition.*

The current environmental scenario, coupled with major global challenges such as climate change and resource management, calls for a collective contribution towards optimization. The government and its policies play a role as important as the efforts by the citizens in tackling serious environmental concerns. As the saying goes, "Little by little fills the pot", everyone's efforts, no matter how small, if channelized towards the right direction, can bring about significant change.

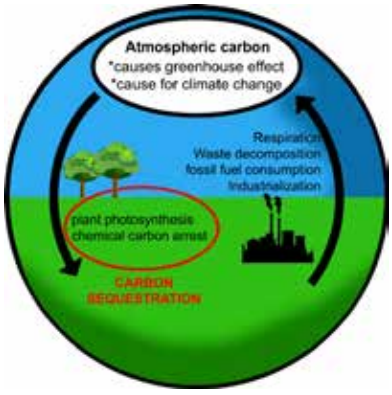
At one end of the spectrum, millions go to sleep with empty bellies; on the other hand, tonnes of wasted food end up in the dumping grounds. While many struggle in the aftermath of floods, acres and acres of land lay barren due to lack of water. These are some of the problems being faced by the one of the fastest growing economies of the world. On a careful inspection, we realize that some of these problems have solutions within them. In India, about 67 million tonnes of food is wasted every year. This wasted food releases methane (GHG) in the atmosphere and occupies space in the landfills, instead of feeding hungry mouths. Mumbai generates about 9,400 metric tonnes of solid waste a day of which 73 per cent comprises food, fruit and vegetable-

related waste.[1] Similar problems are faced by other cities too.

Before examining green buildings and carbon footprint reduction, we need to understand why we have to remove carbon from the atmosphere and bind it to the ground, a process also known as carbon sequestration, as shown in Figure 1.

Carbon cycle is the biogeochemical cycle in which carbon is exchanged between the biosphere, atmosphere, and hydrosphere. These spheres act as carbon reservoirs. The major cause of global warming is the carbon present in the atmospheric reservoir. By analysing the air bubbles trapped in ancient ice, it can be seen that current levels of CO_2 are 414.7 ppm, whereas the millennial high was around 300 ppm (around 38 per cent higher).[2] The dependence on fossil fuels to meet our needs for electricity, transport, and many of our daily activities contributes to the increase of carbon-based compounds in the atmospheric reservoirs.

The method by which carbon can be reduced from the atmosphere is called carbon sequestration. The oceanic reservoir is the biggest carbon holder, followed by the biosphere and atmosphere. Carbon sequestration in the oceans is aided by the fast growth of seaweeds and phytoplankton. Recent estimates have calculated that 26 per cent of all the carbon released as CO_2 from fossil-fuel burning, cement manufacture, and land-use changes over the decade (2002–2011), was absorbed by the oceans.[3] Also, CO_2 readily dissolves in water, and oceans contain a large volume of water. However, in the biosphere, the easiest process for carbon sequestration is strategic planting of tress, which help bind the atmospheric CO_2 to the biosphere. Also, an increase in



» **Figure 1** Carbon cycle

recyclability, and shift to renewables can reduce the carbon emission in the atmosphere.

These processes must go hand-in-hand with what is called the retention period of a reservoir. The average time CO_2 stays in the atmosphere ranges from 50 to 200 years. The higher time CO_2 spends in the atmosphere contributes to a higher heat-trapping impact. Therefore, an increase in the sequestration process could considerably reduce carbon emissions in the atmosphere.

In order to tackle the negative effects of climate change, we can take steps either as an individual or as a community.

Green buildings ca not be truly green until the people residing in them adopt steps to reduce their carbon footprint which are as follows:

Zero-waste Kitchen

About 40 per cent of the food produced in India gets wasted.[4] It amounts to 32 per cent of freshwater used for food production, around 300 million tonnes of oil, and land equivalent to 24.28 per cent, and the greenhouse gases released in the atmosphere add to the true cost of food wastage. However, in order to aid in carbon sequestration, we can follow a few simple steps like preventing food wastage by not consuming more than we actually need, segregating waste, composting, and so on.

A Responsible Wardrobe

A green wardrobe is a closet from where nothing goes into the landfill after the end of a cloth's life cycle. These clothes are made of fibres that do not require pesticides for growth, thereby making them eco-friendly during production. As these fibres are not blended with polyester, they are naturally biodegradable after their life cycle. For a sustainable future, we must buy less, choose well, and make our clothes last longer.

Trees as Temperature Regulators

A planned placement of trees around an apartment can help reduce the temperatures up to 5°C during peak summers through evapotranspiration and shading. As per Bureau of Energy Efficiency, the energy saving of 6 per cent per degree is achieved through air conditioning. So, an effective utilization of trees to regulate temperatures can bring about 24 – 30 per cent in energy saving which in turn can reduce CO_2 emissions by 8.2 million tonnes per year.[5] Small gardens in apartments can purify the air, and improve the overall ambience in the house.

Community Responsibilities

The concern of global climate crisis can be effectively addressed through community mitigation efforts and measures. The government can play a game-changing role by creating policies after taking into account the carbon footprint. A major overhaul is the need of the hour where carbon

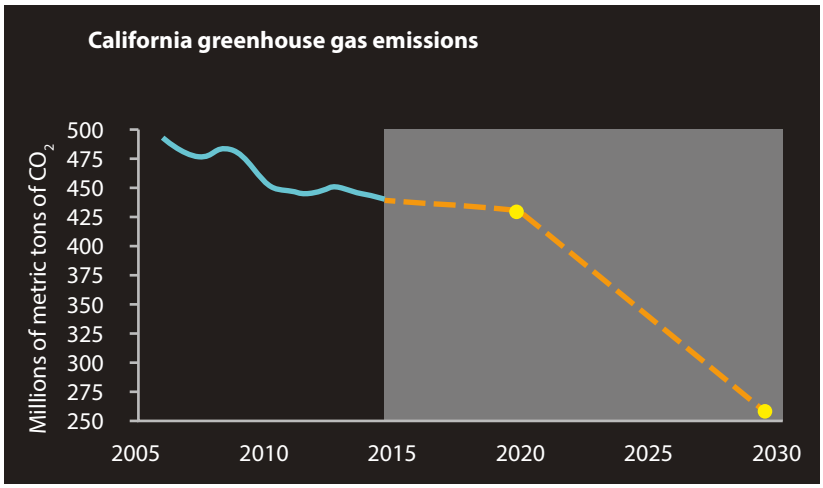
[1] 'Food wastage crisis in India'. 2018. Clean India Journal. Retrieved from https://www.cleanindiajournal.com/food-wastage-crisis-in-india/; last accessed on October 21, 2019.

[2] Retrieved from climate.nasa.gov; last accessed on October 21, 2019.

[3] The Global Carbon Budget (1959–2011).

[4] 'Food Wastage In India, And What You Can Do About It'. 2018. CSR Journal. Retrieved from https://thecsrjournal.in/food-wastage-in-india-a-serious-concern/; last accessed on October 21, 2019.

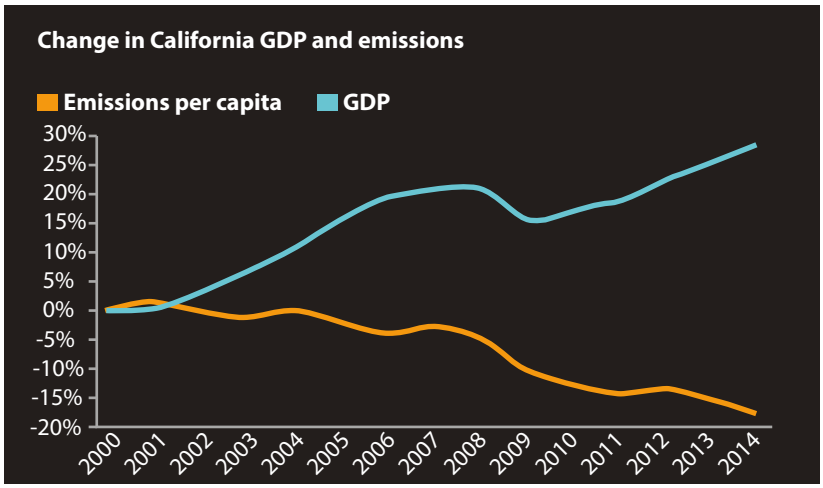
[5] Press Information Bureau, GOI, Ministry of Power. 2018. Retrieved from https://pib.gov.in/newsite/PrintRelease.aspx?relid=180281; last accessed on October 21, 2019.



» **Figure 2** Analysing greenhouse gas emissions
Source: California Air Resources Board

neutral and carbon-negative processes are duly awarded, and responsibilities for mitigation are thrust on those industries employing carbon-positive processes instead of the government and the consumer.

Many nations are experimenting with their policies on controlling carbon emissions. One of the ideas is to put a price on carbon emission beyond a reasonable limit. Initially, it could seem that it would decrease the economic growth by limiting the production capacities. However, this practice would eventually encourage industries to adopt more carbon neutral or carbon-negative processes. This in turn would create more jobs opportunities for the newly emerging industry process, thereby, giving a necessary impetus to the economic and overall hope of a greener future.



» **Figure 3** Effects of greenhouse gas emissions on GDP
Source: California Air Resources Board

Figures 2 and 3 indicate how the economic and environmental scenarios have changed over the last 14 years, and analyse the rate of reduction in greenhouse gas emissions. After California introduced a carbon cap, there was a significant decrease in greenhouse gas emissions per capita of about 15 – 17 per cent. However, this policy did not discourage the overall economic growth of the state. This is supported by the fact that the GDP increased by about 25 per cent during the same time period.

Right now, going green is the only possible way to achieve a sustainable future. We need green citizens, who are aware of their responsibilities and can actively take conscious decisions to reduce the carbon footprint. Also, encouragement and incentives for going green, no matter how small, will help in realizing our goals for sustainable development. The future does have potential in yielding high economic and socio-economic growth prospects if the "going green" industry gets enough traction. All of us should work tirelessly towards developing a country by carefully balancing environmental sustainability with social development, economic growth, and cultural preservation under good governance. This should be our ultimate holistic goal. ◻

Reduce, Reuse and Upcycle – for a Rustic Dining Experience

Creating an eco-friendly space is essential and crucial today especially when environmental hazards are on the rise. How should we ensure sustainability in the interior design industry? In this article, **Ar. Sonali Walimbe** and **Ar. Shantanu Chitgopkar** discuss the benefits of adopting ways of reusing, reducing and upcycling in interior designing and architectural practices. They focus on how Jaafna and Chef Plated in Manipal are eco-friendly restaurants that are leading by example in their initiative to create a sustainable environment for diners.

Introduction: Designing Eco-friendly Spaces

With environmental issues at the forefront, we need to reduce emissions, prevent pollution, check waste generation, control energy use, and incorporate these as core principles of daily activities. Today, people mostly prefer to stay indoors. Hence, these spaces must be comfortable and aesthetically pleasing for the inhabitants. Spaces have a psychological effect on our minds, be it positive or negative. Interior designers and architects are professionals who help make these spaces desirable and tasteful. In a way, they contribute to societal transformation. In the past, such professionals focused more on visual enrichments for their clients. They often overlooked the aspects of energy conservation, environmental pollution, effects of materials on people's physical, and mental health.

Environmental sustainability requires a significant change in values, attributes, and behaviours among interior designers. As a recent development, architects and interior designers have shown an evident shift in their design strategies that promise to focus on creating healthy and sustainable environments for people. Sustainable interior design creates and expands this focus to include environmental considerations by selecting materials that have less harmful impact on the environment, and reduce energy consumption, pollution, and waste. Sustainable interior designers are trying to find various ways and solutions to balance aesthetics and functionality with choices that reduce the possibility of environmental hazards.

Today, our society has become more responsible and it also recognizes the relationship between the built environment and the communities using these spaces. They are aware of the benefits of creating environmentally responsive buildings and surroundings. General awareness about climate change and environmental responsibility motivate people to opt for sustainable interior design. Clients too have begun to understand their role towards environment and society. As responsible citizens, they look for interiors that exhibit sustainability in their designed spaces.

A restaurant is one of the most visited and enjoyed spaces. For most

Ar. Sonali Walimbe *is a professor at Manipal School of Architecture and Planning, MAHE, Manipal. She has a master's degree in interior design from JNAFAU, Hyderabad. As an interior architect, she has worked on various architecture and interior design projects ranging from residential, commercial, healthcare, etc. As an academician for the past nine years, she strives to bridge the gap between theory and practice by giving practical exposure to her students. She can be reached at Sonali.w@manipal.edu.*

Ar. Shantanu Chitgopkar *is an associate professor at Manipal School of Architecture and Planning, MAHE, Manipal. He has a master's degree in advanced design from MSAP, MAHE, Manipal. He has worked on various architecture and interior design projects ranging from residential, commercial, healthcare, industrial and hospitality. As an academician for the last five years, he teaches students about the building services while explaining their importance in each project. He can be reached at Shantanu.c@manipal.edu.*

people, restaurants are about more than just good food. In addition to the aspects of lighting and staff service, a restaurant's ambience plays a vital role in enhancing the pleasure of dining. Restaurants and cafeterias are spaces where people unwind and relax after a hard day's work. Moreover, restaurants, by using recycled material for their interiors, can display the various ways of conserving the environment. Restaurants are subject to more frequent interior renovations than other workplaces or residential spaces. Choosing the right furniture is a major component of interior design that lends an identity to a space. These days, more and more restaurants are consuming a lot of resources in the form of furniture, finishes, and a variety of building materials. This article attempts to put forth an approach to restaurant design that demonstrates the practice of reuse and reduce, along with the concept of upcycling, which requires low-energy input and can eliminate the need for new products. Two specific case studies suggest different ways of reuse, reduce and upcycling, and help understand their effects in order to achieve functional and sustainable interiors.

Sustainability in Interior Design Industry

Sustainable design demonstrates the social, environmental, economic values of a product.[1] Furniture designed to be sustainable most of the time may use materials that include recycled content, produced from either industrial or post-consumer waste. Using recycled materials helps decrease the depletion of natural resources, thereby reducing damage to many thriving ecosystems in the world. These materials require little processing and aid in energy conservation.[2] Upcycling, on the other hand, is a very specific form of recycling that turns waste into a material or product that is of a higher quality. Upcycling does not require the product to be sent to a recycling centre to be broken down.

[1] Yüksel, E., and Kiliç, M. 2015. Eco-friendly approach in furniture design. Retrieved from https://pdfs.semanticscholar.org/4309/314f900162ffd5732d0b6a2b6dd7339d432c.pdf; last accessed on September 24, 2019.

[2] Sung, K., Cooper, T., and Kettley, S. 2014. Individual Upcycling Practice: Exploring the Possible Determinants of Upcycling Based on a Literature Review – Kyungeun Sung, April 2016.

Jaafna, Vidyaratna Nagar, Manipal, Karnataka 576104

» Reused glass bottles not only add colour to the interiors, it also helps the owners save money on the purchase of new lights

Thus, the concept of recycling and upcycling can be used in the interior design industry to achieve sustainability.

Concept of Upcycling

Upcycling, a form of recycling, involves turning waste material or an unwanted product into a better quality product. The word 'upcycling' is a mix of 'reclassification' (adding value) and 'recycling' (reuse). Upcycling is 'the creation or modification of any product from used materials, components or products to generate a product which is of an equal or a higher quality or value than the compositional elements.'[3] This saves the energy cost of recycling process and thus, the overall product cost. The purpose of upcycling is to reduce waste and improve the efficiency of resource use. Some of the benefits of upcycling are:

1. Minimizes the volume of unwanted materials and waste being sent to landfills each year
2. Decreases the demand for new or/ and raw materials
3. Reduces air pollution, water pollution, and greenhouse gas emissions

[3] Sung, K. 2017. Sustainable production and consumption by upcycling, May 2017.

The concept of upcycling gives interior designers the opportunity to use tonnes of waste to create a space in a sustainable way. Using discarded objects as raw material cuts down on the waste from the production process.

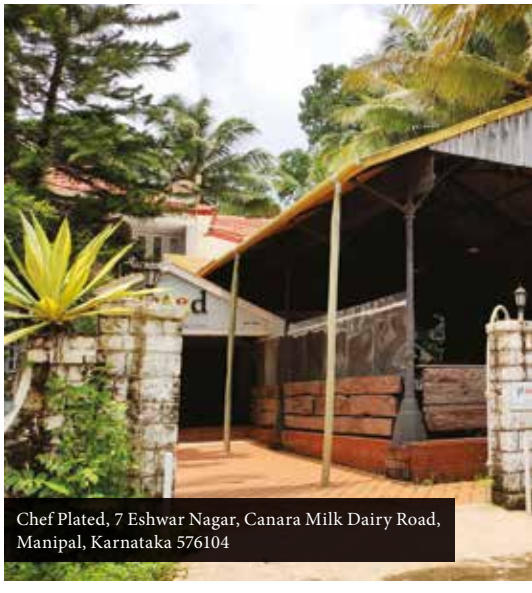
Designing Restaurant Interiors the Eco-friendly Way

As previously discussed, furniture gives character and identity to a particular space. In case of a restaurant, it also conveys its theme. Furniture must fulfil the attributes of function, ergonomics, cost, durability, materials, texture, and harmony for the space it has been used. Lighting is another important element that adds to the aesthetic charm of a restaurant. Curtains, window filters, fixtures, light bulbs, colour schemes, and positioning contribute to the thematic essence of the restaurant. The drive and intent of using upcycling as a concept need not always be out of respect for the environment, it could be out of a sense of attachment towards the product, an aspect of saving money or as an act of responsibility towards society.[4]

[4] Sung, K. 2015. A review on upcycling: current body of literature, knowledge gaps and a way forward, 17(4): 28–40.

Case Studies

Two significant case studies from Manipal, the educational hub, tell us more about the success of the concept of reuse and upcycling for restaurant interiors. They show different ideas for



Chef Plated, 7 Eshwar Nagar, Canara Milk Dairy Road, Manipal, Karnataka 576104

reusing materials considered waste. As an economic move, this concept saves restaurateurs from spending on elaborate interiors and is also a step towards achieving sustainability.

Both these case studies prominently showcase the concept of reducing and upcycling. The owners of these restaurants establish their responsibility toward environment conservation.

Conclusion

The benefits of upcycling can be generic than being precise and quantified. Interior designers and architects are influential people who can bring in a change in the thought process of their clients and motivate them to reuse and upcycle in their projects. Product and furniture designers can develop products and their varieties that are environment friendly. Academicians and researchers can explore social and environmental benefits through reuse and upcycling. In the longer run, we can achieve our goals by being environment friendly and taking small steps in the initial process to make our society understand the various ways and means of achieving sustainability. Using recycled materials can be a way towards contributing to our environment and demonstrating the means to achieve sustainability to our future generations. ◻

» An infested tree was cut in the neighbourhood and its trunk was used to make side tables and waste bins. The rough planks are fixed as service tables in the dining area. The scaffolding logs have been used to make the verandah railing

» An example of adaptive reuse (residence converted to a restaurant) – using reclaimed wood and elements from old decrepit structures

» Glass bottles from scrap vendors have been used to make a partition wall that conceals the washing area from the dining space. Such a move helps in overall cost reduction and conserving materials like brick and cement

The authors would like to acknowledge and thank the owners of Jaafna and Chef Plated, Manipal, and Eren Burak Kuru, an IAESTE intern from MEF University, Turkey, for helping with the case studies.

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Propagating Sustainability Through Mega Structures

The trend of constructing green buildings has assumed more prominence in India than ever before. Creating a sustainable environment for city dwellers is the need of the hour. In this thought-provoking article, **Charanjit Singh Shah** discusses four major case studies in India that can motivate architects to aspire for a future that is built on the aspects of innovative practices without discarding the effectiveness of traditional ways of constructing buildings. The author further elaborates on the ways architects can act as responsible agents of environment conservation without any compromise on sustainability.

Professor Charanjit Singh Shah *is an architect, planner, and infrastructure expert with five decades of practice. He is an author, educationist, a scholar, teacher, and an art and architecture critic practicing sustainable green architecture. His significant works include mega projects like airports, metro, railway stations, transit orient development, inter modal hub, and creating Indian sustainable smart cities of tomorrow. He has served as a professional advisor to various organizations and was also the chairman of Indian Institute of Architects (IIA) and SAARC. Recepient of many awards for his outstanding contribution including the National Unity award in 1995, and CBR Global Transport Engineering Lifetime Achievement award in 2014, he can be reached at* ***pr@creativegroup.co.in.***

During the past decade, massive urbanization has led to a manifold increase in the dependency on energy resources. As architects, we face a lot of challenges to create structures that are aesthetically appealing, technologically advanced, and commercially and financially feasible. This, sometimes, leads to a compromise in striking a balance between efficient management of resources and construction of environment-friendly buildings. When we talk about sustainability, we consider it to be a new concept, but we fail to realize that it has, in fact, been inherent in our practices ever since man began constructing shelters. Ancient civilizations like Mohenjo-daro were planned on functional drainage systems and houses with courtyards for sustainability. Later, cities like Jaisalmer used passive design strategies and water conservation extensively to make its architecture resilient against harsh climates, thus showcasing the importance of reflecting on traditional ways to increase resource efficiency and attain sustainability.

Using technological innovations to make the building "green" is often interpreted as being sustainable, but the essence of designing a sustainable building is based on its perfect harmony with nature. Designing for a "smart and sustainable future" needs an amalgamation of basic design strategies and innovative technological practices.

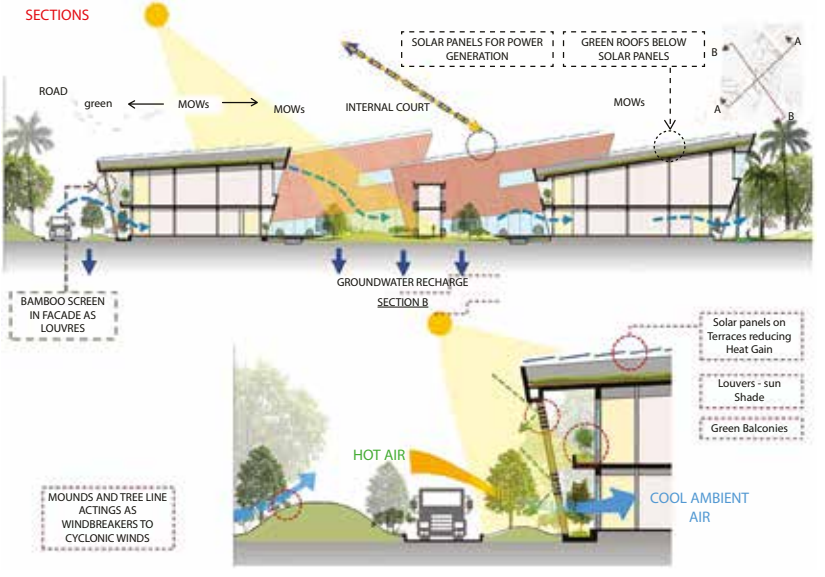
Mega structures like airports, railways, industries, and institutions are considered high-energy requirement buildings. They make use of large amounts of resources with massive ecological footprints. This is why it becomes necessary to understand how to fulfil infrastructural demands without them being a burden on our natural resources.

There are various strategies that can be used for implementing sustainability in the construction sector. Efficient resource management in terms of energy, material, water, and land, is one of the primary goals for sustainable construction.[1] Various methods to achieve this goal are as follows:

- Create a built form that uses passive design strategies like respecting the solar and wind movements
- Create an envelope of the building suitable for the desired climate
- Appropriate material application
- Employ water conservation techniques like rainwater harvesting
- Use landscaping materials, which enable ground percolation and maximum retention
- Strategic use of materials as well as structural systems that are innovative in design but reduce the usage of natural resources, thus cutting down the overall cost

As a multi-disciplinary architecture firm, we at Creative Group have tried to inculcate these practices while designing our projects. Our firm has always stood by its philosophy that "A built form should not be treated as a dead mass of brick and concrete, but as a living organism, allowing it to breathe with nature". The following case studies highlight various design strategies to create a sustainable and less energy consuming design.

[1] Akadiri, P. 2012. 'Design of a Sustainable Building: A Conceptual Framework for Implementing Sustainability in the Building Sector', Buildings, 2, 126-152. Retrieved from https://www.mdpi.com/2075-5309/2/2/126; last accessed on October 3, 2019.



Case Study 1: Amudham Dairy Complex, Erode, Tamil Nadu

Industrial buildings have always been considered the most polluting structures that demand high energy. Therefore, the main agenda for the project was to develop a design that minimizes the consumption of energy.

The built mass was oriented according to the solar movement in the north–south direction, thereby, enabling glare-free light in the processing unit and reducing its operational cost. For those areas that require constant daylight, glass blocks and polycarbonate sheets were used.

Even in terms of the structural system, an innovative roofing system of multilevel vaults was used. The non-conventional design created interest, while using the vault as a repetitive element reduced construction costs and material consumption to a large extent. The vaults range from 4.5 to 27 m, depending on the size, and enabled faster construction, with shuttering removed as early as three days, thus putting it to frequent use.

» Amudham Dairy Complex, Erode, Tamil Nadu

Case Study 2: Chennai Airport, Chennai

With the ever-increasing requirement of infrastructure, the demand for building new airports has evolved from developing them as a mode of transport to multi-functional international hubs. In such a case, it becomes a challenge to design a structure that provides global facilities and enables mass transit, while being interwoven with sustainability.

Taking forward the approach that "airports should not be energy guzzlers", the Chennai Airport is a fine example of one of Asia's largest green terminals. The terminal orientation according to the solar movement ensures shade from the direction of south and southwest, while maximizing the daylight from north. The H-shaped form of the building creates a central green spine with vertical gardens, thus breathing life into the building and clearly echoing the firm's philosophy.

Apart from using passive design features, the airport is also a technological marvel with one of the world's largest cantilever roof of 24 m. The wafer-thin flyover connecting the domestic and international terminals is supported by V-shaped columns, depicting the relation between space and built environment. The columns enable a visual connection while the innovative design saves magnanimous space. Restoration of the native landscape, passive energy conservation strategies, material selection, on-site storm water detention, and on-site wastewater treatment and dispersal systems ensure high level of sustainability in nearly every aspect of the design. Adherence to active and passive strategies is strictly followed. Bricks have been replaced with aerated autoclaved concrete (AAC) blocks which ensure thermal insulation. Besides insulating capability, AACs can be easily installed without any kind of damage.

Case Study 3: Times Square Mall, Naya Raipur

The main ideology of the project revolves around creating a commercial complex made affordable by employing basic designing principles of mutual shading and orientation so that there is minimum consumption of energy. There is no artificial cooling system employed in the building, thereby making it one of a kind commercial building fully operational on the concept of natural ventilation.

The inspiration behind the dynamic form is the traditional jaali used to create an elevation that changes with each viewing angle. It also helps in protecting the building from the heat by cooling the passing air. The built form has been simulated based on the solar movement, the highest point being on the southwest to protect it from the summer sun, giving rise to a curve that seems to originate from its surrounding landscape.

Shaded courtyards create engaging open spaces for interaction. The open space in the centre helps in channelizing the wind, thereby creating a cooling effect throughout the building. The commercial complex is also equipped with stepped terraces which give it an interesting design profile and also provides recreational areas for office spaces.

This design model aspires to cater to sustainability while keeping in mind the economic viability and commercial feasibility of the construction project.

Case Study 4: Bharat Electronics Limited, Andhra Pradesh

In an attempt to understand the need for a design that can change the face of the industrial buildings and how they are viewed, we took up an inventive project called the "Night Vision Factory" by Bharat Electronics Limited.

This project deals with balancing the active and passive strategies with the ultimate objective of developing a low-impact, carbon-neutral building.

The material usage for the factory has been consciously switched from the traditional one to AAC blocks, which increase the thermal mass of the building. This has been further amplified with the insulation of the roof using mosaic tiles and bubble foil, thereby reducing the total cooling load by 17 per cent.

Solar movement has been religiously followed in order to orient the building lateral to north–south direction, which ensures minimum heat gain and maximum daylight. Further, thermal heat gain has been reduced using locally available materials like bamboo for screening the façade. Following this basic philosophy has helped in reducing the total energy consumption due to artificial lighting by 60 per cent. The focus is not only on consuming less energy resources, but also employing non-conventional sources like solar energy that generates 35 per cent and wind energy that contributes about 2–3 per cent of the total energy consumption.

It is essential to understand that the approach to an eco-friendly design is not just limited to an intelligent use of resources but also depends on the overall planning of the site. Introducing green spaces and using green pavers for hardscape reduce heat emission and have helped in reducing the urban heat island effect. The drainage and water reservoir are also planned on the lowest point of the site in order to use the natural terrain of the site to its optimum.

Since industrial buildings are among one of the largest waste water generators, the same has been managed efficiently by using sewage treatment plant for grey water treatment and effluent treatment plant for landscape, flushing water and HVAC.

Due to an unprecedented growth in our cities, new layers of infrastructure are being added without understanding their impact on the environment. We, as architects, have to realize this responsibility and respond sensitively, using the available resources to their full potential in order to design for a better future. Through these aforementioned projects, we aim to inculcate a sustainable lifestyle among people and inspire them to design a better future. □

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Sustainability: The Only Road With a Future

The construction sector in India is undergoing significant changes in its infrastructural policies and architectural practices. However, much needs to be done to realize the successful implementation of the green building movement. **Akash Deep**, in this article, presents a strong case for doing away with installation of glass in buildings. Modernization has forced our buildings to be modelled on western designs and pushed for excessive use of glass in structures. Glass is not a feasible option for the tropical regions in India, and it is about time that we begin to rely on our ancestral knowledge, traditional practices, and cultural strength to achieve sustainability.

***Akash Deep**, B.Arch. (Hons.), from M. Arch. in Sustainable urban design and creative urban practices (Glasgow University), is working as Senior Program Manager, with GRIHA Council since September 2011. While spearheading the GRIHA Council team, supervised GRIHA implementation in various projects across the country, trained more than 10,000 professionals and students. Successfully conducted many national and international level conferences. Presented the GRIHA case at UNFCCC Bonn, Germany on recognition of GRIHA as India's own green building rating system in GoI NDCs. He has many published articles both in print and online media covering various sustainability aspects across the city level issues. Co-authored the book titled: ZEMCH: Toward the Delivery of Zero Energy Mass Custom Homes.*

Knowledge or Information?

"Knowledge is one of the biggest tools" is a very old saying that is more relevant in the modern times. With the growing and evolving IT sector, the gap between the humans across the globe have been bridged by the Internet. This has resulted in transfer of information in a split second across the world. Thanks to the Internet, there is lot of information available for us to grasp and act accordingly.

Human action is generally a result of reasoning and informed decisions. However, lately, with the vast information available to us, our impromptu reactions to certain situations can make us less reasonable. After all, it is our reasoning ability that makes us human. On the contrary, present times suggest that human nature is going against rationality.

The act of sorting information from a vast expanse, processing, and taking an informed decision, is only possible with accurate knowledge. As goes the popular adage – "The easiest and shortest path is not always the correct path".

Probably, after acquiring relevant knowledge, it will be possible for us to choose wisely. One such case, which requires our urgent attention to choose wisely and take informed decisions, is "sustainability". The term in itself has so much meaning that we must first try to understand the concept before we act. Interestingly, sustainability has always been linked with almost every aspect of our daily lives, without us even knowing how it needs to be addressed or practised.

The word *sustainability* means something that cannot end, something that can sustain, something that is unending. However, we all know that in our materialistic world, everything changes and comes to an end. So, does this mean that true sustainability is impossible? With the time passing, nothing is constant, which implies, it can either degrade or regenerate. In the present age, the concept of sustainability is no more helping in regeneration. This further suggests that, we are just trying to slow down the process of degradation. Hence, slow degradation cannot and should not be termed as "sustainable". Also, if the current path leads to an end, it is not sustainable.

How Do We Become Sustainable?

The answer lies in our ancestral knowledge and culture. With development, we are letting go of our cultural strength and increasingly becoming unsustainable in our actions. The need of the hour is to learn from our past and, with the help of modern technology, improve the current rate of sustainable growth. However, in our bid to chase the goals of development, we fall into the trap of aping other countries by making the adopted strategies non-local and unsustainable. With globalization, we try to find solutions to our problems outside our contextual area, and try to replicate and implement the learning without tailoring these solutions to our needs.

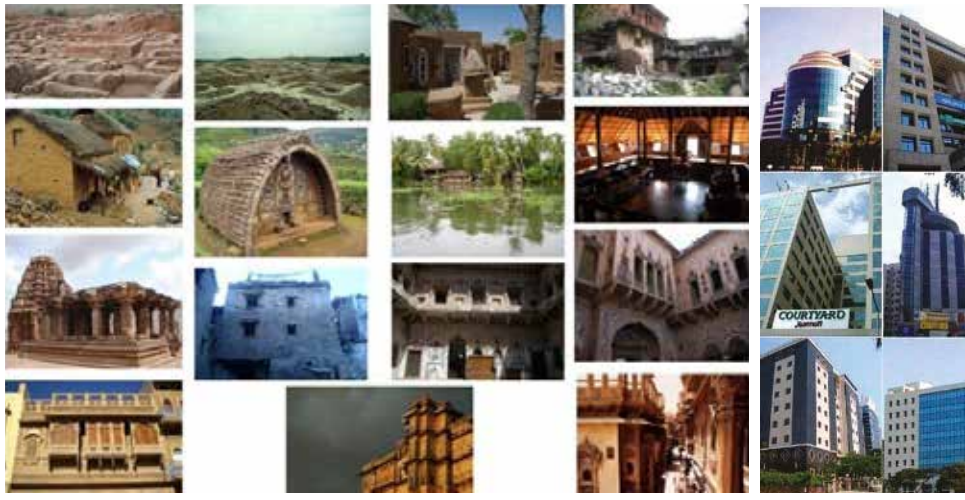
Sustainability has been the base of our culture, be it our lifestyle habits, food, buildings, choice of clothes, etc. India, being one of the biggest nations, with a diverse climate is the best example to have local but climate-responsive solutions to its environmental woes. For instance, the clothing style adopted by each region was once linked to our culture, and in turn, associated with the local climate, which facilitated ventilation during hot and dry seasons across the subcontinent and provided warmth during the cold days. Even the food habits were localized and climate responsive at the same time. Spicy and hot food facilitated perspiration and eventually cooled down the body with forced ventilation in hot and dry regions; light food with less spice in coastal regions was easy to digest and it facilitated less perspiration. The basic philosophy of life was also in sync with nature, as is evident in the saying – "Rise with the sun and sleep with the sun". Such a philosophy made our lifestyle sustainable and less dependent on unsustainable sources of energy.

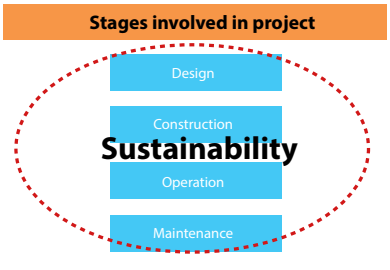
One of the most resource-intensive and most unsustainable areas, which is a result of unprecedented population growth and development, is the building sector. Our ancestral design and planning philosophies, along with judicious use of local materials reduced our demands of high embodied energy systems and materials, and provided us with the basic needs for which we made buildings: visual, thermal, and acoustical comforts. However, lately, emulating the West, as a consequence of modernization, has left us on the brink of a massive resource crunch.

The building sector majorly depends on the consumption of three primary resources, namely, energy, water, and material, and produces huge amounts of secondary resource, that is waste. If any resource is not managed and reduced properly, it will result in unsustainable development. Every resource has a key role to play if we want to move closer to our goal of sustainable development. Lately, sustainability has been linked to systems and has been commercialized. It has lost its true meaning and it contradicts the basics – "sustainable is affordable and affordable is sustainable". Today, the concept of sustainability is thought to be a costly affair. We need to understand the difference between development and planned growth if we want our future generations to survive.

Built Environment: Not a Lost Cause

Currently, the green building movement is picking up the pace in the Indian construction industry. However, the projects need to consider the affordable nature of sustainability and implement measures accordingly. While aiming for sustainability, resources efficiency is most integral part of the process. When a resource's efficiency is considered, there is always the discourse of demand and supply management. Of late, sustainability has been linked to more of supply management than demand reduction. For both energy and water resource efficiency, it is imperative that we start reducing our demands and post reduction, mitigate them through reasonable use of sustainable sources like wind, solar, biogas, etc. in case of energy, and treated wastewater and rainwater in case of ensuring water resource efficiency.





Sustainability in a project cannot be instantaneous; it is a life cycle commitment. In regard to buildings, it starts from design, continues through the construction phase, and is maintained during operation and maintenance phase as well. If, at any particular stage, there is mismanagement, the whole concept of sustainability suffers adversely. For example, if the project is designed keeping in mind climate-responsive architecture, but somehow, during construction stage, there were a lot of wastages, the project becomes unsustainable. Similarly, if the design and construction were sustainable but the maintenance teams were not aware of operation phase requirements, all efficient systems would inevitably fail to work, resulting in high energy and unmanageable water bills along with wastage of resources. Lastly, if the design itself does not have local climate-responsive features, none of the teams during either construction or maintenance phases can help the project achieve sustainability.

Design: The Cost-free Solution

Design is the easiest and free-of-cost solution available to us to promote sustainability. Due to commercialization of sustainability, it is often associated with various technologies rather than cost-effective and 'common sense' based solutions. It is interesting to note that the passive design solution does not have any marketing funds available, and is not promoted well. The passive design solutions help save both capital as well as operation costs in most of the buildings. If right choices are made at the right time, sustainability need not be an expensive affair.

Modernization has forced our buildings to be modelled on western designs and pushed for excessive use of glass in structures. However, our climate, which is majorly cooling dominated in many regions and during most part of the year, due to the excessive use of glass and concrete, has increased demands on air conditioning, which in turn has increased outdoor temperatures. An example to assess the feasibility of glass buildings in India can be seen through the usage of cars. A car user looking for parking space, always prefers shaded parking. The reason is simple – the car tends to heat up if parked under direct sunlight. Materials used in cars include glass, metal, and plastics, which are typically similar to the materials used in buildings. All these have a much higher specific heat, allowing more heat absorption. The irony is, while parking our cars for two hours, we look for shade, but when we are constructing a building,

which can last 50-80 years, we want glass buildings! Also, the excessive use of glass is supported by an argument among most building owners that they wish to have more daylight. However, increase in usage of glass does not contribute to increased daylighting. On the contrary, it increases the heat gain from glass in-turn increasing the AC load of the building. Optimization of glass use is very important along with proper shading design, which helps reduce both glass cost as well as energy consumption for lighting and space conditioning.

The original use of window in an enclosed environment was for:

- Daylight
- Cross ventilation
- Visual connectivity

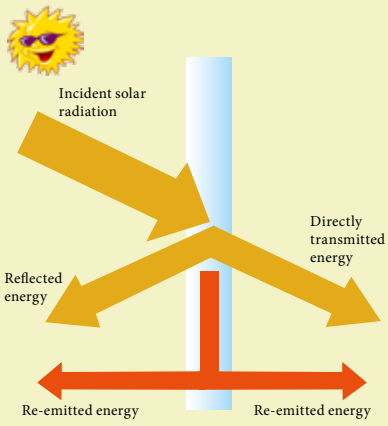
Among them, cross ventilation has been reduced to none as most of the buildings have opted for 100 per cent air conditioning. In regards to daylighting, it needs to be understood that if there is direct sunlight falling on the glass surface, there would always be a glare component in the interior spaces. The current industry, when selecting the glass, always focuses on heat gain through glass, which is a major contributor towards the space conditioning loads. However, we forget that a curtain-glazed building without any shading will result in high glare inside the building from east, west, and south, compelling residents to use blinds and curtains. Consequently, the daylight integration in buildings loses its value. There are many more design interventions that can be adopted to reduce energy demands with passive cost-effective strategies.

Glass Selection

Use of glass contributes to heat and light inside the building, so when selecting the glass, it is important to understand the properties of glass, which suit the project. The heat intake from glass is contributed by its U-value and solar heat gain coefficient (SHGC) value, while the amount of light permitted by glass is governed by visible light transmittance (VLT).

Total heat gain from glass = heat gain due to direct solar radiation (SHGC)[1] + amount of heat transferred due to temperature difference (U-value).

However, the moment we decrease the glass SHGC, the VLT decreases automatically. Hence, we need to balance the light and heat radiation when selecting the glass.



[1] Lower the SHGC, better gain.

» IRRAD Gurugram designed by Ashok B. Lal

Food for Thought

Seventy per cent of India is still under construction. If we amend our ways now and adopt sustainability, there is a ray of hope for our future generations. We must remember that choosing sustainability:

- Does not cost more
- Is common sense
- Will lead to a brighter future. □

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Food Governance: Need of the Hour

Food wastage is one of the most burning and neglected issues in our country. It contributes to greenhouse gas emissions, massive deforestation, and an overuse of pesticides, In this article, **Ajit Menon**, **Madhuri Mehta** and **Rahul Lal** discuss the need for maintaining a functional food circulation system by suggesting ways to tackle malnutrition, improve agricultural practices, and reduce environmental footprint, within the framework of sustainable development.

Ajit Menon *has over 26 years of experience in aviation, hospitality, business process outsourcing, media and manufacturing. He holds a degree in business administration, international business, and has a distinction from Washington International University.*

Madhuri Mehta *is the founding member, CEO and concept creator of Blue Orb. She has spent 16 years in human relations and headed corporate and new business HR at Dalmia Bharat Group. Her experience in interacting with people offered her a unique insight on how people with strong values were the real winners in life.*

Rahul Lal *is the national head for Infra, Facilities, Real Estate and Security at Dalmia Bharat Group. An advocate of environmentally sustainable practices, he is passionate about learning and implementing new ways of doing the same thing. With over 20 years of experience, he is currently spearheading Infrastructure, Facilities, Real Estate & Security for Dalmia Bharat Group; he is on the advisory board of GACS (Global Association for Corporate Services). He is also a member of the esteemed Royal Institute of Charted Surveyor, a global entity for professional property evaluation.*

Food is fundamental to the survival of any living being. The way an engine burns coal or oil in order to generate energy in a machine, similarly, the human body requires food to produce the forces that keep the heart beating, the lungs functional, and the limbs moving. The unfortunate reality is, while millions across the globe remain deprived of food, there are millions who do not think twice before wasting the food they have. Food waste is now one of the biggest focus areas and it is imperative for every global citizen to understand their individual role in the collective fight against food wastage.

When we talk about food wastage, we do not mean only the leftovers that we throw away, but also the unsalable food items that shops, malls, and local stores discard on a regular basis. Achieving food sustainability through efficient food circulation systems is a mammoth task.

Sustainable food production is based on the availability of fertile land, water, nutrients, and a favourable or conducive climate. From technology to government, the implications reach across a range of sectors, which is why a holistic approach is the need of the hour to address systemic and interconnected challenges. At every stage, along the food value chain, the various stakeholders – from manufacturers to consumers – play an important role in ensuring food safety and quality. They address the concern of environmental footprint, in addition to the issue of hunger, in a sustainable way. The long-term goal of food

sustainability is to produce enough food, consistently, in order to feed the ever-growing human population. At the same time, a sustainable shift must be made towards nutrition-sensitive agriculture and food systems that can provide high-quality food for all. Around the world, obesity, malnutrition, and hunger coexist. Despite medical advancements, we are still battling an unprecedented crisis in human nutrition.

Food loss and food wastage have become global issues. Our management of food and environment needs long-term inspired thinking. Education and the knowledge of what is and what is not sustainable are the first steps toward leading a more sustainable lifestyle. Climate change is already affecting production of major crops such as wheat, rice, and maize in tropical and temperate regions. Unfortunately, to meet the demands of the masses and to improve crop yields, pesticides are used in agricultural practices, further leading to long-term environmental impacts, following the overuse of such chemicals. Pesticides are carcinogenic and they infiltrate the groundwater supply, polluting water; they contaminate our food and create an increased risk of exposure for farm workers.

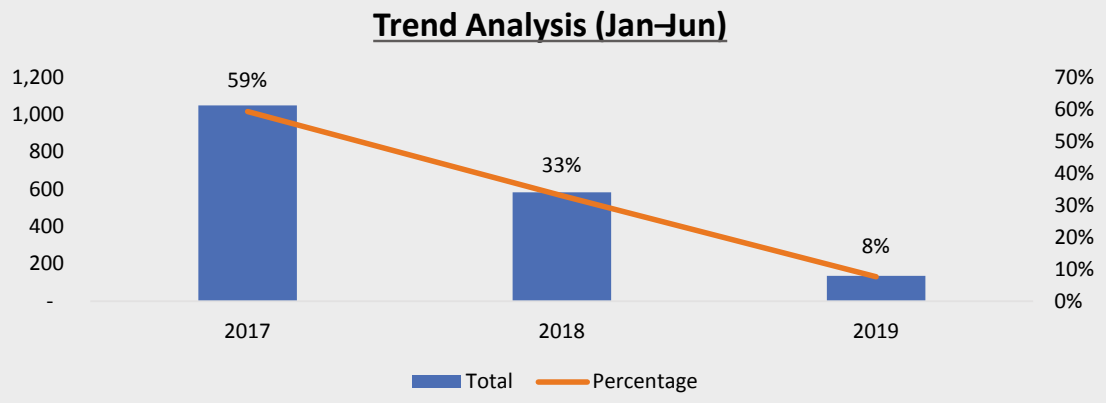
The Sustainable Development Goals aim to end hunger and malnutrition by 2030. Based on the current trajectory, there is concern whether this is achievable or not. According to a report of the United Nations, it is observed that a target is set under Sustainable Development Goal

12 – responsible consumption and production – to reduce by half "the per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses". Most businesses have embraced the three dimensions of sustainability, or "triple bottom line (TBL)". This idea is based on the premise that for a company to be sustainable, it needs to be economically feasible, environmentally dependable, and socially responsible. The concept of TBL goes even further by allowing interchangeability, which means, if a business falls short in one of the dimensions, it can make up by "investing" in another dimension.

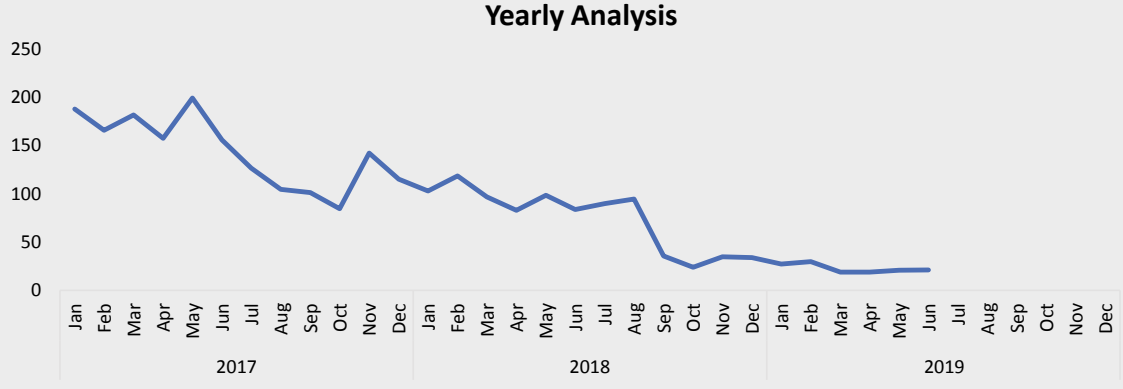
Clean and abundant supply of water is a must-have for any living creature to survive. But each year, more than 66 trillion gallons of water is used for producing food that either perishes before reaching the consumers due to crop failure and adverse climatic conditions or, it is simply wasted. We can change this by producing and eating only the food we need. Production of sufficient food while limiting its impact on the environment is one of the biggest challenges today. Wasted food represents about 8 per cent of global greenhouse gas emissions, and is a main contributor to deforestation and the depletion of global water sources. In order to meet global food security needs, as well as the food demands of an increasingly affluent global population, we will be needed to increase both productivity and efficiency as well as reduce food waste. Policies must focus on groups that are most susceptible to the consequences of poor food access including: infants, children aged under five, school children, adolescent girls, and women.

While food is important for our health, the way we produce food leaves harmful effects on land and water. At Dalmia Bharat Group, we recognize the responsibility of upholding sustainable business practices. Conservation of natural resources is a clear focus area for us. Sustained value creation is rooted in our core values and we have always attempted to integrate needs of our people, customers, community, and the environment into our operating and governance model. Apart from the Group's endeavour to substitute conventional fossil fuels and raw materials with alternative solutions, and enhance social responsibility, thereby improving the lives of millions, we also focus on addressing food wastage.

No – Bin – Day, an initiative towards zero food waste, which was implemented in our Delhi/NCR offices, is now being adopted by our offices across all regions. The purpose of this exercise was to sensitize people about the issue of food wastage. As shown in Figure 1, through such exercises and many other initiatives



» **Figure 1** Reduction in food wastage



» **Figure 2** Yearly analysis of food wastage

and partnerships, we have achieved 70 per cent reduction in food wastage. Since we do not merely run a business but run it ethically by consuming less from and giving back more to nature and society, we understand that certain populations, such as low-income, minority, and urban communities are at a risk of experiencing food insecurity and poor diets due to financial constraints, transportation limitations,/ and environmental factors. Hence, our focus is more on these neglected communities. As a partner with the Government of India (GOI) in its nation-building exercise, we are now aiming to assist GOI in bringing awareness to all the villages near our plants through an awareness programme on sustainable farming, organic farming, protection of biodiversity, improving soil fertility, production of low carbon food, and so on. We sincerely hope that in the long run, we would be able to play an instrumental role in doing work that is beneficial to our own existence and the planet, of course. ◻

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Paryavaran Rakshak

Earth को अनर्थ से बचाएँ

This is a 2-hour programme conducted by the GRIHA Council where people are made aware about environmental issues through several activities designed in the form of games, such as waste segregation, tambola with sustainability words, drawing competition for children, and energy consumption calculation for households. The programme focuses on increasing the residents' awareness about the general environmental issues and at the same time instilling in them a good-practices routine.

Residents of all age groups at Anandlok society, Mayur Vihar, New Delhi engrossed in a energy management game–Power Wars

Certificate of appreciation presented to the authorities, RWA, Devraai, phase 2

Residents at UNA Enclave, Mayur Vihar, New Delhi learnt the concept of waste segregation while having fun with GRIHA team

Winners of various games receiving goodies from GRIHA Team at UNA Enclave, Mayur Vihar, New Delhi

GRIHA Team addressing the residents of Anandlok society, Mayur Vihar, New Delhi on environmental issues in a thought-provoking discussion

Residents of UNA Enclave, Mayur Vihar, New Delhi sharing their experience with the GRIHA Team about the Paryavaran Rakshak programme

Group photograph of the participants and GRIHA Team while handing over the token of appreciation at UNA Enclave, Mayur Vihar, New Delhi

Residents all geared up for the waste segregation game at Anandlok society, Mayur Vihar, New Delhi

Residents of UNA Enclave, Mayur Vihar, New Delhi deeply involved in playing 'Power Wars' – a game to learn energy management at household level

Urban Energy Demand Reduction: Roadmap to Sustainability

Unplanned expansion of cities is a growing concern today. With a rise in urbanization and population, energy demands of city dwellers are increasing at an alarming rate. Impacts of human activities result in overexploitation of natural resources and distress the environmental balance of the existing ecosystem. In this article, **Himani Pandya**, **Kartikay Sharma, Sachin S.,** and **Tithi Soladhara** elaborate on various tools that can aid cities in planning the provision of sustainable energy and water services to citizens.

Cities are termed as the engines of economic growth.[1] Approximately, 55 per cent of the world's population resides in urban areas. This proportion is likely to stretch to 68 per cent by 2050.[2] It is expected that nearly 90 per cent of this increase in the urban population will be accounted for by the Asian and African countries.[2] It is very important for these developing countries to plan their future urbanization happening in a smooth and sustainable manner. Unplanned expansion of the cities without considering the future scenarios will exacerbate the urban inequalities and cause a great amount of economic and environmental risks for the nations.[3]

The provision of basic infrastructure facilities and public services towards addressing the increasing demand is one of the major challenges for the cities in the developing countries. The growing rate of urbanization is continuously widening the gap between supply and demand for basic services such as

[1] Colenbrander, S. 2016. Cities as engines of economic growth: The case for providing basic infrastructure and services in urban areas. Retrieved from http://pubs.iied.org/pdfs/10801IIED.pdf; last accessed on October 10, 2019.

[2] United Nations. 2018. '68% of the world population projected to live in urban areas by 2050'. Retrieved from https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html; last accessed on October 10, 2019.

[3] Du, J., & Mahendra, A. 2019. 'Too Many Cities Are Growing Out Rather than Up. 3 Reasons That's a Problem'. World Resources Institute. Available online at https://www.wri.org/blog/2019/01/too-many-cities-are-growing-out-rather-3-reasons-s-problem; last accessed on October 10, 2019.

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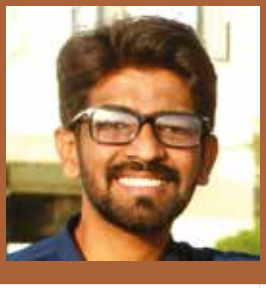

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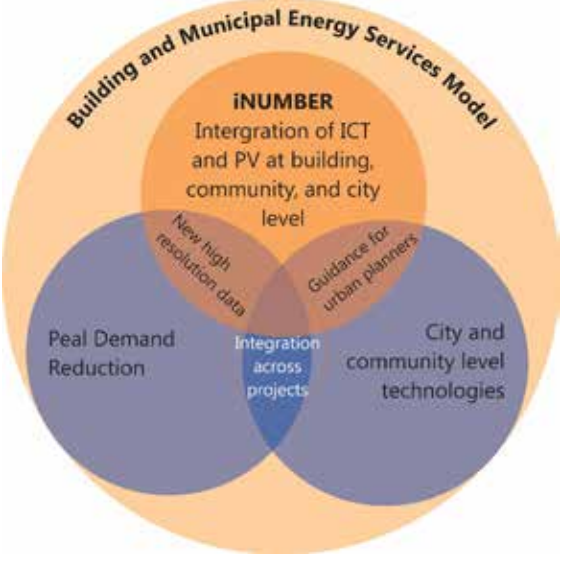
water, energy, housing, etc. The unplanned and unmanaged urbanization might result in overexploitation of these resources and distress the environmental balance of the existing ecosystem. The impacts of these anthropogenic actions increase the carbon footprints of the cities and cause serious risks of climate change. In order to evade such consequences, it is essential for the cities to plan and develop these basic amenities towards meeting the future demands of the citizens.

Clean energy and water services are primary requirements of the cities to ensure better health facilities and comforts for the citizens. With changing lifestyles and rising urban population, it becomes significantly important to understand the variations occurring in the demands of the citizens and identify sustainable methods for catering to them. These variations can be understood only through regular monitoring and analysis of service-level data sets. Such understandings, pertaining to the service, will assist the cities to envisage and plan for their future demands. However, obtaining the form of data sets that offer opportunities for developing a deeper understanding of these services is a major challenge in the case of cities of the developing countries.

In the context of the Indian cities, data sets available in the public domain, pertaining to the energy and water services, will mostly assist in understanding the current situation. The audit data sets and one-time study data will not assist much in analysing the trend and rationalizing the future demands.

Therefore, it is mandatory to obtain and gather data sets representing the real-time variation in the demand for these services over a period of time. These variations can further be understood considering the effects of seasonal variations, spatial forms, and built environments of the cities. Such analogy will help understand the significant factors affecting the demand for energy and water services. Therefore, any tool creating the database by capturing the variation in the demand for the services over time and space will serve the greater cause towards rationalizing these demands by examining the latest trends. Thereby, such tools will aid in planning the provision of sustainable energy and water services to citizens.

iNUMBER primarily focuses on developing one such tool for capturing and assessing the variation in the energy demand of the cities over space and a span of time. This project is primarily focused on the city of Ahmedabad. iNUMBER is an Integrated Urban Model for Built Environment Energy Research. It is a collaborative research project between India and UK towards improving their electrical and water services. The main objective of iNUMBER is to work towards reducing the carbon footprints, stabilizing electricity grids, and assisting cities in planning the provision of secure and sustainable energy services to residents. The building energy and municipal energy account to a large share of electrical consumption of any city. The building energy accounts to nearly 36 per cent of the global energy consumptions and is responsible for nearly 40 per cent of the global carbon emission.[4] The increasing floor area, improved access, and ownership of the energy-consuming devices are expected to increase the carbon footprints at higher rates in the coming decades. It is necessary to understand the built forms and environments of the cities to overcome their negative effects on our ecology. One of the work packages of the iNUMBER aims to capture the built environment of the city using the advanced aerial technologies and developing a 3D stock model as well. Further, the project intends to incorporate the knowledge from the partnered country to investigate and scale-up the 3D stock model using Building Information Modeling (BIM) based energy simulations to develop a viable city energy model. This model assists the Indian municipalities in better planning and effective optimization of their current and future energy demands.



The model will further be integrated with the intense and granular energy data at the dwelling unit level and the community level. These data enhance the credibility of the model and comprehends the energy consumption details at the household and appliance levels. This in turn provides a deep understanding pertaining to the existing housing typologies in Ahmedabad and the energy demands of the residents. Such details will assist the policymakers and decision-makers towards regulating the energy demands in the building sector.

As far as the Indian cities are concerned, it is observed that municipalities dedicate nearly over 60 per cent of their operational budget on the energy expenses of the water and

[4] IEA: Buildings. 2019. International Energy Agency (IEA). Retrieved from https://www.iea.org/topics/energyefficiency/buildings/; last accessed on October 10, 2019.

wastewater utilities. Moreover, research shows that the municipalities account to nearly 23 per cent of the electrical energy inefficiencies in the country.[5] This increased rate of inefficiencies, accounting to an increased share of energy expenses, identifies the great potential for optimization and conservation of electrical energy in the municipal services sector. Identifying the scope of intervention for betterment, a part of iNUMBER extends the study to incorporate the energy consumption of the municipalities in delivering water and wastewater services to its citizens. This primarily aims to develop understanding pertaining to the effects of urban form on energy consumption in the municipal services. The study utilizes the real-time granular data of the utilities from the municipalities to understand the analogy.[6] Such understanding will assist in developing a framework towards assessing the energy consumption in the municipal services, thereby, helping the cities to regulate and enhance the quality of these services.

In the modern world, electrical energy is one of the basic necessities for the regular functioning of the cities. However, unplanned development and overexploitation of this energy would cause serious threats to our environment. With a larger population shifting to urban areas, the accessibility of clean and secure energy will be one of the key thrusts towards deciding the comfort levels and livable conditions in the cities. In order to ensure a better standard of living, the future demands of the citizens must be analysed so that developments could be made accordingly. Highlighting the significance and impacts of the buildings and municipal services sectors on total energy consumptions of a city, this article examines the importance of envisaging the energy demands of city dwellers towards optimizing their future consumption in an energy-efficient and sustainable manner. □

[5] Vasudevan, R., Cherail, D. K., Bhatia, C. R., & Jayaram, N. 2011. Energy Efficiency in India History and Overview. *Alliance for an Energy Efficient Economy*. Retrieved from http://www.aeee.in/wp-content/uploads/2016/03/AEEE-EE-Book-Online-Version-.pdf; last accessed on October 10, 2019.

[6] Iyer, M., Rawal, R., Sachin, S., Pandya, H., Joshi, A., & Janda, K. 2019. 'Incorporating Municipal Energy Services into the City Energy Model and Developing a Water-Energy Nexus'. Ahmedabad. Available online at http://www.inumber.org/wp-content/uploads/2019/04/iN_TechnicalReport_WP2.pdf; last accessed on October 10, 2019.

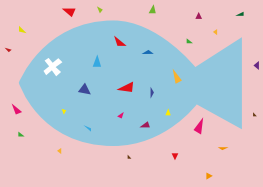
INFO-BYTES

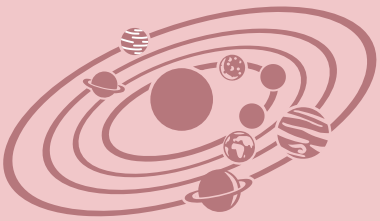
It takes around 2700 litres of water to grow enough cotton to make a single cotton shirt.

A large-screen television turned on for 6 hours a day can generate half a tonne of greenhouse gas a year. That is about the same amount as running a fridge for a whole year

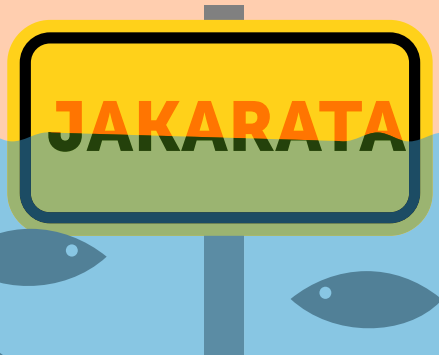
There is an island of garbage four times the size of Rajasthan (the largest state in India) inside the Pacific Ocean. The number of plastic pieces here outnumbers total marine life by six to one

There is more microplastic in the ocean than there are stars in the Milky Way!





Indonesia will move its capital city as its current one is sinking



Glass, like aluminium, is infinitely recyclable-without any loss in purity or quaor quality

Architectural Conservation and Sustainability: Two Sides of a Coin

Sustainable preservation of historic buildings is an important factor in assessing the lifespan of India's architectural heritage. With innovative techniques and concepts being introduced in green building strategies, conservationists and heritage experts are becoming catalysts of environmental development. In this article, **Ar. Divya Chakravarti** explains the need for adopting a holistic approach towards promotion of green spaces within the ambit of heritage conservation. She further argues why the use of non-renewable resources should be replaced with reusable materials for infrastructural growth and how retrofitting redundant buildings could save taxpayers' money.

Ar. Divya Chakravarti *is a practicing conservation architect who is a partner in Samrakshan Heritage Consultancy LLP, Chennai. She holds a Master's degree in historic preservation from the University of Southern California, and has briefly worked in the planning department of City of Pasadena, California, and Historic Scotland, Edinburgh. She is also involved in the field of academia as a part-time professor. She has co-founded an enterprise called De Artisan, which strives to revive traditional materials, methods of construction like Athangudi Tiles from Chettinad, etc. Currently, she is an associate professor at Mohamed Sathak A.J. Academy of Architecture, Chennai, for the M.Arch programme in conservation. She can be reached at dcarch6@gmail.com.*

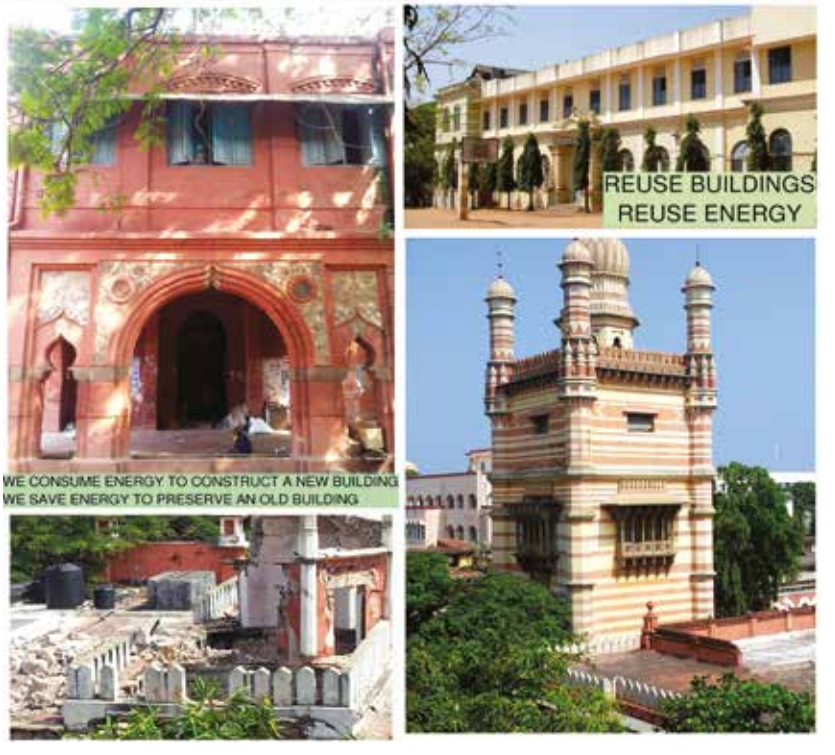
In a world where sustainability is becoming a guiding principle, there is a need for engineers with expertise in the areas of heritage conservation and green building design or vice-versa. It is crucial to bridge the two concepts – sustainability and architectural conservation and to realize that conservation is not a single stream of thought that can be applied to a building but a multifaceted approach that needs to be adopted. Depletion of the country's historic resources has impacted the environment by creating more debris in landfill sites and using high levels of energy by destroying sound buildings, levelling trees, and hillsides. The effects of automobiles and the promotion of development on green-field and heritage sites are well known.

This paper examines the important dimension of sustainability, helping us quantify the value of a building in terms of energy and money rather than subjective parameters like historic, cultural, and emotional value, thus making the concept of conservation more palatable and acceptable to both the clients and the developers. Adopting a holistic approach towards preservation entails considering the embodied energy, lifespans of structures, and design (flexibility for adaptive reuse). Embodied energy is the total non-renewable energy that goes into the manufacturing of a material and plays a major role in the choice of building materials. It

is an important factor to consider when assessing the life cycle of a building and it relates directly to the sustainability of the built environment.

Towards a Sustainable World

The purpose of this paper is to contribute to the forging of linkages between architectural and urban conservation and the broader environmental agenda of sustainability. Cities around the world occupy 50 per cent of its land surface, house around 50–60 per cent of its population, and consume nearly 75 per cent of natural resources and discharge of wastes.[1] Among these energy sources, a substantial proportion is non-renewable yet reusable materials that are not being recycled and becoming a huge part of landfills, in addition to toxic wastes that are polluting our lands and oceans as well. The city as an entity is the biggest challenge of the 21st century and the starting point for a sustainable world.[2]



Sustainability consists of three components – environmental, social, and economic; of these, environmental takes precedence as it underscores the survival of all living beings on our planet. When we usually consider historic cities, they consist of two important qualities – primarily, the environmental capital that is represented by their buildings and urban infrastructure; and secondly, the socio-cultural values that they signify, and the role that these perform in defining the sense of place, community, belonging, and social cohesion.[3] Recognizing and acting upon the full range of values inherent in historic cities is a core component of the challenge. Besides the two important qualities aforementioned, the important quality of a sustainable city through economics will be touched upon too. The economic side of historic buildings and cities will be expressed through the embodied energy of materials and reiterate the point that "the greenest building is the one that has already been constructed"[4] and historic preservation is the ultimate recycling.

Functional, Material, and Cultural Resources

Historic buildings and areas represent a non-renewable capital resource

1 Ashworth, G. J. & P. J. Larkham. 1994. 'From history to heritage: From heritage to identity: In search of concepts and models'. *Building a New Heritage: Tourism, Culture, and Identity*; London: Routledge.

2 Rodwell, Dennis. 2007. *Conservation and Sustainability in Historic Cities*; chapter 10; Blackwell Publishing, Oxford.

3 *Ibid*, p. 207.

4 'Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples'. Advisory Council on Historic Preservation, January 1979. Available online at https://dnr.mo.gov/shpo/docs/ACHP_embodied-energy_1979.pdf; last accessed on October 03, 2019.

of materials, energy, and financial investment as well as a cultural one. In 1970, the editor of *Architectural Review* wrote, "It is the mark of an immature culture – a demonstration of a childish attitude towards valuable and historic buildings – to assume that if new accommodation is required…it can only be provided by demolishing…and rebuilding on the same site."[5]

These buildings have the potential of not only solving the need for new structures but also retaining the architectural quality and essence of that particular city. Conservation could mainly include retrofitting of existing buildings with sustainability as the primary objective.

This brings us to the final dimension or main quantifying factor of embodied energy of materials. When sustainability is the driving principle in creation of buildings and cities, it becomes our duty as planners and architects to not only conserve monuments or iconic buildings but also retrofitting redundant buildings and giving them a new lease of life at the same time, saving not just the environment but also crores of taxpayers' money.

Embodied Energy and Sustainability

It is estimated that buildings, their construction, operation, and disposal, account for over 40 per cent of the total energy consumption. The consumption of this energy has implications for the depletion of natural resources and for the production of polluting agents and problems such as global warming and acid rain. The total energy consumption that can be attributed to a building in its lifespan will depend on the energy consumed for the production of the building materials, construction, operation, maintenance, and for demolition and disposal or recycling.[6]

[5] Ref: Footnote 1.

[6] *ibid*. p. 40. Ref: Footnote 5.

Buildings not only use energy during their operation, they also utilize energy during construction. This is "embodied" energy, which is all the energy required to extract, manufacture, and transport building materials as well as that required to assemble and "finish" it. Following this logic, it is definitely sensible to "reuse" buildings – retrofitting an old building will consume significantly lesser energy than demolishing and constructing a new structure and simultaneously will help in carrying a chunk of history to posterity. Conservation architects will benefit from exploring how embodied energy calculations could be used as a more quantitative method of measuring the overall environmental benefits of building renovation versus new construction.

What is embodied energy?

There are two forms of embodied energy in buildings, as follows:

1. Initial embodied energy
2. Recurring embodied energy

The initial embodied energy in buildings represents the non-renewable energy consumed in the acquisition of raw materials, their processing, manufacturing, transportation to sites, and construction. This initial embodied energy has the following two components:

- Direct energy is used to transport building products to the site, and then to construct the building.
- Indirect energy is used to acquire, process, and manufacture the building materials, including any transportation related to these activities.

The recurring embodied energy in buildings represents the non-renewable energy consumed to maintain, repair, restore, refurbish, or replace materials, components, or systems during the lifespan of a building.[7]

There are a few caveats for using the regular tabulated data about embodied energy available to compare the embodied energy of historic buildings to new ones. First, there is a strong likelihood that the overall building figures in the report underestimate

[7] Slater, T. R. 1990. 'Conservation and the Management of Historical Townscapes': The built form of western cities; University Press, Leicester. Available online at https://doi.org/10.1016/0197-3975(91)90016-E; last accessed on October 3, 2019.

the true embodied energy of older buildings. This underestimation rises from the following two principal factors: older buildings often had more volume and greater amounts of materials. On the volume side of the equation, older buildings often had higher ceilings and used more massive masonry construction. There has been hardly any attempt to calculate the embodied energy of construction processes used in the historic construction.

Three different methodologies for measuring the embodied energy in historic buildings were developed in *Assessing the Energy Conservation Benefits of Historic Preservation: Methods and Examples* (produced by the Advisory Council on Historic Preservation in 1979 but not widely distributed). These were identified as concept, inventory and survey models. The concept model can be characterized as a planning approach, in which various building types are given an embodied energy value based on square footage. The inventory model requires accurate accounting of the materials used to construct the building. This is fairly complicated, especially, as most old buildings lack proper records and documentation. The survey model is based on the assumption that most of the embodied energy in a building is contained in the bulk of architectural materials. The seven primary materials are wood, paint, asphalt, glass, stone, clay, primary iron, and steel, and primary nonferrous metals.[8]

Demolition Energy

Evaluating the environmental benefits of renovating a building instead of demolishing it to construct a new one raises the question of calculating the energy of building demolition. There is also the possibility of dismantling a building for salvage, which would recapture embodied energy. It may be difficult to renovate a historic building while trying to achieve a green rating and meet preservation standards. However, it is possible to renovate historic buildings to a great extent, improve their operating efficiency and reduce the cost and energy consumption in demolition and new construction,[9] in addition.

Shifting to a Heritage Approach

In a country like India, there is no shortage of historically relevant buildings but the question we need to ask ourselves is: how many museums or memorials can a city host? In the name of architectural preservation, any historic building is "preserved" and used either as a memorial or a museum, which eventually begins to gather dust.

To make conservation financially viable, it is important to treat it from a business angle as well. Since heritage cannot logically exist without a consumer, then, in effect, the consumer defines heritage. Further, the perceived problem of authenticity is largely irrelevant in heritage planning, because the consumer authenticates the resource. A building is sustainable if it is able to support its own energy needs and does not prove to be a "fuel guzzler". With changing times, redundant buildings should be treated in a different light and retrofitted with minimum energy, thereby making it viable both for the developers and the city as a whole. The same principle would apply to an entire historic area as well. Modern conveniences and amenities do take precedence but the same may be achieved with some thoughtful planning from the three important stakeholders: planners, architects, and conservation specialists.[10]

Conclusion

There is a consensus[11] that sustainability and conservation are both compatible and complimentary, although there remains a continued lack of a balanced, holistic approach for guiding development and moving towards sustainability. The absence of social and cultural perspective is evident in the conservation and heritage planning literature in which the physical product forms the principal focus. Practical problems do arise from the dichotomous relationship between preservation for posterity and change and development necessary for keeping heritage places alive and attractive.

Embodied energy should be an important parameter in assessment of sustainable design, especially for historic preservation. The built environment represents a huge resource that can be conserved and made efficient for the 21st century, which is approaching fossil fuel exhaustion. By combining preservation principles and the concept of embodied energy, a stronger argument for the environmental benefits of building reuse can be made. This article has examined the potential between sustainability and conservation, which may be incorporated in urban planning as well. □

[8] *Ibid*. p. 35. Ref: Footnote 7.

[9] Holtzhausen, H.J. 2007. 'Embodied Energy and its Impact on Architectural Decisions'; University of Johannesburg.

[10] Cole, R. J. & Kernan, P. C. 1996. 'Measures of Sustainability, Life-Cycle Energy Use in Office Buildings', Building and Environment, vol. 31 (4); p. 307-317. Available online at http://amet-me.mnsu.edu/userfilesshared/solarwall/Benchmarking/Misc/Life-Cycle%20Energy%20Use%20in%20Office%20Buildings.pdf; last accessed on October 03, 2019.

[11] The principal data for embodied energy was obtained from the 1967 Census of Manufacturers, (vols. I & II), produced by the US Department of Commerce & Bureau of Census (Washington DC), Government Printing Office, 1971.

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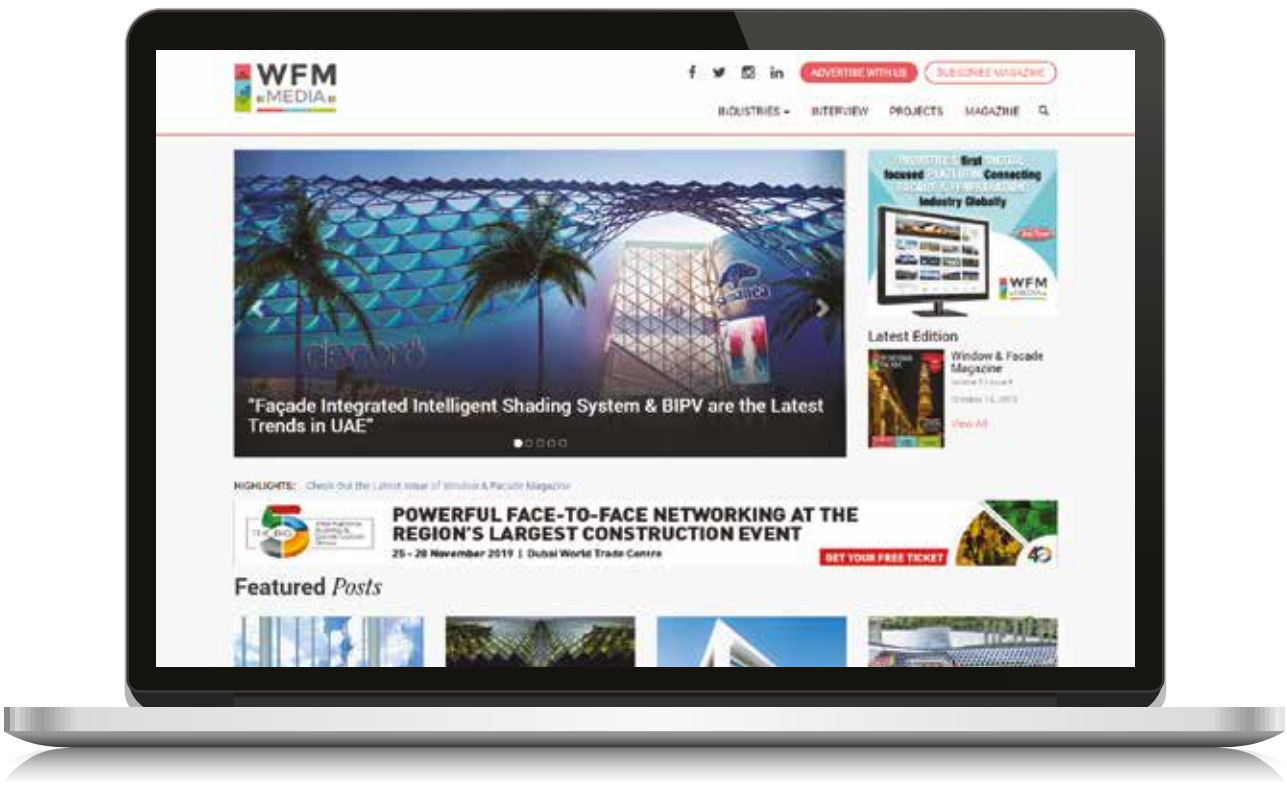

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LIVE PLAY LEARN REPEAT

— Ms Pooja Rai, *CEO, Anthill Creations*

Imagine a child, running around, dancing with joy, and happily playing with fellow mates. The sight that is so hard to come by these days.

Play is disappearing at home, at school, and in communities. Today, we have transformed into a society that is increasingly staying indoor, engaged in creating a social universe within the confines of our digital counterparts. A massive lack of playscapes within our cities and schools, combined with an active ignorance about the importance of play in our day-to-day life is only fuelling this phenomenon.

Anthill Creations aims to bring back play by mobilizing communities towards the lighter, quicker, and cheaper transformation of dead zones within the cities into interactive and sustainable playscapes using scrap tyres and industrial waste. Till date, we have designed and built 124 playscapes across 18 regions in India, US, Nepal, and Peru, impacting the lives of approximately 65,000 children.

Our journey started in college when we visited a residential school for underprivileged children, located within the campus of our alma mater IIT Kharagpur. We saw little kids playing on the lawn with broken sticks and stones. Some of them were using slippers and pebbles to play badminton. Deep within, we felt that these kids deserve so much more than this! And, the very same year, we built our first playground.

Out of college, a few of us pursued this initiative along with our jobs for almost a year. In 2016, I decided to quit my full-time job and devote my entire time towards scaling this movement. An 18-month incubation by NSRCEL, IIM Bangalore (supported by Michael & Susan Dell Foundation) followed by a 6-month accelerator programme with N/Core (supported by Mphasis), propelled the organization towards new opportunities and fast-paced growth.

We have our design library of modular playscape designs, which are easily replicable and can be built in just four days without any prior expertise. By using cost-effective, locally sourced raw material and volunteers instead of paid labour, we can optimize on overall costs by up to 50 per cent.

Our playscapes have been directly attributed to greater classroom performance, improved attendance rates, and reduced violent behaviour. These playgrounds are contextual to the child's current setting and are built only after rigorous interaction with the children to understand their perception of life and everything around them. Anthill has transformed the children's lives from a mundane, monotonous routine in slums and classrooms to a more active, happier, and healthier one.

By 2025, we are aiming to build over 10,000 playscapes across the globe. Currently, Anthill is transforming itself to be able to grow at a scale of 5X year-over-year, with the help of technology. We are also enabling champions within the community (micro-entrepreneurs) to become change-makers and mascots for this movement. Our goal of transforming dead zones within the city into clusters of usable playscapes will eventually alter the fabric of the urban landscape, bringing in a playful quotient while fostering increased community interaction.

Play does not just mean a swing, a slide, and a see-saw, it is the smiles, the happiness, the creativity, the camaraderie, the learning that it fosters, that truly define its essence. Let us bring back play for all!

Church Acoustics: Towards a Better Worship Experience

Away from the cacophony of daily life, a place of worship becomes a refuge of peace and tranquillity. Churches are sacred spaces where the experience of listening to the priest's chants and sermons along with the choir's carols is truly calming. In this article, **Nikita Kargaonker** foregrounds the importance of ensuring high–quality acoustical properties and reverberation times that add to the optimal celebration of the sacred liturgy. The author further explains how a synergy between music, chants, speech, and silence can guarantee the present congregation a blissful worship experience.

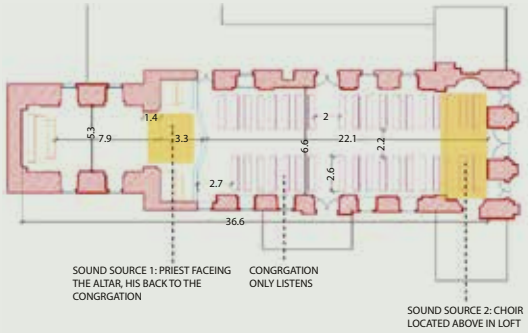
Nikita Korgaonker *is an architect with a Master's degree in sustainable architecture. She has three years of experience in architecture and green building consultancy. She is currently working as a green building analyst at Environmental Design Solutions Pvt. Ltd, Mumbai. She can be reached at korgaonkernikita@gmail.com.*

A church is a space of worship where communication is paramount. Even the simplest and smallest church is a multi-use facility where, the priest communicates to the congregation by preaching the holy scriptures. The congregation actively participates by listening and responding to the prayers led by the priest. The choir invokes an emotional response from the congregation and amplifies the overall experience through carol singing. For optimal celebration of the sacred liturgy, optimized synergy between speech, music, singing, and silence is required.[1] The dual activity within the space requires different reverberation times, so that both speech and music can be heard clearly throughout the space.

In worship spaces, there is a need for acoustical properties to support both speech intelligibility and reverberance of music. Three conditions of reverberation take place in the church:

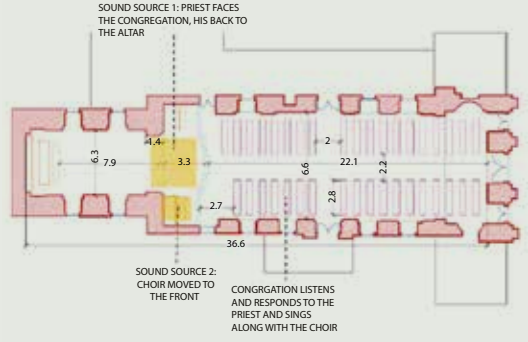
- Short reverberation allows clear speech intelligibility as well as represses music and congregational response
- Medium reverberation serves both speech and music acceptably but neither exceptionally
- Long reverberations impart fullness and character to the music but if done in excess, speech can be rendered incomprehensible.

The way Catholic rites were performed changed after the Vatican II Council (1962–65). Such a change had a direct impact on speech and songs sung during the Holy Eucharist. Prior to the Council, the church was



» **Figure 1** Location of sound sources before the Vatican II Council

divided into specific parts – the altar at the front, the congregation facing it, and the choir, positioned above in the loft. Later, all the speech and music sources were shifted to one place – in front of the altar, facing the congregation.



» **Figure 2** Location of sound sources after the Vatican II Council

[1] Egan, M.D. 1988. Architectural Acoustics. Fort Lauderdale (J. Ross Publishing Classics), McGraw Hill, New York. 2007.

As a consequence of these structural changes in the celebration, the acoustical performance within the space also changed. There was a need for enhanced emphasis on speech intelligibility as well as resonance of music. However, the church is still using buildings that were constructed before the Council took place. Often, the long reverberation times, characteristic of these churches, are not compatible with the changed celebrations. Consequently, the clarity of speech is greatly reduced within the space. Moreover, the number of people attending Mass has increased over the years. The rise in congregation has increased the absorption coefficient in the church, further affecting the reverberation time and speech intelligibility.

Sound systems and television screens are commonly used as a support for speech intelligibility and clarity of music in old churches. However, the installation of these systems is not properly designed, and the issues in sound propagation persist. To accommodate the increase in occupancy, churches are being renovated and expanded. These extensions might solve the problem of inadequate space but they have also added more defects to the propagation sound within the space. Well-designed sound systems can help overcome acoustic problems and enhance the worship experience. To achieve this, the architects must work on the design taking into consideration the acoustics of the room. They can be used either to enhance speech alone or speech and music both. In case of the latter, it is necessary to ensure that the system is properly designed to allow graceful integration of sound components and ease of operation. The requirements of the acoustic environment could vary from one congregation to another. For example, Gothic churches are best suited for congregations whose normal liturgy is rooted in European music and Gregorian chants. The same church would not suit for a jazz Mass or a choir in the contemporary Gospel tradition. Hence, the requirement and design of the system also depend on

» **Figure 3** Centre cluster speakers at St Joseph Catholic Church, Pinole, CA[2]

» **Figure 4** Wall-mounted speakers used at Our Lady of Merces Chapel, Goa

the type of congregation and whether the existing room acoustics is apt for the same. If the acoustic design is suitable, then the sound system is required only for enhancing speech intelligibility. The design process is further challenged by architectural and aesthetic priorities that strive to minimize visual intrusions due to the location of the system components.

The most important function of a sound reinforcement system is to provide excellent speech intelligibility. It must achieve this within the reverberant environment, required to support the assembly and choir. Care must be taken in the design and use of sound systems so that the assembly's voice is not overpowered or made less significant by amplified sounds. For good speech intelligibility, the direct signal from the loudspeakers to the listeners' ears must be louder than any intruding external or internal noise. In highly reverberant rooms, the sound system must increase the direct sound more than it can increase the reverberant sound. Excessive reverberation can reduce speech intelligibility. It is not uncommon to find churches, treated with excessive amounts of sound absorbing materials, which reduce reverberation with the intent of ensuring speech clarity. This might enhance speech clarity and allow the use of simpler and less expensive sound systems, but it often creates a reverberation that is too short for music and congregational response. Therefore, it is better to design the sound system to function properly with a longer reverberation, one that supports all the elements of liturgy.

For a proper sound system design, the designer should be aware of the required reverberation time. With this information, the sound system can be designed specifically to work within the requirements of the reverberant environment. Echo and feedback (squealing or howling sounds regenerated between microphones and loudspeakers) are two common issues faced when the sound system is not properly designed. They greatly reduce speech clarity. Echo-producing surfaces can be readily identified by an acoustical consultant or sound system designer. These surfaces can be reoriented, reshaped, or treated to eliminate the echoes. To avoid feedback, microphones should be located outside of the loudspeaker coverage and their frequency response should be as smooth as possible. The preferred loudspeaker design is a central cluster, which usually locates the loudspeaker or a cluster of loudspeakers 20 to 40 ft above the ground, and slightly in front of the actual sound source. One major advantage of the central cluster design is directional realism: the audible impression that sound is coming from the speaker rather than from the loudspeaker. This type of loudspeaker directs the sound towards the audience. This way, reflections from ceiling, walls, and floor surfaces are avoided and the sound system is able to provide high speech intelligibility by increasing the level of sound energy from the location of the speaker more than the level of reverberant sound energy.

Another type of system commonly used along the walls (mounted or within structural columns) is the column loudspeaker. These loudspeakers direct amplified speech throughout the congregation, evenly. They are tilted in the direction of the congregation and the throw distance is kept short. The space between two column loudspeakers should be less than 25 ft so that the direct sound field could be increased more than the reverberant sound level.

With an increase in the church-attending population, extension of existing churches has become unavoidable. This surge should not only take into account the rise in occupancy, but also the impacts it would have on the existing acoustic parameters. Carrying out these checks and calculations at the design stage of the extension plan is mandatory as it will save on unnecessary costs incurred for correcting the reverberation time after construction work is undertaken. ◘

[2] Retrieved from https://pro.harman.com/insights/enterprise/hospitality/house-of-worship/point-source-line-arrays-or-column-speakers-whats-best-for-your-church/; last accessed on October 10, 2019.

Creating a Sustainable Neighbourhood

How often do we think about a sustainable neighbourhood? In this article, **Dipika Tuteja** discusses the pros and cons of walkable humane neighbourhoods in a world where urbanization and industrialization have pervaded a human being's lifestyle. Today, people prefer to travel greater distances to explore more options in malls and multiplexes when they can easily go to nearby grocery stores and help reduce carbon footprint. What should be the forward to enable a thriving yet sustainable society?

Dipika Tuteja *is a practicing architect from Chandigarh College of Architecture, in Delhi. With more than 30 years of experience, her work has been in consulting and designing. She is currently working in the areas of sustainability, communications/media, client engagement, team leadership, and dissemination of case studies. She is the founder of In AWE, an online portal for knowledge sharing. In 2019, she received the Best Sustainability Initiator of the Year Award. She can be reached at dipika.tuteja@gmail.com.*

What Is a Neighbourhood?

A neighbourhood is the smallest denominator in urban planning. While it has very broad usages in the context of communities, cities, states, or countries, in this article, we will explore how they have evolved over the years. Any residential development comprises a broad mix of types like bungalows, semi-detached houses, apartments, and affordable housing that brings people of diverse ages, races, and income groups, together. The ease in accessing all the facilities and amenities provided for the residents is accomplished through a neighbourhood planning concept. This is a general concept for any given geographical location. With time, due to increase in population, developed countries kept experimenting and upgrading the infrastructure. But with developing countries, where the

ratio of increase in population to the development of infrastructure was much lower, it became a herculean task to bridge the gap.

The Delhi Development Authority's focus on the "Master Plan for Delhi 2041" will work towards sustainable and green mobility, along with accessible high-quality public transport. The agency also aims to create walkable humane neighbourhoods and public areas.[1]

Approach to Integrated Sustainability

Issues of sustainability have arisen due to rampant advancement in the developing and developed countries. Some of the ramifications have been on air quality, traffic snarls, increased Floor area ratio (FAR), changed land use, etc. It is a vicious cycle, as migration to cities because of lack of opportunities and development in rural areas has added to population explosion. Cities are bursting at the seams, and boundaries between cities and towns are fading. The extension of a city's periphery has brought with it the menace of landfill sites. Revamping of infrastructure requires cutting of old trees, and to combat pollution, new ones are
being planted. Where do we pick the thread from?

From Millennium to Sustainable Goals

The World Commission on Environment and Development (the Brundtland Commission), in its report to the United Nations in 1987, defined sustainable development as meeting the needs of the present without compromising on the ability of future generations to meet their own needs.

Agenda 21, adopted during the United Nations Conference on Environment and Development (UNCED) called Earth Summit, held in Rio de Janeiro in Brazil in 1992, is a blueprint on how to make development socially, economically and environmentally sustainable.

Two relevant principles of sustainable development discussed at the summit were as follows:

1. People are entitled to lead a healthy and productive life in harmony with nature
2. Development must not undermine the developmental and environmental needs of present and future generations

Further, the SDGs were built on the success of Millennium Goals. Goal No. 11 focuses on "Sustainable Cities and Communities" that has many targets. One such target states universal access to safe, inclusive, and accessible green spaces.

The Way it Was

Going back in time, cities like Delhi and Chandigarh were planned on the concept of self-sufficient neighbourhoods within limited boundaries. A neighbourhood was interwoven with the main and sub-arterial roads. Houses were planned around a common green area and neighbourhood amenities were at a walking distance. Ideally, the size of a neighbourhood was strategically planned in such a way that a majority of population was accommodated within a walking distance of five minutes from its centre, where most of the daily needs were fulfilled within this area. This type of zoning activities diminished the amount and intervals of automobile trips to a great extent, and contributed towards low carbon footprint.

Eventually, a single unit was remodelled into three or four units, thus increasing transportation requirements. Today, roads with pedestrian paths have disappeared to accommodate the growing number of vehicles. Informal vendors have taken over the paths meant for cyclists. Parks and green areas were once embedded in our lifestyle. Walking was a reflexive way of commuting. Day-to-day requirements were met within the local markets. Sustainable, sustainability, and their synonyms were unheard, and environment and nature were only referred to in poetry.

» Pedestrian paths taken over by informal vendors

Coming to the present age, it is important to understand that our choices are flawed. Today, local markets have been taken over by malls, cinema halls by multiplexes, and parks by gyms.

My Corner Store

The neighbourhood grocery store has fewer options but still, we choose to travel at least a few more kilometres to another bigger departmental store in search of better and more options. In

[1] Retrieved from https://indianexpress.com/article/cities/delhi/making-neighbourhoods-walkable-a-priority-in-delhis-master-plan-2041-5591898/; last accessed on October 11, 2019.

» Garbage dumps on pedestrian paths

the process, we actually end up adding to carbon emissions, pollution, and traffic congestion. This attraction of more options and freebies has created large establishments that consume more energy, encourage wasteful expenditure, and add to carbon footprint. This whole turnaround of walkable neighbourhoods to travelling longer distances for daily needs is not a sustainable practice. Home delivery from the corner store on a bicycle is the most sustainable way of life, for there is no carbon emissions, no traffic congestion and no plastic consumption.

Walkable neighbourhoods in small towns or big cities can improve a citizen's health through high happiness index, and resilience, while promoting sustainability.

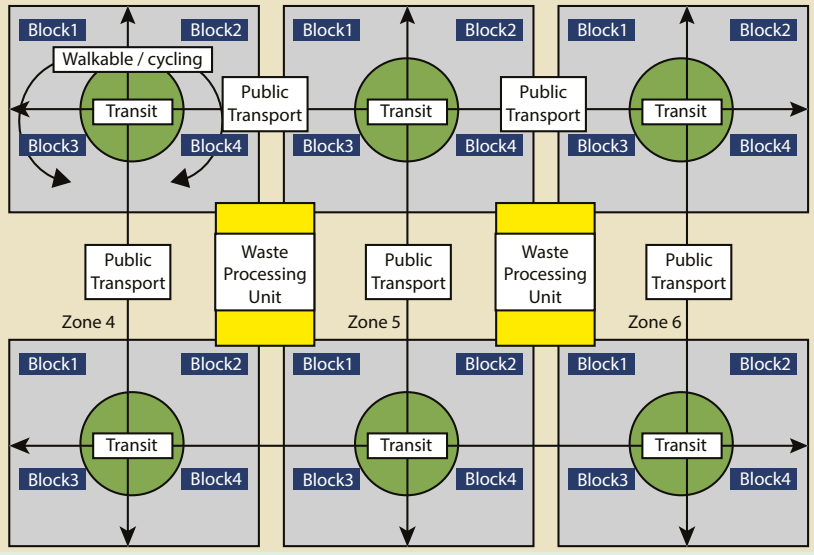
The basic factors that contribute to a good quality life are as follows:

1. Roads and transport
2. Walkable paths
3. Community centre
4. Air quality
5. Zero waste

Our Proposal

Decentralization and segregation of motorized and non-motorized traffic, and waste management are required.

» Peripheral roads in red are for vehicles and internal arterial roads in yellow for pedestrians and cyclists



What Is a Model Neighbourhood?

A sustainable neighbourhood is the key to a healthier community. Some global examples are:

- With more people in cities, the need for more public space arises. Forced to work with the constraints of existing urban landscapes, cities such as Seattle are revitalizing underused areas in order to create vibrant social spaces.[2]
- Walking reduces stress, anxiety and depression. "When you walk through a city, you are always walking through time as well as space, and that is what I really love about an urban walk."[3]
- Cooperation:
  - » Inclusion of our citizens.
  - » Getting the companies on board.

These are all ways that we – that I – have talked about partnerships and cooperation in the past. This approach suggests that we, as the city government, always know best and are simply convincing the rest to run with us. In fact, what we are looking for is cooperation in its truest form, where we reap the benefits of shared knowledge, shared experiences, shared ownership and shared responsibility. Where we all play the best part we can in the process. That is what we had on our minds when we launched our new vision for the future development of Copenhagen called "Co-creating Copenhagen". Although the word "co-create" may sound like a meaningless buzzword from the desk of an overpriced consultant, it has some genuine truth to it.

We do not simply need to include our citizens in a process, we need to engage them and they need to engage us. We should not simply involve companies in hearings and bilateral talks, where we figure out how to minimize the impact, we need them to be part of the process with all the benefits and hard work. Copenhagen successfully created solutions where climate adaptation, green infrastructure, and social effort go hand-in-hand to improve the situation in our disadvantaged urban areas. We have created solutions that make for a better quality of life of Copenhageners and at the same time, they make financial and sustainable sense. They are solutions that quite simply make for a better city.[4]

- How do you solve a problem like traffic, noise and pollution in our growing cities? For the Spanish city of Barcelona, the answer could lie in the creation of "superblocks". Under the plans, the Catalan capital intends to restrict traffic to a number of big roads, creating pedestrianized, small communities within the city's grid system. It is hoped that doing so could reduce traffic by 21 per cent as well as free up around 60 per cent of the city's streets.[5]

"The aim is to improve the quality of life for people in the city's inner suburbs," says JLL's Luis Guardia Torres, JLL Director, and General Cataluña. "Superblocks should lead to a more sustainable, greener environment with greater productivity within these communities."[6] □

[2] Retrieved from http://popupcity.net/pavements-for-the-people/; last accessed on October 11, 2019.

[3] Retrieved from https://www.theguardian.com/cities/2016/aug/06/a-good-wander-unveils-the-wonder-of-a-city-readers-on-urban-walking; last accessed on October 11, 2019.

[4] Retrieved from https://blog.nationalgeographic.org/2016/07/13/why-cooperation-sharing-and-co-creating-are-key-to-solving-climate-crisis/; last accessed on October 11, 2019.

[5] Retrieved from https://www.propertyobserver.com.au/finding/commercial-investment/55450-can-the-idea-of-superblocks-improve-city-living.html; last accessed on October 11, 2019.

[6] Retrieved from http://www.jllrealviews.com/places/can-idea-superblocks-improve-city-living/; last accessed on October 11, 2019.

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- Specific heat capacity

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Testing as per **ASTM-C1363**

- U-value
- Resistance
- Conductance

For any queries regarding test, please contact us at
sbmail@teri.res.in

AWARDS & TRAINING PROGRAMMES

Ar. Revathi Kamath interacting with the particpants of mud Workshop at TERI Gual Pahari, by Ar. Revathi Kamath, TERI Gual Pahari, December 1, 2018

Insight 360 Workshop by Autodesk, TERI, New Delhi, November 16, 2018

3-day GRIHA training programme, Jaipur, August 28-30, 2019

1-day SVAGRIHA training programme in association with Prestige Institute of Engineering management and Research, Indore, September 23, 2019

Financial incentive approved for Devraai Phase-II, GRIHA 3-star rated project, Pune, by Hon. Municipal Commissioner, PCMC, Shri. Shravan Hardikar (I.A.S.).

Mud Workshop by Ar. Revathi Kamath, TERI Gual Pahari, December 1, 2018

1-day GRIHA Awareness Programme in association with Indian Institute of Architects (IIA), Northern Chapter, TERI, New Delhi, March 16, 2019

3-day GRIHA training programme, Chandigarh, June 19-21, 2019

3-day GRIHA training programme, Pune, September 16-18, 2019

Choosing Vegetative Flat Roofs for Office Buildings in Nagpur

Vegetative roofs are used as a passive cooling technique that stops incoming solar radiation from reaching the building structure below. In particular, the roofs of buildings have been identified as a possible field of intervention that could contribute to provide significant energy savings and environmental benefits. In this article, **Ar. Aditi Mahajan** deals with the comparative energy analysis for an office space in Nagpur, Maharashtra. Presently, the reduction of energy demand for space cooling requires adequate solutions both at building level and urban scale. She discusses energy efficiency of built spaces and suggests intriguing ways to enhance the horizon of climate-responsive flat roof designs.

Ar. Aditi Mahajan *is a practicing architect and holds a Master's degree in environmental architecture from the Institute of Design Education and Architectural Studies, Nagpur. She also has a Bachelor's degree in architecture from Smt. Manoramabai Mundle College of Architecture, Nagpur, and a diploma in French from Nagpur University. She has a keen interest in working on energy-efficient building design, and using simulation tools for assessing a built space. Previously, she was working as an architect at A.B. Dongre Architects, Nagpur. Currently, she is an assistant professor at Sinhgad College of Architecture, Pune. She can be reached at aditimahajan710@gmail.com.*

Introduction

Improving the energy efficiency of building elements is one of the first steps to improve energy efficiency and reduce energy demands within the built spaces, resulting in an economically beneficial way to save energy. This article attempts to explore such ways of energy preservation, with a focus on single building element – flat roof – in its three varied formats namely conventional flat roof, cool flat roof and vegetative flat roof.[1]

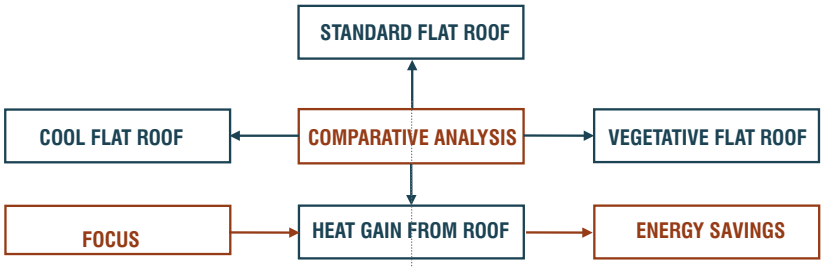
One of the most adopted strategies to reduce the heating and cooling loads of buildings is to increase the thermal insulation of the envelope components, including the roofs. A comparative study was done to analyse the discrete amount of electrical energy required to attain desired cooling in an office space. Buildings consume maximum amount of energy. The untreated building envelopes invite extensive heat ingress, leading to a demand for active cooling techniques, which further result in extensive emissions, adding to the overall environmental degradation. This article attempts to highlight the comparative analysis of the treated and untreated aspects of a specific building element, and present the percentage of energy savings.

Methodology

Quantitative information from simulations of heat gain from software design builder for vegetative, cool, and standard flat roofs is useful to analyse the performance and energy required to maintain the indoor air temperature in design. This comparative study helps understand and further promote the use of vegetative roofs over standard flat roofs. The quantitative data comprising simulation results are compared to arrive at a conclusion for selecting the most appropriate type of flat roof with respect to the energy savings.

Selecting Energy-efficient Roofs

This article focuses on analysing the consumption of electrical energy to achieve stipulated indoor air temperatures and reduction of the overall cooling load demands of a building by adopting alternative thermal insulation methods for a roof, rather than having a standard conventional flat roof.



Heat Gain from Roofs

Heat gains and heat losses through building surfaces are the main factors that determine a particular building's cooling and heating loads. The more solar radiation received in the surface area of building fabric (roof, walls, windows, and floor) means there will be an increase in heat gains. The roof, as a building surface, is most exposed to the sun, thereby contributing most in heat gains in the building. Therefore, the amount of solar heat gains received by roofs needs to be minimized by designing energy-efficient roofs. The impact a roof has on energy use depends on the climate, the orientation of the roof, the thickness and quality of insulation, the reflectivity of the roof's surface, and how well the roof has been maintained.[2]

Vegetative Flat Roof

The roof of a building can be fully or partly covered with a layer of vegetation known as a "green roof" or "vegetative roof". A green roof is a layered system comprising a waterproofing membrane, growing medium, and the vegetation layer itself.

A vegetative or green roof consists of a vegetation cover on top of a roof

[1] Castletona, H.F., V. Stovinb, S.B.M. Beckc & J.B. Davison. 2010. 'Green roofs; building energy savings and the potential for retrofit'. Available online at https://pdfs.semanticscholar.org/5a67/0eb2636151824af880b5a9dde2a7637424c1.pdf; last accessed on October 16, 2019.

[2] Del Barrio, E.P. 1998. 'Analysis of the green roofs cooling potential in buildings', Energy and Buildings, vol. 27 (2), p. 179–193.

surface. The two types of green roofs are generally identified as extensive green roofs, whose soil thickness is below 15 cm, and intensive green roofs, with a soil thickness above 20 cm. The energy balance of a green roof is governed by radiant and convective heat exchange, evapotranspiration from soil and plants, evaporation/ condensation of water vapour, as well as heat conduction and storage in the soil layer. Generally, a green roof is subdivided into three main layers for modeling its energy balance which are structural support, soil, and canopy (leaf cover).

The soil component contains three phases, which are solid (mineral and organic material), liquid (water), and gaseous (air and water vapour). The canopy is composed of the leaves and the air within the leaf cover. The height of the plants and the leaf area index, which is the total one-sided area of leaf tissue per unit ground surface area, are two fundamental characteristics of the canopy.

Other characteristic parameters are the emissivity, the reflectivity, the absorptance, and the transmissivity of the leaves, including the minimum stomatal resistance, which governs the flow of water vapour through the stomates. Evaporation from the ground surface and evapotranspiration from the vegetation layer strongly depend on the moisture content of the soil layer. Vegetative roofs greatly reduce the proportion of solar radiation that reaches the roof structure beneath, while offering additional insulation value.

Cool Flat Roof

A cool roof is substantially a roof with a highly reflective material (cool material) on its outermost surface. Cool materials are characterized by high values of solar reflectance, which strongly reduce the amount of solar radiation absorbed by the outer layer of the roof. Further, cool roofs are also characterized by high infrared emissivity, which contributes to

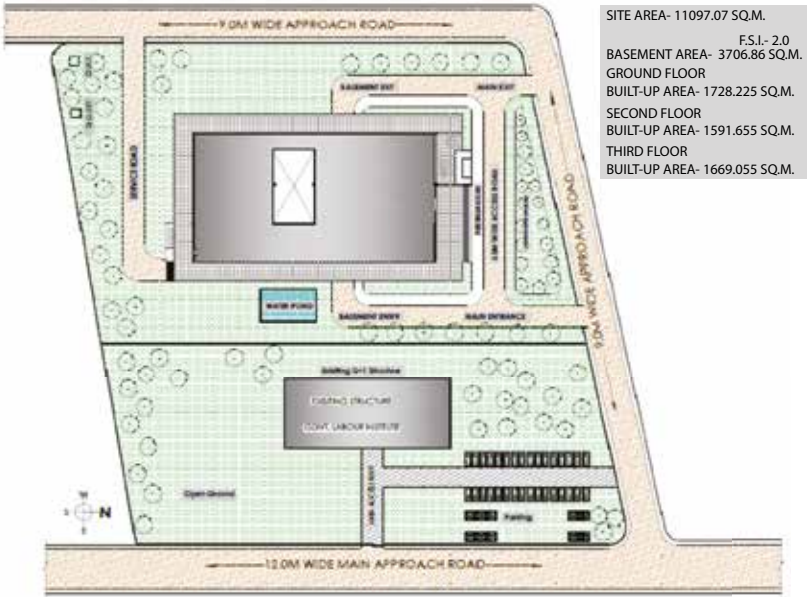
dissipate the heat accumulated during the day through an intensive radiant heat exchange at night. A wide range of cool materials are commercialized like paints, coatings, membranes, tile and pre-painted steel panels. A cool roof usually shows lower values of the surface temperature if compared with a traditional roof, and it reduces the daily heat gain from roofs.

Cool flat roofs and standard flat roofs mainly differ in their surface reflectivity. The upper surface of the roof, assumed as a grey body, is exposed to the following thermal fluxes:

- Incident short-wave radiation from the sun
- Long-wave radiation exchange between the sky and the buildings
- Convective heat exchange with the outside environment
- Heat exchange with the indoor environment

Application Case

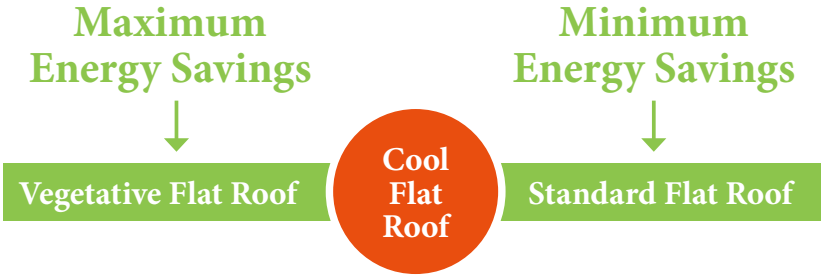
The base case used for comparative simulation is shown in Figure 1. The office space, located in Nagpur, Maharashtra, has a floor area of 1724 sq., and the same case has been considered for all the other cases. The geographic coordinates of Nagpur are – latitude: 21.15, longitude: 79.08.



» **Figure 1** Base case for simulation

Simulation Software

The software used for conducting simulations in order to assess heat gain from roofs on the energy parameter was design builder. The application of design builder includes building energy simulation, visualization, internal heat gains, solar shading, natural ventilation, hourly weather data, heating and cooling, equipment sizing, and daylight simulation. This builder operates on self-simulation engine.



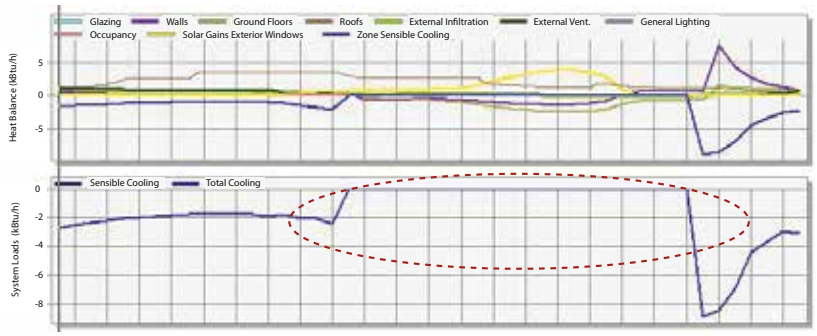
Simulation Analysis

In Figure 2, the light brown band depicts general heat gains from the roof and the graph below with the blue band shows the cooling requirement for the office space. The standard flat roof depicts more than 80 per cent heat gain from the roof.

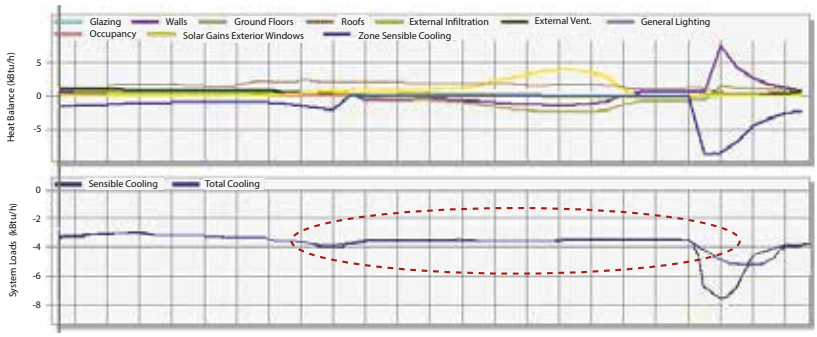
In Figure 3, the light brown band depicting general heat gains from the roof indicates reduction in the overall gains and the graph below with the blue band showing the cooling requirement, which is lower than standard roof. The cool flat roof depicts around 60 per cent heat gain from the roof.

In Figure 4, the light brown band is optimum, depicting the diminished amount of heat gain. This further aids in optimizing the overall energy consumption requirements for cooling the office space. The vegetative flat roof represents around 50 per cent heat gain from the roof.

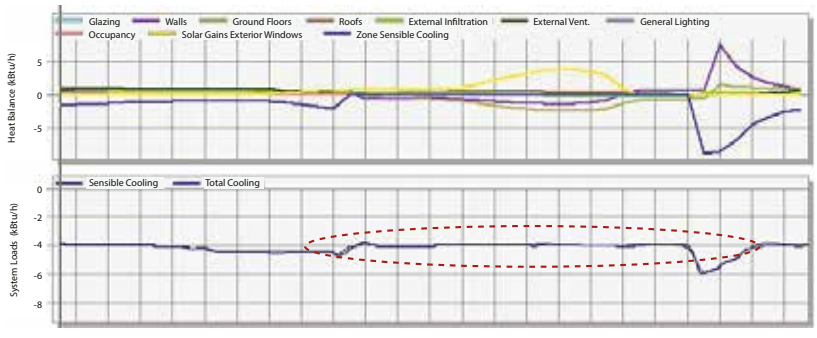
Base Case Results



» **Figure 2** Energy requirements for cooling using standard flat roof



» **Figure 3** Energy requirements for cooling using cool flat roof



» **Figure 4** Energy requirements for cooling using vegetative flat roof

Conclusion

This article aimed to contribute to an overall understanding of the energy requirements for adopting different approaches for flat roof structures. The simulation results depict that vegetative roofs prove to be the most effective technique used within the flat roofs to reduce the energy requirements for cooling the built space. As evident in Figures 2 to 4, the cooling load requirement is maximum in the standard untreated concrete flat roofs, while it is diminished by 20 per cent within cool flat roofs and further reduced by 30 per cent in the vegetative flat roofs. Hence, the vegetative flat roofs aid in optimizing the energy requirements and enhancing the thermal mass. □

STARTUP STORY
ECO365

Many cities in India are facing the worst-ever water crisis. One of the major reasons is the ineffective use of water. Optimizing the use of water efficiently is the need of the hour, and that is exactly what our company Eco365 has set out to do at an affordable cost.

I come from a small town 'Goalpara' in Assam. Due to ULFA and Naxalite problems, in 1990s, I was forced to leave my hometown and I shifted to the city for higher studies. During my higher studies, I understood that in cities, people are wasting lot of water at home due to high pressure in pipelines and less attachment to nature. In 2009, I gave up my IT and telecom based job and started researching different ways to save water. It was in 2010, I started a company with the brand name Eco365 to provide water efficiency solutions for existing properties, that is, to retrofit existing taps, shower, and toilets to reduce water wastage, and save energy with the help of aerators, flow restrictors, showers, and waterless urinals.

By water efficiency we mean reducing water wastage by doing changes that do not impact the performance or the purpose of plumbing fixture, like reducing the flow rate of tap and shower to optimal levels. It can be sometimes using no water also. The concept of water efficiency was not known to common people in the country around 2010; also the awareness level on water scarcity issue was less.

Water efficiency was a very new and unique concept in India; majority never heard about the solutions we provided to save water or reduce water wastage. We reached out to individuals, PWD government officials, and property managers of private companies to explain the concept. Many would hear to us, but will hold the decision to buy, the reason is water is inexpensive. The first two years were challenging for us for various reasons; the concept was new, we had limited funds, water was inexpensive (free, in many cases), and many thought water was abundantly available. These thought processes made the sales cycle slow.

But we were confident about our product. We knew that by creating awareness, we will increase our sales. We soon learnt the art of convincing prospective customers to do trials for water-efficient products. We started concentrating more on business from private companies across India as the decision-making process was faster. Private companies also had norms related to environment, to be followed, as imposed by the government. They found our solutions attractive and unique.

GAUTAM SURANA

Soon, word spread in the industry, one customer started referring more customers and property managers to us. Since our innovative solutions to save water were easy to adopt and cost-effective, soon, we received numerous testimonials and referral business.

In 2015, we ventured into bio-plastics, also known as compostable plastics made from natural and biomaterial, for our existing customer. Majority of our products and solutions were developed based on inputs and requirements received from our clients. We made sure we are client-centric and flexible to changing business dynamics. Recently, we received numerous appreciations and media featuring, which make us believe we are in right direction.

Our goal is to conserve 3500 billion litres of fresh water by 2030, and help millions of Indians save water, energy, and money. We have recently appointed partners in international markets, and are confident to do good business abroad in the near future. We will also launch more new products in the same segment to achieve the objective of sustainability.

Our Awards and Recognitions
"Indian of the Year 2017"
(for water conservation)
"Green Excellence Award 2018"
(for innovative green products and technology)
"Best Green Entrepreneur Award 2018"
by National Awards for Excellence in Green & Waste
"Waste Water Management – 2019"
(Online Sustainability Awards 2019)

OPTIMIZING AFFORDABLE HOUSING

Through Building Materials

India's housing industry is not only one of the fastest growing sectors, it also consumes enormous energy leading to a massive reduction in natural resources. With India's growing population, rising income level and rapid globalization, it has become important to formulate and implement certain housing schemes, initiatives, and policies so that the growth in this sector is monitored in a sustainable manner. In this article, **Deepak Bansal** and **Vijay K Minocha** discuss affordable housing strategies in India including schemes like Pradhan Mantri Awas Yojana (PMAY), an initiative by the Government of India, ways of tackling shortage of housing facilities, and they explain the anomalies that affect the apparatus of the housing sector in India.

Deepak Bansal *is currently serving HUDCO Ltd, as joint general manager (projects) in New Delhi. He is involved in civil and structural engineering, green buildings, alternative building materials and construction technologies, disaster management, PMAY, Environmental Impact Assessment (EIA), Terrorism Prevention and Investigation Measures (TPIM), Department of Parks and Recreation (DPR), arbitration, estimation and tendering. He is a member of many national and international professional organizations. He is a PhD candidate with GGSIP University Delhi.*

Vijay K Minocha *is currently serving in Civil and Environmental Engineering Department of Delhi Technological University, New Delhi. He is a PhD in civil engineering and has extensive experience of industry and academics. He has presented many papers in national and international peer reviewed journals, conferences and seminars.*

The construction industry is one of the major sectors responsible for the fast depletion of natural resources and increased energy use in building and other operations. This industry consumes about 24 per cent of the total materials extracted from the Earth.[1] Manufacturing of materials and construction of buildings consume enormous amounts of energy resulting in increased CO_2 emission and global warming. The construction sector contributes to 17 per cent in CO_2 emission in India.[2] A recent assessment by Intergovernmental Panel on Climate Change (IPCC), considers construction as one of the crucial industries that can help reduce the energy demand as well as mitigate climate change issues. According to the IPCC report, efforts must be made to limit and control the levels of CO_2 in the atmosphere by 450 parts per million (ppm), to have a 50 per cent chance of staying below a 2˚C rise in the global average temperature above pre-industrial levels.[3]

India is the second most populous country in Asia, with a population of 1.2 billion in 2011 and this figure is only growing. There is a severe shortage of housing facilities, especially among the economically weaker sections or lower-income groups (EWS/LIG). In India, an affordable house for people in these sections typically constitutes two rooms, a kitchen, a toilet, and a bath. These houses are mostly naturally ventilated. In India, more than two million houses are being constructed annually, in the category of 25–60 m^2 of plinth area to overcome the shortage of affordable housing. Most of these houses are built using fired clay bricks, cement, and steel, which are energy-intensive construction materials. These houses are made for poor people, who rarely utilize energy for heating, cooling, and ventilation. This is why the operating energy of these houses is not significant. The energy required in constructing these houses is also less due to the easy availability of labour. Hence the embodied energy of construction materials determines the carbon footprint and the energy invested in making/building such houses. Moreover, there are other aspects like foundation, wall, roof, terracing, flooring, finishing, joinery, etc., in these houses, which rely on different amounts of embodied energy. A building's element-wise analysis would be helpful to understand the usage of energy-intensive elements and construction materials, in order to minimize their energy invested and carbon footprint. These could be substituted by low-energy materials through interventions in the structural design.

This article aims to assess the building's element-wise embodied energy for affordable urban houses in India, and further identify energy-intensive elements so that they can be optimized.

In this study, we have chosen 22 houses that have been designed, appraised, and built by public agencies of the Government of India, under PMAY, which is an initiative to provide affordable housing to the urban poor. The plinth area of these houses varies between 27 and 60 m^2. These houses have been constructed as single, double, triple, or four storeys, depending on the load-bearing capacity of the ground and other economic concerns. The bill of quantities of these houses has been calculated from the GFC

(good for construction) drawings and quantities of major construction materials including a computation of the corresponding embodied energy of used elements.

The typology of the houses (used in this study) is most common in India. The fired clay brick is the most commonly used construction material for walls and foundations. The embodied energy values are dynamic and region specific, which might change according to the technological uses and transportation distances.

In this study, the embodied energy values (EEV) of different building elements of the houses have been calculated from the bill of quantities in the actual construction of these elements, based on the GFC drawings, specifications of the building, and the EEVs of the construction materials.[4] Table 1 shows the average quantities for foundation, walling, roofing, plastering, flooring, terracing, etc., per sqm. of plinth area, which have been computed based on the design strategy for the selected 22 houses.[5]

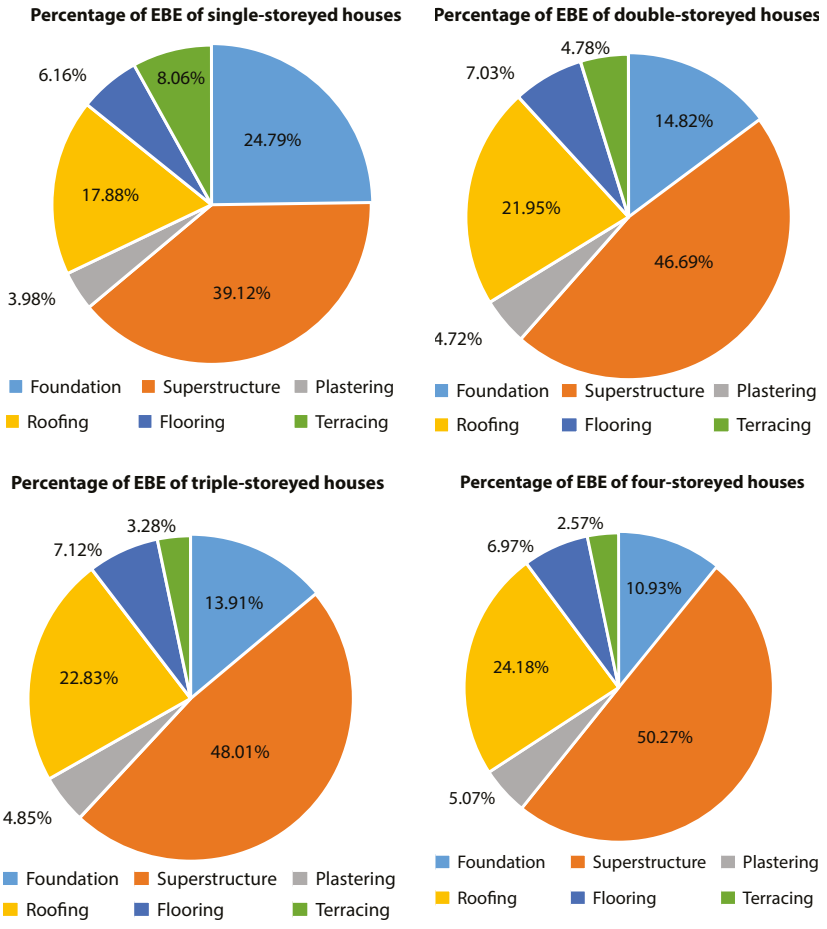
[1] Zabalza Bribián, Ignacio, Antonio Valero Capilla, Alfonso ArandaUsón. 2011. Life cycle assessment of building materials: Comparative analysis of energy and environmental impacts and evaluation of the eco-efficiency improvement potential: Building and Environment 46: 1133-1140.

[2] Sengupta, Nilanjan, Souvanic Roy, Himadri Guha. 2018. Assessing embodied GHG emission reduction potential of cost effective technologies for construction of residential buildings of Economically Weaker Section in India, Asian Journal of Civil Engineering 19: 139–156. Available online at: https://doi.org/10.1007/s42107-018-0013-8; last accessed on September 27, 2019.

[3] 'Mitigation Contribution of Working Group III to the Fourth Assessment Report', IPCC (AR4). January, 2007.

[4] In this study, basic embodied energy values (EEV) of the construction materials have been taken from previously published and widely accepted work by Chani et al., DA (Development Alternatives) and BMTPC: Chani, P.S., Najamuddin, S.K. Kaushik. 2003. 'Comparative Analysis of Embodied Energy Rates for Walling Elements in India': IE (I) Journal-AR, vol. 84, October 2003: 47-50.

[5] 'Development Alternatives, Energy in Building Materials': Final Report, BMTPC. 1995.



» **Figure 1** Percentage share of embodied energy by different elements for one to four-storeyed affordable houses
EBE:Embodied energy

Table 1 Consolidated bill statement of quantities of building materials for houses per m^2 of plinth area

S No	Item	Units	Single storeyed	Two storeyed	Three storeyed	Four storeyed
1	Fired clay bricks	No.	443	339	324	300
2	Cement	Bags of 50 kg	3.81	3.25	3.13	2.98
3	Steel	kg	12.57	11.83	11.59	11.46
4	Coarse sand	cum	0.50	0.41	0.39	0.37
5	Coarse aggregates	cum	0.34	0.28	0.27	0.26

It is evident that the quantities of the construction materials are decreasing with an increase in the number of storeys. However, there is no linear interpolation between the number of storeys and quantities of construction materials. This leads to another complication with reference to the embodied energy values of all construction materials that differ from each other. Therefore, the carbon footprint of these houses needs to be analysed, material wise, as well as building element wise. The quantities of the construction materials as presented in Table 1 are multiplied with their respective embodied energy values to calculate the building element-wise total embodied energy.

Conclusion

The embodied energy of the building elements used in constructing affordable houses for up to four storeys is explained in Figure 1. The embodied energy values do not change because these are dependent on plinth areas. However, other elements like walls, flooring, finishing/rendering are components whose values change depending on different storeys. For instance, this analysis shows that wall are the most energy-consuming element, consuming embodied energy[6] between 39 per cent and 50 per cent. The roof is identified to be the second most energy-consuming element, which accounts for 18–24 per cent of the total embodied energy. The third most energy-consuming element is the foundation, which takes up about 11–25 per cent of the total embodied energy. More than 82 per cent of the total embodied energy is consumed by wall, roof, and foundation, which are most energy intensive. The percentage share of EEV increases with the number of storeys for walls and roof, significantly. However, the absolute value of embodied energy for roof remains same for all storeys and the absolute values of embodied energy for walls decrease with higher storeys. The percentage share of EEV decreases for foundation and terracing elements with more number of storeys. The variation in EEV in flooring and finishing/plastering/rendering elements is found to be negligible. □

The authors are thankful to Dr Shailesh Kr Agarwal, Executive Director, Building Materials and Technology Promotion Council (BMTPC), New Delhi, India and Ms Yashika Bansal, student of B Design, FDDI, Noida, India, for their encouragement, critical comments and help in analysing the data used in this article.

[6] Bansal, Deepak, Ramkishore Singh, and R.L. Sawhney. 2014. Effect of construction materials on embodied energy and cost of buildings — a case study of residential houses in India up to 60 msq of plinth area, *Energy and Buildings* 69: 260–266.

Mitigating Plastic Pollution

__Tanu__, a student of Amity Institute of Environmental Science, Amity University, Noida, recently worked as a project consultant in Environmental and Waste Management division of TERI, New Delhi. She has a keen interest in understanding critical environmental issues that India is facing today, and she wishes to work on developing a plethora of strategies for the cause of sustainability and environment preservation. She can be reached at tanu94c@gmail.com.

Global plastic consumption is on the rise. Every year, millions of tonnes of plastic end up in the oceans, seas, and other waterbodies. India's commitment to eradicate single-use plastic by 2022 is an ambitious goal. Our country's per capita plastic consumption indicates that the growth rate of this industry is one of the highest in the world. In a bid to boycott single-use plastic, responsible disposal of used plastics is one of the first steps to overcome the plastic waste challenge. In this article, **Tanu** discusses sustainable ways and techniques like ecolabelling, recycling, bans, and behavioural change, through which negative effects of plastic use can be controlled.

The increasing demand for and dependence on plastic as an ordinary thing, and subsequent indiscriminate disposal by people and industries have made this material the focus of interest of many researches, and its usage an important environmental concern. Plastic generation expanded to more than 250 million tonnes in 2009 with a yearly expansion rate of 9 per cent. In 2015, the worldwide utilization of plastic materials was accounted to be greater than 300 million tonnes – a figure that is expected to surge exponentially. Consumption of plastic poses serious threat to aquatic life. When ingested by aquatic biota, especially the filter feeders, such as molluscs, mussels, oysters, plastic makes its way into the food chain, thereby leading to toxicological consequences for both aquatic organisms and human beings as final consumers at the end of this chain. To limit the negative effects of plastic use, many techniques are required for proper regulation and management of plastic waste.[1]

Mitigation Strategies

- **Ecolabelling:** Ecolabelling has turned into a valuable tool for the government in encouraging effective environmental practices, and for organizations too, in distinguishing and establishing markets for environmentally preferable products.[2] These labels cover a huge number of items that can be considered recyclable, eco-friendly, low-energy, and reusable substances. Items classified under ecolabelling are plastics, cleaning products, batteries, materials, cosmetics, bundling materials, drugs, and electrical goods. The main objective of ecolabelling is to reduce the harmful impacts of products and help customers become conscious and mindful buyers. The method of environmental performance certification and labelling provides data to consumers so that they can take into account relevant factors while making a purchasing decision, and eventually buy products that are not only less harmful for the environment but also economically viable.
- **Recycling**: There is a growing move towards reuse and reprocessing of plastics for economic, as well as environmental reasons, with many praiseworthy examples of companies adopting various technologies and strategies to recycle plastic. Recycling is a waste management procedure mainly for reducing the harmful effects of waste, for example, plastic polymers and asset consumption. Reusing plastic waste is necessary to reduce the quantum of plastics entering our seas and other waterbodies. Recyclability of plastics depends primarily on the sort of plastic resin or the blend of resins, and methods accessible for reuse.
- **Bans and forced charges:** Excessive discharge of plastics into the environment and consequent pressure from civil society have led to the implementation of serious measures by both the government and business sectors.[3] Strategic plans have been made by governments everywhere, across the world, to boycott the trade and utilization of lightweight packs and microplastics in items. For example, Europe, Germany, and Denmark were the early adopters of plastic sack bans more than two decades ago. Complete boycott from the deals and utilization of plastic sacks (single use) are ways to decrease plastic waste and its disposal in waterbodies, which in turn reduce negative effects on marine life. In any event, more than 30 nations in Asia, Africa, Europe, North America, South America, and Oceania have either partially or totally prohibited the utilization of plastic bags.
- **Action plans and administrative measures to decrease the inputs of plastic from land or ocean-based sources**: Several global conventions and agreements have been introduced to control and check the inclusion of plastic and microplastics in the marine spheres.

[1] Ogunola, O. S., O. A. Onada, & A. E. Falaye. 2018. 'Mitigation measures to avert the impacts of plastics and microplastics in the marine environment'.

[2] Global Ecolabelling Network (GEN). 2004. 'Global Ecolabelling Network (GEN) *Information Paper*', Introduction to Ecolabelling. Retrieved from http//www.gen.gr.jp; last accessed on October 17, 2019.

[3] Godfrey, L. 2019. 'Waste Plastic, the Challenges Facing Developing Countries—Ban It, Change It, Collect It', p. 2–7. Available online at https://www.mdpi.com/2313-4321/4/1/3; last accessed on October 9, 2019.

The issue of plastic waste is a common concern for humankind. Extensive participation, regular endeavours to minimize the use of plastic, and formulation of sustainable solutions are some of the ways to address this burning issue. Many regional conventions have helped establish harmonized guidelines to decrease the dumping of plastic into the waterbodies.

- **Behavioural change strategy**: There is a requirement for individuals to see a connection between their plastic utilization pattern and the outcomes like environmental degradation. In one of the biggest scientific appraisals of public observations about plastic contamination in Europe, it was revealed that an enormous number of respondents were ignorant of the natural issue. Educational outreach and public awareness programmes must be set up by different legislative and non-administrative (NGOs) organizations to motivate people to boycott plastic use.
- **Removal/clean-up strategy**: Beach cleaning is a community-based methodology that includes volunteers, and it has been a powerful method to decrease plastic accumulation from being washed into the seas or oceans. For example, during a survey, around 1271 plastic sections and 912 resins were recovered from the sandy beach of Punta del Este in Uruguay. The best time to perform a beach clean-up is when there are accessible labour, great climatic conditions, and adequate funds. For a critical impact to be acknowledged, it was suggested that beach clean-up be conducted every two years.

Plastic contamination is growing at an alarming rate, worldwide, as compared to other issues, such as climate change and sea fermentation, due to increased production and indiscriminate disposal practices by people and industries. It is concurred that microplastic contamination is a critical stressor to marine ecosystems because of unprecedented faunal ingestion. Despite various interventions to mitigate the issue, plastic use is still rampant. Among the methodologies elaborated, a positive human behaviour change is the most impactful answer to this ecological issue. Effective waste administration, responsible production, and behavioural changes are coordinated methodologies that can keep plastic from entering our marine environments. Intensive research must be done to quantify the positive effect of such methodologies for posterity. ◻

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KAIZEN GOAL: A Paradigm Shift in Waste Management in India

India is a water stressed country which is grappling with issues of water scarcity, adequate supply and quality. Inaccessibility to potable water is a grave concern. In this article, **Ar. Sneha S. Reddy** explains the various facets of water conservation in India, with specific reference to Kaizen Goal – an initiative that is committed to the use of sustainable ways of water consumption and preservation. While C&D waste management is the need of the hour, proper disposal and recycling of single-use plastic products are crucial for a better and green future.

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KAIZEN GOAL: Stepping towards Sustainability

Kai means change and Zen is a realization of the expectation. Kaizen's philosophy is committed to a goal that works on the premise of "**g**rabbing the **o**pportunity **a**nd **l**iving happily" – a process, which has four major principles: Plan, Action plan, Check, and Act. As per 2018 demographical data, India, a country with 1.35 billion people, is a land of diverse cultures with a prominent presence in the world. However, it is also a country where, in a year, 62 million tonnes of waste is generated and it increases by 4 per cent every year.[1] Sixty per cent of this waste is collected and the remaining is processed. Numerous surveys have been conducted to understand the cause for the rise in waste generation. According to these surveys, waste generation increases with an increase in the income level, thereby affecting human health, environmental quality, waste picker families' lifestyles, etc. In the field of sustainability, a gap has been observed, which requires individual effort to achieve a holistic sustainable development by 2030. Considering these issues, this article aims to elaborate on the various sustainable practices that can help bridge the gap between our present and future needs. The present scenario of sustainability in India includes the following aspects:

1. **LPG:** Amount of resource consumed is 13.568 million tonnes and imported resources consumed is 6.093 million tonnes
2. **Construction and Demolition Waste:** In 2000, 15 million tonnes of waste was generated, this figure is most likely to increase in the coming years
3. **Water:** 163 million Indians lack access to potable water; 125 million litres of water is wasted daily, moreover, half of the rivers that the country has are polluted
4. **Waste:** In 2017, 62 million tonnes of waste was generated in India annually making it stand 10th in the world in generating municipal solid waste.[2]
5. **Energy:** According to the Ministry of New and Renewable Energy (MNRE), India has a potential of producing 1700 MW from urban waste, but converts only 2 per cent of that waste to energy.[3]
6. **Pollution:** Delhi is a highly polluted city, followed by Gurugram with a highest concentration level of PM2.5.[4]

Food, water, shelter, and clothing are essential for the survival of a human

[1] Press Information Bureau, 2016.

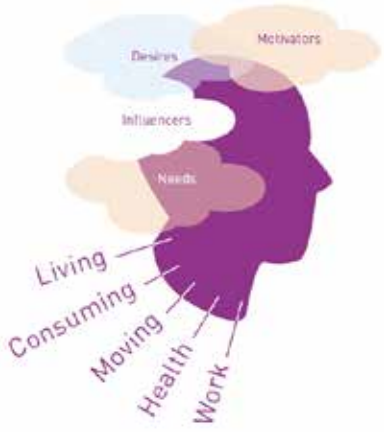
[2] Planning Commission, GOI. 2014. Report of the Task Force on Waste to Energy (Volume I). Retrieved from http://planningcommission.nic.in/reports/genrep/rep_wte1205.pdf; last accessed on October 17, 2019.

[3] Retrieved from http://www.eai.in/ref/ae/wte/wte.html; last accessed on October 17, 2019.

[4] Greenpeace India report, 2018.

being. But for a sustainable life, water, soil, and air are crucial and potential environmental sources that are shrinking at an alarming rate, every year. As every individual performs different activities every day, these daily chores have a huge impact on the depletion of natural resources. Such segmented activities have been represented in Figure 1, along with several other influential factors causing this destruction of resources, as explained in Figure 2.

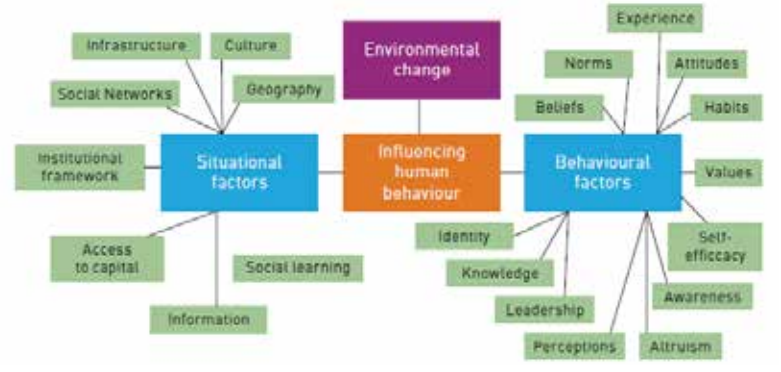
Every individual in the country has a different profession, and these individuals generate various types of waste (directly or indirectly) on a daily basis, which have been listed in Table 1. Typical composition of Indian waste is represented graphically in Figure 3. Figure 4 shows there are three lifestyle changes that can help achieve sustainability.



» **Figure 1** Zonal activities in a human's life

Table 1 Waste generated through routine works

Work	Types of waste generated
Brushing	Water
Cleaning utensils	Water
Preparing tea/coffee, etc.	Water, tea filter, plastic milk covers
Newspaper reading	Newspapers
Cooking	Vegetable matter, water, meat residues
Breakfast	Left over food (if any), fruit peels, etc.
House cleaning	Water, chemicals
Vehicle washing	Excessive water, chemicals
Getting ready	Deodrants, perfumes, creams (affecting IAQ)
Pooja/any religious rituals	Flowers, turmeric, rice, agarbattis
Travel to work	Gas emitted from vehicles, carbon footprint
At office/work place (probable basis)	Stationery, cardboard, e-waste, plastic covers, green tea bags, water, excessive electricity
At corporate offices	E-waste, plastic covers, water, excessive electricity
Smokers	Cigarettes
Food points	Food waste, plastic plates, cups, covers
Textiles	Remaining cloth pieces, threads
Industries	Harmful gases emitted
Urban scale	Tree litter, water, open drains filled with waste
Dairy	Plastic covers
Carpentry	Saw dust, wood pieces/logs
Salons	Hair, chemicals, water, plastic items
Juice stalls/ restaurants	Plastic glasses, bottles
Construction field	Construction waste, materials waste
Butcheries	Meat waste
Agriculture	Crop waste
Pharmaceuticals	Drugs
Wine Shops	wine bottles



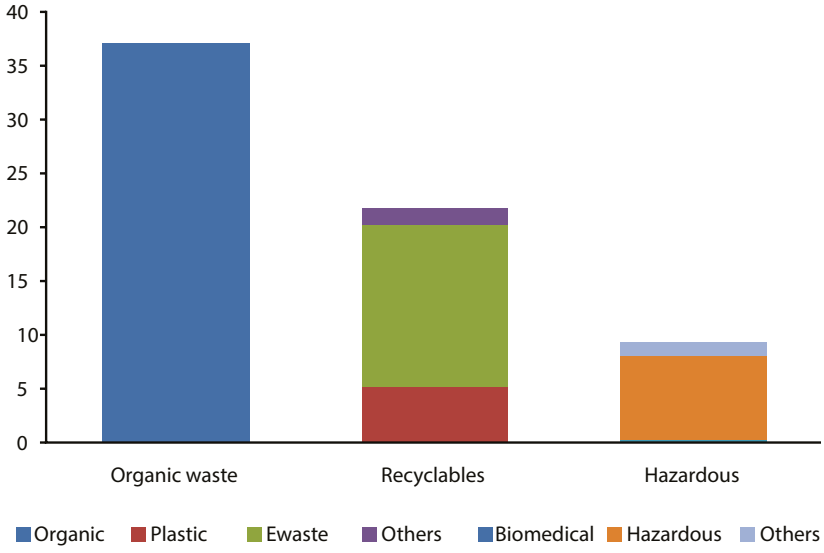
» **Figure 2** Various factors affecting the availability of natural resources[5]
Source: Defta, Sustaionable Lifestyles Framework, 2011.

KAIZEN GOAL methods focus on looping one sustainability issue with another for optimum solutions.

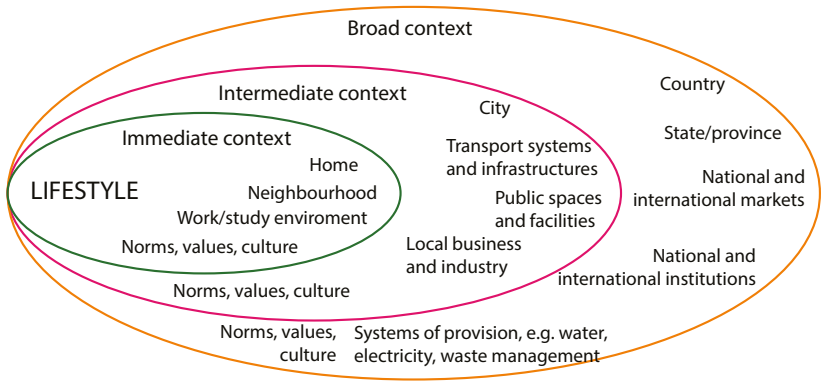
Food waste: India generates 67 million metric tonnes of food waste per annum.[6] Typical composition of Indian waste is represented graphically in Figure 3.

[5] Julia Backhaus, S. B. 2010. Sustainable Lifestyles: Today's facts and Tomorrow's trends. Netherlands: European Union's Seventh Framework Programme (FP7 SSH-2010-4).

[6] Khan, S. 2019. This Hyderabad Startup Aims to Curb Restaurant Food Waste. Retrieved from https://www.restaurantindia.in/article/this-hyderabad-startup-aims-to-curb-restaurant-food-waste.13101; last accessed on October 17, 2019.



» **Figure 3** Waste composition (in million metric tonnes) per annum.
Source: PIB, 2016



» **Figure 4** Impact of three lifestyle layers on sustainability [7]

Ways to avoid food wastage are as follows:

- Replace plastic straws with stainless steel or glass straws, avoid consuming fresh juice in plastic glasses
- Food waste can be converted to organic manure or biogas
- Use eco-friendly and smart disposable food packaging, made from the residue of wheat, sugarcane leaves, banana stem, and so on.[8]

Use of food and agricultural waste in construction industry: These days there are technologies that readily make use of agro-waste and convert them into products that can be very useful in the field of construction. Peanut shells can be used for partition boards (fire, ice-resistant), burnt rice with cement (eliminate fillers), mushrooms for growing buildings, potato peels act as a good insulating material,[9] and banana leaves can be used for textile industry development.[10] Food waste along with wooden chips or saw dust is rich in humus content and act as fertilizer for soil.

Putting plastic to use: As per 2030 UN Report, 619 million tonnes of plastic is produced per year in which 115,342 tonnes plastic gets wasted per day. Some of the possible solutions to address this crisis are as follows:

- Use bags of less than 50 microns
- EcoDom (a technology where plastic gets industrially processed, converted into flakes, melted, added to moulds, pressed at plasma state and blocks are developed
- Promote the use of plastic Paver tiles
- Plastic toilets: a 4 ft x 4 ft model, which costs INR 40,000 per unit
- Plasphalt roads[11] (made of plastic and asphalt)

A fine example of best use of plastic waste can be observed in Hyderabad.[12] A 225 ft^2 house, constructed with 4000 mud-filled plastic PET bottles arranged horizontally and vertically, in a budget of INR 75,000, acts as a good thermal insulator. Mud and cow dung are used for plastering.[13] In the present Indian scenario, it is a good

[7] Refer to Footnote 5.

[8] Salian, P. 2018. Making Products with Crop Waste Could Improve India's Air and Water. Retrieved from https://www.citylab.com/environment/2018/04/making-products-with-crop-waste-could-improve-indias-air-and-water/558338/; last accessed on October 17, 2019.

[9] Froelich, A. 2017. This company wants to turn food waste into building materials — Here's how. Retrieved from https://inhabitat.com/this-company-wants-to-turn-food-waste-into-building-materials-heres-how/arup-group-seeks-to-turn-food-waste-into-building-materials-2/; last accessed on October 17, 2019.

[10] Fitzgerald, F. 2017. Organic waste could provide the building materials of the future, Arup report shows. Retrieved from https://www.arup.com/news-and-events/organic-waste-could-provide-the-building-materials-of-the-future-arup-report-shows; last accessed on October 17, 2019.

[11] TV18, C. 2018. What do you do with plastic waste? Make tiles! Retrieved from https://www.cnbctv18.com/changing-india/what-do-you-do-with-plastic-waste-make-tiles-1761441.htm; last accessed on October 17, 2019.

[12] Chronicle, D. 2018. Hyderabad ranks 6 with 32,000 tonnes of waste. Retrieved from https://www.deccanchronicle.com/nation/current-affairs/240518/hyderabad-ranks-6-with-32000-tonnes-of-waste.html; last accessed on October 17, 2019.

[13] Richi, P. 2018. This Hyd entrepreneur is making houses, bathrooms and more using treated plastic. Retrieved from https://www.thenewsminute.com/article/hyd-entrepreneur-making-houses-bathrooms-and-more-using-treated-plastic-89327; last accessed on October 17, 2019.

alternative to housing shortage. It not only provides shelter to the needy but also reduces CO_2 emissions and adds speed to the execution.[14]

Some examples of e-waste are as follows:

- Metals like nickel, cobalt, and cadmium in the old batteries can be used for new batteries with stainless steel
- Circuit beads (gold, silver) for jewellery
- Handsets for pallets, fence posts

Construction and demolition waste: As per the report released in 2017 by the Central Pollution Control Board (CPCB), India produces 10–12 million tonnes of construction and demolition waste, annually. The generated waste is sent to landfills or illegally dumped into water bodies, thereby choking storm water drains, polluting the riverbed.

As per the Central Public Health and Environmental Engineering Organization (CPHEEO), CDE Asia uses more than 50 million aggregates for road construction. It has also developed a C&D waste processing plant in Burari, New Delhi.

Another promising C&D waste initiative has been implemented by the Delhi government for the new houses of ministers.[15] These houses have been made from demolition waste out of the old parliament ministers' residences.

There are a few mitigation strategies, as given in Table 2, that can be adopted to reduce the harmful impacts on the environment.

In this process of protecting the environmental resources, there are many governing bodies such as GRIHA Council, MNRE, BMTPC, CBRI, APEDA, etc. that have taken up green initiatives by creating awareness, providing innovative and affordable solutions for a better future.

Table 2 Mitigation strategies to reduce harmful environmental impacts

Impacts	Mitigation strategies
High traffic density	▪ Efficient public transport ▪ Compact city design
High Amount of waste	▪ Recycling
Urban warming	▪ Increasing green space ▪ Using reflective materials
Increasing air pollution	▪ CO_2 capture ▪ Filtering exhaust gases ▪ Increasing efficiency of industrial processes/ vehicles
Increasing energy consumption/ sinking resources	▪ Using renewable sources ▪ Achieving low energy buildings ▪ Increasing efficiency of device/processes
Lack of biodiversity/ natural habitat	▪ Increasing green space ▪ Developing animal/ plant protection areas
Sinking water resources	▪ Water purification ▪ Desalination ▪ Rainwater harvesting
Rising food demand/ poverty	▪ Vertical farming ▪ Artificial food production ▪ Greening of deserts
Land shortage for housing	▪ Constructing multifunctional buildings ▪ Creative architectural designs
Weak social cohesion	▪ Improving socio-cultural environment ▪ Increasing the number of organisations and events that bring people together

Source: Saffa Riffat, R. P. 2016. Future cities and environmental sustainability. Future Cities & Environment, Springer (23).

Initiatives by TERI Green Agenda 2019

TERI Green Agenda[16] is an integrated resource efficiency initiative that focuses on ways of reducing air pollution, energy transitions, resource efficiency, water, and waste management.

Conclusion

The article aims to create awareness among every individual in taking an initiative for a larger difference to environment preservation. Development work should be initiated at the level of an individual first, then residence, followed by neighbourhood, eventually a village, city, and finally the country as a whole. In this process of development, awareness through media is necessary along with social responsibility. For a better life and a sustainable lifestyle in future, guidelines and by-laws by municipal corporations, NBC, GRIHA Council, CBRI, BMTPC, etc. should be mandatorily followed. Every problem has a solution. For instance, utilizing the leftover of any waste as a byproduct, directly or indirectly, can produce an innovative and environment-friendly product. Such initiatives can help build a green society.

Think green globally, but act locally □

[14] Patel, Pratima A., Akash Shah, Henish Patel. 2016. Waste Plastic Bottles Offering Innovative Building Materials with Sustainable Application. International Journal of Innovative and Emerging Research in Engineering, vol. 3 (3). Retrieved from http://www.ijiere.com/FinalPaper/FinalPaperWASTE%20PLASTIC%20BOTTLES%20OFFERING%20INNOVATIVE%20BUILDING%20MATERIALS%20WITH%20SUSTAINABLE%20APPLICATION170636.pdf; last accessed on October 17, 2019.

[15] PTI. 2019. Construction waste to be used to build flats for MPs. Retrieved from https://www.telegraphindia.com/india/construction-waste-to-be-used-to-build-flats-for-mps/cid/1692581; last accessed on October 17, 2019.

[16] TERI. 2019. TERI Green Agenda 2019, p. 16; New Delhi.

Social Sustainability in Indian Smart Cities

The most successful global cities across the world today are characterized by not just high levels of technology and economic activity but high levels of social well-being as well. A positive perception of a city is the reflection of its social fabric. This article by **Sugandha** and **Dr Paola Favaro** presents a critical reflection on the practice of social sustainability (social capital, social inclusion and social equity) in the built environment through observations of Indian smart cities under 100 Smart Cities Mission.

***Sugandha** is currently pursuing her PhD in built environment at UNSW, Sydney. With 12 years of professional involvement in urban planning projects, she has worked on the master planning of the first few Indian smart cities including GIFT city, Integrated Manufacturing Clusters (IMCs) in 7 AKIC states and Bhopal smart city. She can be reached at sugandha@unsw.edu.au.*

***Dr Paola Favaro** is a senior lecturer in architecture and a postgraduate research coordinator in the faculty of Built Environment at UNSW, Sydney. Her research and publications are related to architecture and urban history, and their role in solving the design of a sustainable 21st-century city. Her work has been presented at the CTBUH international conference – Connecting the City, 2018. She can be reached at paola.f@unsw.edu.au.*

One of the burning questions we are grappling with today is whether smart cities are the panacea for the increasing urbanization problem and discontentment among citizens. Smart cities have become a global phenomenon, initially by utilizing technological advancements and then by gradually moving towards a focus on digital databases. The evidence of social content in smart cities is limited,[1] hampering its relevance in many contexts. The concept of a smart city is new to developing countries and provides an opportunity to introduce social sustainability to the smart city agenda. As reported by McKinsey Global, India with a high rate of urbanization will add 590 million people to its cities by 2030,[2] raising the urban population to 40 per cent. The Government of India has acknowledged the requirement of a comprehensive development of physical, institutional, social and economic infrastructure to improve the quality of life and attract people and investments to the city. As part of the urbanization process, the development of smart cities through the 100 Smart Cities Mission (SCM) is a step in the way of comprehensive development. In general, there is no clear definition of smart city and therefore, there is an opportunity for SCM to develop its own meaning, depending upon the chosen path of growth. It is relevant to examine how the Indian smart cities are absorbing the diverse definitions[3] of "smart city" as a global concept and the extent to which they follow the direction of realizing a socially sustainable built environment appropriate to their context.

> **"There is no universally accepted definition of smart city and its meaning is interpreted differently by people, cities and countries depending upon their level of development and vision."**

Smart City Discourse in India

The Smart Cities Mission guideline[4] states:
The unclear definition of smart city has invited international technology corporate giants to dictate and navigate the direction of smart city discourse in India. Eighty-three out of 100 selected smart cities in India have prioritized ICT-based smart city control centre as part of their Smart City Plan (SCP), keeping technology at the forefront.[5] Whereas, SCM's objective is to promote compact, sustainable, and inclusive cities demonstrated through 24 smart city features. The absence of a true definition and the consideration of multiple elements as mandatory to the SCP highlight a major drawback of the programme. It imposes everything on every city without being sensitive to the social context of the city.

Importance of Social Sustainability in Built Environment

Social sustainability concerns how individuals, communities and societies live with each other and set out to

[1] Colding, J. & Barthel, S. 2017. 'An urban ecology critique on the "Smart City" model', Journal of Cleaner Production, vol. 164, p. 95–101, DOI: https://doi.org/10.1016/j.jclepro.2017.06.191; last accessed on October 9, 2019.

[2] McKinsey & Company. 2015. 'Global Media Report – Global Industry Overview', Global Media and Entertainment Practice, London. Available online at https://www.mckinsey.com/~/media/McKinsey/dotcom/client_service/Media%20and%20Entertainment/PDFs/McKinsey%20Global%20Report%202015_UK_October_2015.ashx; last accessed on October 9, 2019.

[3] O'Grady, M. & O'Hare, G. 2012. 'How Smart Is Your City?', Science, vol. 335 (6076), p. 1581–1582, DOI: 10.1126/science.1217637; last accessed on October 9, 2019.

[4] Ministry of Urban Development (MoUD). 2015. 'Smart Cities – Mission Statement and Guidelines', Government of India. Available online at http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf; last accessed on October 9, 2019.

[5] Praharaj, S., Han, J.H. 2019. 'Cutting through the clutter of smart city definitions: A reading into the smart city perceptions in India', City, Culture and Society, DOI: 10.1016/j.ccs.2019.05.005; last accessed on October 9, 2019.

achieve the objectives of the selected development model. The main aspects of social sustainability in the built environment are social capital, social inclusion, and social equity.

Social capital must emphasize on the involvement of people through social interaction and a sense of community. Social inclusion and social equity are manifestations of equal access to important services and facilities. Thus, it is mandatory for the Indian smart cities to achieve a socially sustainable urbanism while drafting the SCM objectives along with the SCPs. Socially sustainable urbanism is the creative process where citizens with planners, urban designers, architects, landscape architects, and engineers collaborate to understand the city and transform the place in which they live.

Social Sustainability in Indian Smart Cities

The mission framework on a macro level is sensitive towards socially sustainable parameters where 24 features clearly include citizen participation, inclusion, compact, mixed-use development, and walkability among others. But the implementation of the parameters on a micro level rests on city administrations, leaving it open ended for interpretation. There is a biased approach towards environment sustainability focusing on smart technological innovations, which are mostly business motivated. The short duration of drafting SCP made city administrators vulnerable to embrace technology push while competing with other cities and ignoring the actual demands of the citizens.

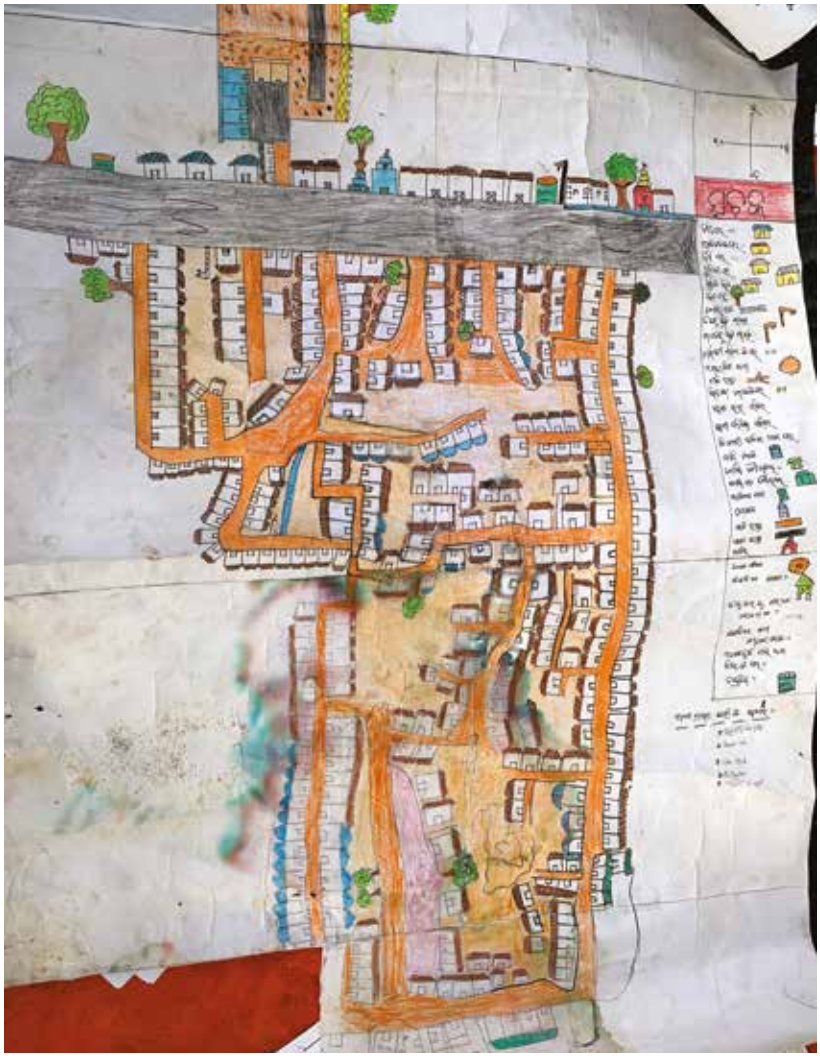
The "New Urbanist" paradigm has successfully adopted the relationship between social capital and the built environment. It seeks to "enhance social capital through the creation of pedestrian-friendly, walkable neighborhoods with easy access to parks, public transport, and retail outlets, which may also require a high density of dwellings". Social capital can be manifested in the built environment through the creation of an urban system where pedestrian paths and urban spaces provide chances of public interaction among the residents of densely populated settlements and access to formal recreational spaces like sport clubs and community centres offering opportunities for collective/group activities. Although the construction of community centres, libraries, and sport clubs has been dismissed in many proposals, a number of SCPs promote the revitalization of new open spaces and parks, and the walkability by creating continuous walkable footpaths and walking trails, as shown in Figure 1, to enhance the "last mile connectivity". In the built environment, social inclusion is linked with the public participation in planning programmes whose impact aims to reach the highest number of citizens. Citizen participation is a core feature of SCP but the city administrations have no evidence of meetings held between citizens and professionals. A robust analysis of 100 smart city proposals suggests that only six cities have undergone social/equity audits to make sure that all sections of society are included in discussions with authorities and planning professionals. The city of Bhubaneswar, whose SCP was praised for its social smartness, has no record of citizen interaction data. In most cities, social inclusiveness is limited to the street design for citizens of all age groups and special requirements. Only a few SCPs (15 in number) have the provision of facilities for the deprived

» **Figure 1** New urban walkable system in Bhubaneswar smart city (photo by Sugandha)

» **Figure 2** Schematic showing child-friendly smart city, Bhubaneshwar

and homeless. Bhubaneswar smart city aims to be child-friendly, as explained in Figure 2, which inevitably embraces many elements of being socially inclusive. Projects like Kutumb (social equity centres, working hostels and shelters for homeless), Kusum (early childhood care centres) and Swabhiman (multi-skill centres) initiated under SCP, strengthen the social inclusiveness of the smart city in Bhubaneswar.

Susan Fainstein in her article 'The just city' prioritizes social equity in "planning and redevelopment decisions made at the city level." [6] The various programmes that can enhance social equity in built environment include housing development for low-income households, preventing involuntary displacement, providing widely accessible and varied public spaces, and mixed land uses. Most SCPs (approx. 80 per cent) propose affordable housing and mixed land use as an integral part of city development. On ground, the displacement rate of slum dwellers for SCP implementation has been highly criticized by media and social activists. According to Humara Bachpan Trust,[7] Bhubaneswar has 40 per cent of its population as urban poor and the smart city area-based development boundary includes 24 out of 463 slums in the city. To overcome the challenge of displacement of the slum dwellers from the region, the government first sensitized and empowered the slum dwellers through social programmes. As shown in Figure 3, children were given an opportunity to design their new neighbourhood with professional support. There were different initiatives taken to improve the built environment of such slums like, identifying the dark corners and lighting them up, creating and cleaning up of public open areas for community gatherings and participations, and building new community facilities among others.



» **Figure 3** New neighbourhood designed by the children of slum dwellers

Way Forward

Indian Smart Cities Mission has great potential to bring social cohesion and better quality of life for the citizens. The administrators, decision-makers, and professionals need to be sensitive towards the local context and requirements of the citizens. The city can be smart not just by providing wide area network coverage but professionals committed to the cause, also need to be responsive to people's demands and needs. This is a challenge for planners, particularly with regard to the way they can reciprocate and envision a place that supports sustainable growth and welfare of the community. A unifying framework of bottom-up and top-down approaches in designing the built environment with a focus on people's well-being can deliver aspired results to achieve the future city. ◻

[6] Fainstein, S. 2013. 'The Just City', International Journal of Urban Sciences, Routledge, vol. 18 (1), p. 1–18. https://www.tandfonline.com/doi/abs/10.1080/12265934.2013.834643; last accessed on October 9, 2019.

[7] Available online at https://humarabachpan.org/; last accessed on October 9, 2019.

LAB 4 LIVING

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Playponics

Hydroponic Playground Gardens for Schools in India

The Playponics project is being funded by Sheffield Hallam University's Global Challenge Research Funding (GCRF). It involves apparently unconnected topics; physical play, environmental sustainability and early years STEM education. We propose a joint venture with your organisation that will enable installation of Playponic playground equipment that facilitate hydroponically enabled crop growth, promote physical activity and sustainability education.

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Approach to Integrated Sustainability – Industrial Sustainability

In this article, **Purva Saxena** elaborates on the importance of industrial sustainability and explains the problems faced while implementing sustainability targets in India. Developing a promising infrastructure for electric vehicles and installing necessary equipment to curb emissions are the need of the hour for India's booming industrial sector. Profitable industrial sectors must incorporate sustainability in their business approaches, models, and governance processes to capture growth opportunities, resource advantages, and cost savings.

Purva Saxena *(GRIHA CP) is an assistant manager at Design2occupancy Services LLP. She has completed her MTech in environmental science and engineering and has an experience in guiding the new construction and existing projects to achieve Green Building Certification. She is actively involved in developing sustainable ways for the projects to reduce their carbon footprint. She can be reached at purvasaxena953@gmail.com.*

Introduction

The Indian industrial sector is diverse and comprises sub-sectors such as textile, food processing, chemical, cement, steel, mining, petroleum, etc. Since the consumption demands are increasing, the industrial sector is advancing its footholds manifold. Further, our understanding of the negative impacts of the industrial activity has compelled us to reach out to sustainability that has found its way in top management agenda as well. This is also because, in the current environment, competitive advantage is for those organizations that do more with less. Profitable industrial sectors are incorporating sustainability in their business approaches, models, and governance processes to capture growth opportunities, resource advantages, and cost savings.

Measuring Sustainability and Bottlenecks

A conventional measurement of industrial sustainability comprises plant installation, building operation, raw material input, manufacturing process, and final product output. In India, by far, the conventional ways of industrial sustainability have been legally imparted or made applicable in a certain set of industries identified as either Orange or Red Category, and further based on their built-up areas.

Such industries are required to take a no objection certificate (NOC) from the Ministry of Environment, Forest and Climate Change apart from other clearances from other government departments. Obtaining such NOCs require impact assessment in the form of strategic environmental assessment, health impact assessment, and social impact assessment. This does sound foolproof on document; however, it all succumbs down under a plethora of documentation. Limited involvement of public and government agencies in the initial phases and no site visits ensure that sustainability is more on the document rather than on-site.

Additionally, in the absence of an alternative to energy information administration (EIA), even the most vigilant organization falls into the traps of red-tapism, continuous meetings, and incorporations without any being implemented on-site. Rather than a thorough study of the specific industry, it is mostly about meeting the pollution control board norms, which are generalized sets of requirements.

Thus, these bottlenecks must be further tackled by defining new norms of measuring sustainability.

> **"Sustainability is no longer about doing less harm, it is about doing more good."**

New Sustainability Approach

Environmentally aware companies are leading by example. One such company demonstrated that an approach to sustainability efforts has the following five critical elements:

1. Designing a strategy, organization, and governance model that defines clear sustainability ambitions and ensures they are achieved. It is important to ensure that sustainability reaches the board during the conceptualization stage itself.
2. Reshaping supply chains to assure long-term, sustainable supply of resources – ensuring that sustainability becomes contagious. Vendors and stakeholders, who are onboard for a longer term, must incorporate sustainability in their preamble and in further processes.
3. Rethinking operating and business models to enhance resource efficiency through innovative approaches that consume and waste less critical inputs such as water and energy – putting energy and capital on alternatives.

4. Capturing growth opportunities by developing new sustainability-based products and value propositions that support price premiums and adjacent growth – creating a vertical of more sustainable products through consumer and market-based researches.
5. Measuring impact by defining and communicating metrics for corporate social responsibility – defining the benchmark for CSR and subsequently improving by attrition for the years to come.

If the aforementioned elements are adhered to, industrial sectors might save themselves from falling in the Critical Category of waste production and contributing to pollution emission. Such industries have found out a way to penetrate the social structure of India and have found out areas that impact regional sustainability as a whole. One such company is Standard Chartered — WASHE (Water, Sanitation, Hygiene, and Education) is the bank's approach to sustainability. It provides access to water, sanitation facilities, and education opportunities to adolescent girls in municipal schools and disadvantaged communities at large. This takes care of the social structure and in turn, contributes to a better society.

Hence, the new sustainability approach moves away from defining sustainability only within the paradigm of product design and process technology. Though it is true that processes and raw inputs define the types of pollutants emitted, solid and hazardous wastes generated, resources harvested, and energy consumed. However, in a business environment, there are other factors such as exploitation of new markets for growth, enhancement of products to maintain demand, and global sourcing to sustain margins. This is why, the life cycle assessment is unsustainable.

The evolution of a new definition of 'sustainability' focuses on smart supply chains, and requires a fundamental shift to a holistic approach with a critical reassessment of the value and product creation. Some of the new sustainability concepts have been analysed and proposed by reformers such as:

- The challenge of closed-loop supply chains[1]
  sustainable supply chains: an introduction[2]
- Sustainability in the supply chain domain[3]
- Energy efficiency in supply chain and climate change[4]

These approaches bear considerable resemblance in the current industry scenario such as:

- Supply and consumption are interdependent, therefore, both consumption and production must be sustainable.
- Management of inter-organization relationships is often detrimental to the project's sustainability. One of the departments in an organization strives for Green Building Certification while the other department fails to recognize any such agencies.
- Replacing a traditional value proposition with a sustainable value proposition is hard to implement.[5] This is true because replacing a successful business model on the pretext that the environment is being harmed is hard to practise in industries.
- Fragmentation limits understanding. It is still unclear to most industries what sustainability implies. However, the approach is changing and by the way of recruitment and faculty training in the existing organization, the zeal for understanding the concept and advantages of sustainability is becoming slowly and steadily visible.

1 R. Guide, V. Daniel, Terry P. Harrison, and Luk N. Van Wassenhove. 2003. The challenge of closed-loop supply chains. *INFORMS Journal on Applied Analytics,* Vol. 33 (6).

2 Linton, Jonathan, Robert Klassen, and Vaidyanathan Jayaraman. 2007. Sustainable supply chains: An introduction. *Journal of Operations Management*. Details online at 25. 10.1016/j.jom.2007.01.012; last accessed on November 22, 2019.

3 Carter, C.R. and D.S. Rogers. 2008. A framework of sustainable supply chain management: Moving toward new theory. International Journal of Physical Distribution & Logistics Management (38); 360–387.

4 Halldórsson, A. and Kovács, G. 2010. The sustainable agenda and energy efficiency: Logistics solutions and supply chains in times of climate change. International Journal of Physical Distribution and Logistics Management, 40(1-2); 5–13. Details online at http://dx.doi.org/10.1108/09600031011018019; last accessed on November 22, 2019.

5 Srivastava, S.K. 2007. Green supply-chain management: a state-of the-art literature review, International Journal of Management Reviews, Vol. 9 (1); 53–80.

- Limited number of economical and successful sustainable models.

The Road Ahead

Organizations have collaborated and intensive research has led to companies relying on environmentally sustainable supply chain business models. It focuses on the management of information and interfaces between the customer, marketing, design, operations, logistics, and other external agents of the entire supply network.

There are developmental phases that focus on improvement in product durability and performance, incorporation of external supply networks, inclusion of the customer and the usage phase, and other activities to recover reuse and re-manufacture the residual value through economies of scale. These steps also generate a new vertical of employment. It would require suppliers to be able to provide the services to support original equipment manufacturer and third-party recovery specialists for reverse flows, including end-of-life operations. Thus, a new industrial sustainable design approach has been structured. Direct process implications of this revised approach are as follows:

- Reduce waste during industrial processes
- Yield improvements (less waste)
- Increased energy efficiency and material usage
- More recycling rate
- Reduced virgin material extraction

Finally, this approach requires a fundamental reassessment of how and where value is added, consumed, and recovered involving product and manufacturing processes and their redesigning.

Additionally, the government incentives including the parallel government bodies and organizations like GRIHA, LEED, etc., are creating the path ahead for a new way of thinking and implementing sustainability. This falls under the COP 21 global tax agenda, and promises to further smoothen the road to sustainability. The Paris Agreement requires all the Parties to put forward their best efforts through "nationally determined contributions" and to strengthen these efforts in the years ahead. This includes requirements that all the Parties report regularly on their emissions and on their implementation efforts. There will also be a global stock, taken every 5 years to assess the collective progress towards achieving the purpose of the agreement and to inform further individual actions by the Parties.[6]

A fine example of industrial sustainability is the relationship shared among the firms comprising the Kalundborg Eco-Industrial Park. This is an ideal case and an inspiration for various industrial parks around the world. It involves exchange material wastes, energy, water, and information.

Conclusion

According to ANAROCK's report 'Go Green – The Mantra for Sustainable Living', India is only second to the USA in terms of the built-up area under green projects. In trying to understand the loopholes in regulation by government bodies, in turn, not being able to cooperate with the upcoming organizations, business models, and industries from the conceptual stage, the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India, offers fast track environmental clearance for green building projects and sustainable projects.

Additionally, the government is pushing to encourage sustainable developments by monetizing the incentives in terms of time and money (i.e., floor area ratio). India has proposed incentives to the energy-intensive industrial sector or energy-generation sector to install equipment to curb emissions and develop infrastructure for electric vehicles. Still, it is a long road ahead; education of the end user is the mantra for a functional, sustainable, and a successful industrial sector. □

[6] UNFCCC. What is the Paris Agreement? Retrieved from https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement.

GLIMPSE OF 10TH GRIHA SUMMIT 2018

AAKAR Exhibition was centered on augmented and virtual reality based tools to enhance user's experience and allow them to make informed decisions and thereby save the capital cost

Prelude event of the Summit: Sustainability – A way of life, held on 1st November, 2018 contemplated on of ideas and life of people who practice and preach sustainability

Launge as felcitation of winners of Paryawaran Rakshak contest held for schools

Launge as felcitation of winners of Paryawaran Rakshak contest held for schools

Group photograph of Team GRIHA during the Cultural Evening and Awards Night held on 12th December, 2018

Panel discussion was held on the topic – 'Is Inclusive Growth Achievable by 2030?'

Scintillating dance performances by Nrityakaya by Rakesh Sai Babu, TRIKAYA, Rakesh and Priya Dance Company representing India's rich culture enthralled the audience

Group photograph of Team GRIHA during the Cultural Evening and Awards Night held on 12th December, 2018

'We are slowly turning the corner, creating threads, and connecting science to bring innovations to weave a sustainable future by tomorrow.' – **Mr Laurie Pearcy**

Understanding Air Leakage in Residential and Commercial Buildings

Innovation in architectural practices has revolutionized the construction sector in a way that, today, architects and designers are aiming to build structures that do not create an imbalance between infrastructural demands and ecological concerns. In this article, **Nikhilesh Singh Bist** and **Ankit Debnath** present a study of 23 residential buildings and 30 air-conditioned double occupancy hotel rooms in Ahmedabad to understand the air leakage characteristics that lead to an unwanted increase in the energy consumption of the building. Infiltration and penetration of outdoor contamination are some of the hazards that the author warns both the builders and residents about, while highlighting the importance of air quality within an enclosed space.

Nikhilesh Singh Bist *completed his MTech in building energy performance from CEPT University and is currently working in AECOM India Pvt Ltd as a sustainability consultant. He is among the few in India who can perform an airtightness test using the blower door method and can generate air leakage data for different building types. He has presented two research papers on air leakages in buildings at international conferences which were appreciated by the international jury members.*

Ankit Debnath *did his MTech in building energy performance from CEPT University. His work in infiltration for hotels in Ahmedabad using the blower door method is one of a kind. He has an experience in working with LEED V4.0 materials and interiors in JLL. Currently, he is working as an energy analyst on high side chiller optimization at Smart Joules Pvt Ltd.*

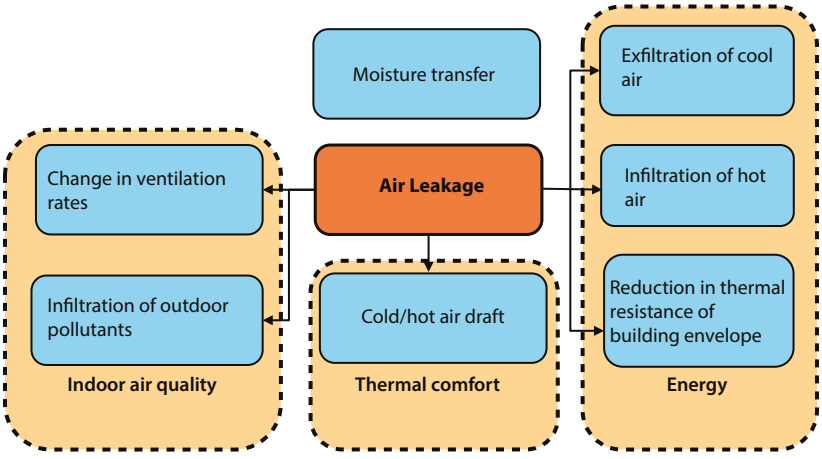
The best architectural and engineering practice in meeting green building codes and international standards includes constructing airtight buildings while maintaining adequate ventilation. In practice, post occupancy air change rates may not meet design intent, possibly due to multiple factors like infiltration/exfiltration from cracks and openings in the building envelope, change in building construction, etc. A large body of research has shown that tightening the building envelope can lead to significant saving in energy and reduction in HVAC equipment size. From an energy point of view, it is always favourable to reduce air leakage by tightening the building envelope, but without a dedicated ventilation system, the indoor air pollutant concentration may increase. Infiltration may reduce these concentrations; however, it is not possible to control infiltration/exfiltration exchange through building leakage area, which possibly leads to an unwanted increase in the energy consumption of the building.

While providing energy simulation parameter for air leakage, we either refer to codes

and standards or use default values from the software available in the market. The study in this article will help to quantify the infiltration rates for Indian residential buildings and commercial buildings, and develop air infiltration parameters for energy modelling. An estimation of the infiltration rates of existing Indian buildings will help in proper sizing of air-conditioning systems for commercial and residential buildings (tighter the building envelope, lower the air-conditioning system size). The study also describes the approaches for developing an air sealing strategy, which could be crucial in reducing the penetration of outdoor contaminants, which deteriorate the indoor air quality of the space.

There are different methods to measure ventilation rates – tracer gas decay, injected concentration decay, and blower door. The last method is more viable because it is affordable and can be applied on a large scale for commercial as well as residential buildings. In comparison to the other methods, the blower door approach is less affected by outside weather conditions. In this method, a powerful blower fan is attached and sealed to the front door of the house (preferably) and then it either blows the air in or out to pressurize or depressurize the building. The inside–outside pressure difference drives the air through the cracks or holes present in the building envelope. The measurement of flow rate takes place at a specified pressure level (50 Pascal or 0.2 inches of water), which is normalised to 4 Pascal to find the leakiness in the building envelope.

This article aims to study the air leakage characteristics of 23 residential buildings and 30 air-conditioned double occupancy hotel rooms in Ahmedabad. Out of the 30 hotel rooms, 21 rooms had split ACs, and 9 rooms had central ACs. The main process to measure air leakages through the blower door method was same in each building type but due to complexities in each, the measurement process was modified to get the desired results. This is a first known study in India that gives a report on air leakage in hotel rooms and residential buildings in Ahmedabad. Individual rooms were checked for their airtightness at 50 Pa pressure difference to find the infiltration rate. The objective of this study is focused on correlating the measured infiltration rates with international ACH standards, envelope characteristics, leakage pathways, and quantifying the energy penalty due to infiltration. The study was able to identify the correlation between ACH due to infiltration and multiple varying envelope characteristics like WWR, floor area, HVAC systems, types of window frames, tariffs, and age of the building.



» **Figure 1** Consequences of air leakage

When compared to international standards like LEED homes, IECC, and Passivhaus, none of the 23 residential buildings in Ahmedabad seemed to comply with the standards. Conclusions here can only be made for the 23 measured residences. Therefore, the result cannot be extrapolated for the entire building stock of either Ahmedabad or India. However, the measurements do provide some information on what could be the air leakage rates in typical Indian bungalows and apartments.

The comparative study of air change rate for different hotel rooms showed that 70 per cent of the hotel rooms had airtightness of 0.6 ACH, which is below the international standards. Eighty-five per cent of the rooms with casement windows and a WWR of 10–20 per cent had a leakage area greater than 12 in^2. Fixed windows showed that they were more effective in minimizing only infiltration than sliding or casement window frames. Hence, hotel rooms without compromising on the outdoor view can build an airtight envelope by using the correct type of window frames, which are a potential source of air leakage.

Airtight envelopes were mostly seen in hotel rooms with a tariff of more than 2000 INR, having a floor area greater than 20 m^2. These rooms had a good outdoor view with a WWR from 30 to 70 per cent with a leakage area less than 15 in^2. Rooms above 2000 INR range mostly had fixed

glazing. These were four-star rooms with a mean leakage area of 5.6 in^2 and WWR of 45 per cent. These were newly built rooms constructed after 2012 that would have used good quality construction material to achieve an airtight envelope. For the studied data set, 43 per cent of these hotel rooms were built in the past ten years, achieving a leakage area of less than 10 in^2 compared to older hotel buildings. Similarly, rooms built between 2005 and 2010 with operable windows had a mean leakage area of 13 in^2. The three-star rooms built between 2005 and 2011 had a mean leakage area of 10.2 in^2 and WWR of 21 per cent. Similarly, two-star and below rooms had an average area leakage of 16.5 in^2 and 18 per cent WWR.

In this study, 64 per cent of rooms with split systems had a mean floor of 16 m^2 with a leakage area above between 10 in^2 and 15 in^2. Whereas, 87 per cent of hotel rooms with centralized systems had a leakage area below 10 in^2. A mean effective leakage area of 7 in^2 for centralized systems and 20 in^2 for split systems, respectively, were found for this study. For rooms conditioned with split systems, infiltration can also be a source of fresh air, however, this cannot be held true for the centralized systems where fresh air is already provided by the system itself. Therefore, any case of infiltration is a source of energy penalty for the hoteliers in a centralized-conditioned room. From the simulation, it was found that hotel rooms with split systems had a maximum financial saving potential of 6135 INR for seven months. Similarly, hotel rooms with centralized systems had a maximum financial saving potential of 1094 INR for seven months. This gives clarity on the potential financial savings for one room. However, in a hotel, rooms with similar infiltration characteristics can scale up the potential financial savings for the entire building.

As mentioned earlier, this is the first study to measure the airtightness for commercial and residential buildings, towards estimation of air infiltration rates in India. The primary objective is to develop and conduct a blower door test and measure airtightness of Indian buildings. The results here cannot be considered a statistical representative of the entire housing and commercial stock of India. This is a first step towards quantifying average infiltration rates and providing data on airtightness; however, it is primarily focused on finding the range and extent of building air leakage, and the application of the blower door method on Indian buildings. It is hoped that this study will lead to successive studies to accurately characterize the distribution of the air leakage parameter in the residential and commercial building stock of India.

Table 1 International air change rates for different countries

Air change rate (ACH50, h-1)			
Country	**Number of houses**	**Average**	**Min-Max**
Belgium[1]	51	7.8	1.8–25
Canada[2]	222	3.1	0.4–11
Estonia[3]	31	4.9	0.7–11
Finland[4]	16	6	2.2–12
Greece[5]	20	7	1.87–11.3
Italy[6]	20	7.3	3.2–23.3
Norway[7]	10	4	3.3–5.4
Ireland[8]	28	10.27	5.39–14.9
Sweden[9]	44	1.02	–
UK[10]	471	13.1	2–30
USA[11]	12,902	29.7	0.5–84
Ahmedabad, India	23	28	14–55

1 Bossaer, A., Demeester , J., Wouters , P., Vandermarke , B., & Vangroenweghe, W. (1998). Airtightness performance in new Belgian dwellings. Proceedings of AIVC 19th conference ''ventilation technologies, p. 77–84. Oslo, Norway.

2 Hamlin, T. 1997. Airtightness and energy efficiency of new conventional and R-2000 housing in Canada. Ottawa: Canada Centre for Mineral and Energy Technology, Natural Resources Canada.

3 Kalamees, T. 2006. Air tightness and air leakages of new lightweight single-family detached houses in Estonia. *Building and Environment* (42), p. 2369–2377.

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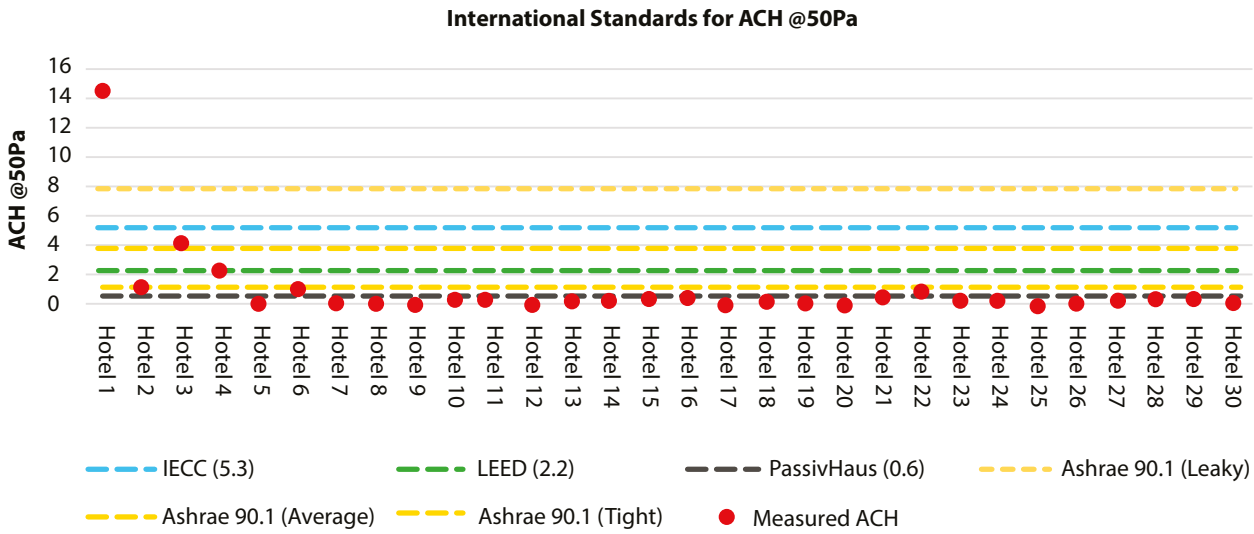
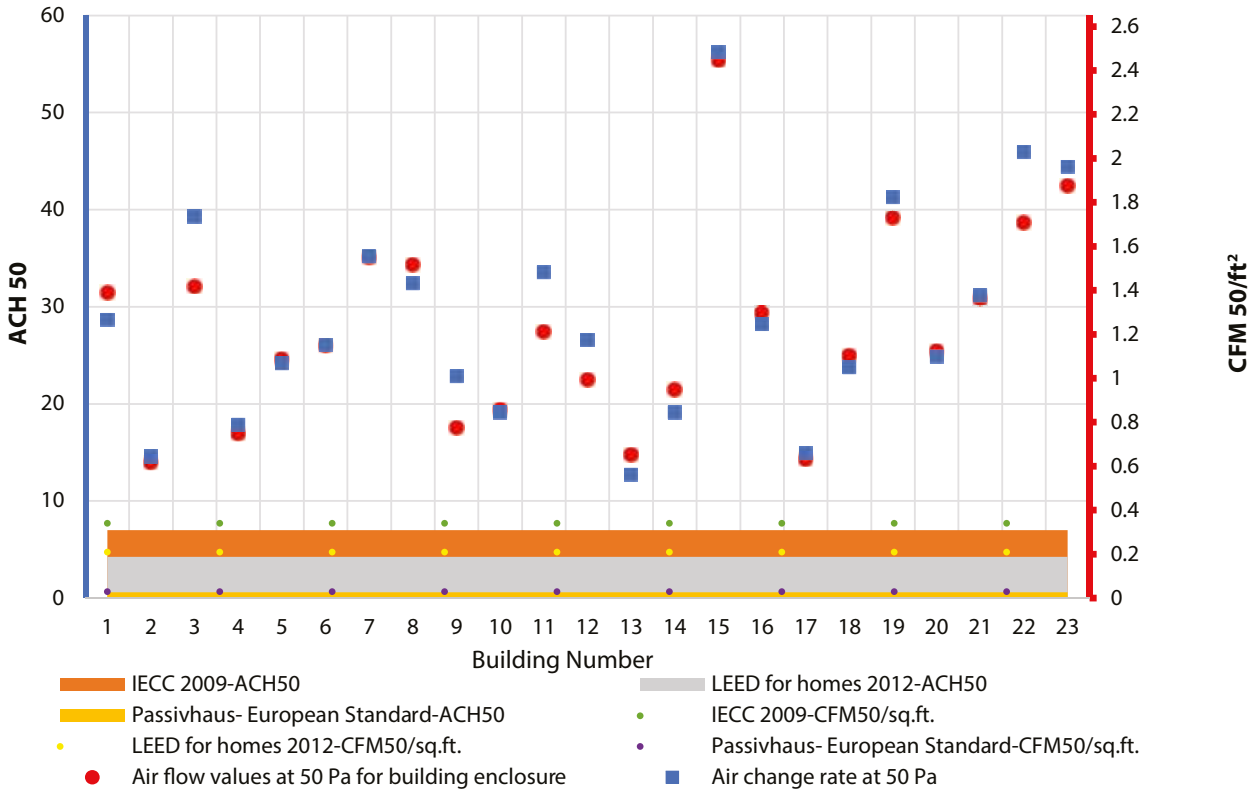


» **Figure 2** List of international standards and air leakage of 23 measured residential buildings



» **Figure 3** Comparison of measured ACH in different hotels with international standards

In Figure 3, the comparison with the recommended airtightness for six international standards is shown. The comparison is to understand the airtightness of air-conditioned double occupancy hotel rooms. Passivhaus is the most stringent airtightness standard among the six international standards. It is observed in Figure 3 that 70 per cent of the rooms have airtightness of 0.6 ACH as recommended by Passivhaus. These hotel rooms had a leakage area less than 10 in^2 compared to older hotels constructed before 2010. □

Making Investments Climate Smart in India and the World

Financiers and investors across the globe play an instrumental role in ensuring the well-being of our planet. Today, climate finance is top priority for climate-resilient projects that is important for both developing and developed countries. In this thought-provoking article, **Sameer Kwatra** and **Poonam Sandhu** discuss the various ways in which a balance could be achieved between global capital flows and the underlying climate risks. A successful green bank design equipped with private and commercial capital can be the backbone of a climate-friendly project, thereby helping every investor to envision an efficient and thriving economy.

Sameer Kwatra *specializes in policy research that promotes clean energy, energy access, and sound climate policy in India. He holds a Bachelor's degree in mechanical engineering from India's National Institute of Technology, an MBA from the Indian Institute of Management, and a Master's degree in environmental management from the Yale School of Forestry and Environmental Studies. He works out of National Research Development Corporation's (NRDC) Washington, DC office.*

Poonam Sandhu *is a banking and finance expert and leads National Research Development Corporation's (NRDC) India team in New Delhi. Her work focuses on clean energy finance and climate change policy. Her professional experience of over 20 years includes engagements at GIZ as senior advisor, DFID and multinational banks in India. Poonam has a Bachelor's degree in economics and a post graduate diploma in business management.*

A new report[1] by the World Economic Forum warns that three years after the Paris Agreement on climate change, global transition to clean energy has slowed down. Human-induced climate change is an epoch-defining[2] event that is already affecting all life on earth and, if left unchecked, portends catastrophic consequences. Both mitigating greenhouse gas emissions to alleviate the effects of climate change and adapting to its adverse impacts require significant amount of financial resources. Cost of inaction, however, is even higher. Fortunately, the global financial community is recognizing that mainstreaming climate change impacts in investment decisions is not just good for the planet but also makes sound business sense.

Let us size up the numbers first. According to the estimates,[3] a total of $90 trillion[4] of global investment in low

[1] Retrieved from http://reports.weforum.org/fostering-effective-energy-transition-2019/executive-summary/#view/fn-2; last accessed on October 7, 2019.

[2] Retrieved from https://www.theguardian.com/environment/2016/aug/29/declare-anthropocene-epoch-experts-urge-geological-congress-human-impact-earth; last accessed on October 7, 2019.

[3] Retrieved from https://sdg.iisd.org/news/climate-bonds-initiative-report-calls-for-increased-investment-in-renewables-to-implement-sdgs-paris-agreement/; last accessed on October 7, 2019.

[4] Retrieved from https://sdg.iisd.org/news/climate-bonds-initiative-report-calls-for-increased-investment-in-renewables-to-implement-sdgs-paris-agreement/; last accessed on October 7, 2019.

carbon, climate-resilient projects is needed by 2030 to combat climate change. To get there, global green finance needs to reach at least $1 trillion annually[5] by the end of 2020 and grow each year during the new decade.

In international climate negotiations, climate finance is a key issue. Developed countries are expected to mobilize $100 billion annually by 2020[6] (which is just a tenth of the $1 trillion figure). However, getting to even $100 billion is not easy – climate finance reached $56.7 billion by the end of 2017[7], still woefully short of the goal. While public climate finance from developed to developing countries is important from equity and justice[8] perspective, it is never going to be enough to match the scale of investment required.

But the world has enough financial resources. Just the top 400 asset managers manage about $75 trillion[9] in global assets between them. What is needed, clearly, is the alignment of global capital flows with the underlying climate risks.

Infrastructure investments illustrate the point rather well. Climate risk to infrastructure is already evident. Flights, across the world, have been grounded[10] because of very hot weather. The International Civil Aviation Organization (ICAO) has warned that the aviation industry

needs to prepare[11] for severe disruptions as a result of climate change. The world needs to invest $3.7 trillion in infrastructure annually[12] to meet its development needs. What is needed to make these investments climate risk compatible? That, in the words of Masamichi Kono, Deputy Secretary-General, Organisation for Economic Co-operation and Development (OECD), is a trillion dollar question.[13]

One way is to choose renewable energy over fossil fuels, thus avoiding the risk of stranded assets[14] down the line as renewables are becoming cheaper (even before accounting for the health and environmental costs). Infrastructure planning also needs to factor in climate risks such as the impact of sea-level rise and extreme weather events. The impact of drought, extreme heat, and storms is more direct on power generation[15] and distribution infrastructure. For example, without carbon mitigation actions, US power generation costs are expected to increase by 14 per cent by 2050 due to rising temperatures.[16] In a hot country like India, the sheer increase in cooling demand can put the entire electricity grid under tremendous strain. Bloomberg estimates that 24 per cent of all electricity used in India by 2050 would be just for air conditioning.[17]

Mainstreaming of climate finance has major implications for India. India is the third largest GHG emitter, after China and the USA, and is also home to hundreds of millions of people vulnerable to adverse effects of climate change.

Here are some key strategies India can adopt to position itself as a reliable and attractive market for climate-smart investments:

- Build credibility with investors so that they have confidence

5 Retrieved from https://www.climatebonds.net/resources/reports/bonds-and-climate-change-state-market-2018; last accessed on October 7, 2019.

6 Retrieved from https://www.nrdc.org/experts/han-chen/paris-agreement-rulebook-tracking-financial-flows; last accessed on October 7, 2019.

7 Retrieved from http://www.oecd.org/newsroom/public-climate-finance-to-developing-countries-is-rising.htm; last accessed on October 7, 2019.

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9 Retrieved from https://www.ipe.com/top-400/total-global-aum-table-2018/10007066.article; last accessed on October 7, 2019.

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13 Retrieved from https://www.responsible-investor.com/home/article/oecd_op/P0/; last accessed on October 7, 2019.

14 Retrieved from http://www.lse.ac.uk/GranthamInstitute/faqs/what-are-stranded-assets/; last accessed on October 7, 2019.

15 Retrieved from https://royalsocietypublishing.org/doi/full/10.1098/rsta.2017.0298; last accessed on October 7, 2019.

16 Retrieved from https://www.sciencedirect.com/science/article/pii/S0301421514002675; last accessed on October 7, 2019.

17 Retrieved from https://about.bnef.com/new-energy-outlook/#toc-download; last accessed on October 7, 2019.

that there is no "green washing" of investments. Securities and Exchange Board of India (SEBI), the regulatory authority for securities market operations, has issued guidelines for Green Bonds[18] issuance originating in India. The importance of standards and guidelines has been recognized by Indian issuers. More of the issuance, especially those targeting global investors, conform to internationally accepted standards, and have resulted in better terms and pricing to the issuer.

- Domestic financiers in India need to take heed now before locking in their investment in stranded assets. Private and public institutions need to apply strong climate-related filters when making investments. The Reserve Bank of India should mandate Environment, Social and Governance (ESG) standards for banks as part of their standard risk screening measures to ensure that carbon-inefficient assets are penalized by the financial sector. This will not only save the financial sector from being stuck with stranded assets at a later stage but also help in building a carbon-efficient economy in India.
- Urgent and fast change is required in boardrooms of corporations and institutions to ensure that investments decisions are smart, account for cost of environmental damage, and are incentivized for environmental protection. Corporate investments should incorporate and price climate risks, aided by the many tools available such as the international Task Force on Climate-Related Financial Disclosures (TCFD)[19] framework and various ESG Toolkits created by credible international bodies, even if the regulators do not mandate them. For example, Fitch ratings[20] have launched an integrated scoring system for ESG factors that impact credit rating of a company. Extending this, or similar, framework to Indian corporations would have far-reaching consequences.
- An effective and viable strategy is necessary to set up focused, climate finance cells or subsidiaries in established public institutions that can be termed as "green windows."[21] Green windows, based on the globally successful green bank design,[22] will focus on green finance and projects that conform to green principles. Green windows will be staffed by expert teams to use special pools of low-cost public and donor funds to catalyse private and commercial capital in multiples to invest in high impact climate-friendly projects. Given the exclusive climate focus, sectoral expertise and strong parentage (respected public financial institutions), green windows can bolster international and domestic investor confidence for investing in climate-friendly projects in India. Indian Renewable Energy Development Agency Ltd (IREDA), a leading green finance organization in India, is in the process of establishing the first green window in India.

The world and India stand to benefit from recognizing and mainstreaming climate risk in all investment decisions. For financiers, green investments are synonymous with good investments — having moved from a "nice to have" to a "need to have" in their portfolio. India and other countries need to create an enabling environment to catalyse the capital needed for combating and coping with climate change. Establishing green windows is a good first step. ◻

[18] Retrieved from https://www.sebi.gov.in/legal/circulars/may-2017/disclosure-requirements-for-issuance-and-listing-of-green-debt-securities_34988.html; last accessed on October 7, 2019.

Bamboo: The Most Effective Renewable Resource

Bamboo has a tensile strength equivalent to that of steel and that's why it could not only lead to sustainability but also control large-scale deforestation in today's urbanized world. In this article, **Krunal Negandhi** attempts to give suitable examples of how using bamboo in construction and architectural practices can help in mitigation of greenhouse gas emissions. Migration of population from rural to urban areas is increasing due to better livelihood opportunities and quality of life guaranteed in urban areas. Choosing bamboo as a primary material in construction and building could bring respite to farmers' woes.

Krunal Negandhi *is a professional with more than 25 years' experience, and has been in senior positions in the corporate sector for more than 21 years. He initiated his own enterprise Jurian, for sustainability advisory and JANS, to build eco-friendly structures using bamboo and rammed earth. He has an innovative bent of mind, along with a passion for business excellence in all his endeavours. He can be reached at krunal.n@jansbamboo.com.*

Stop Deforestation by Using Bamboo

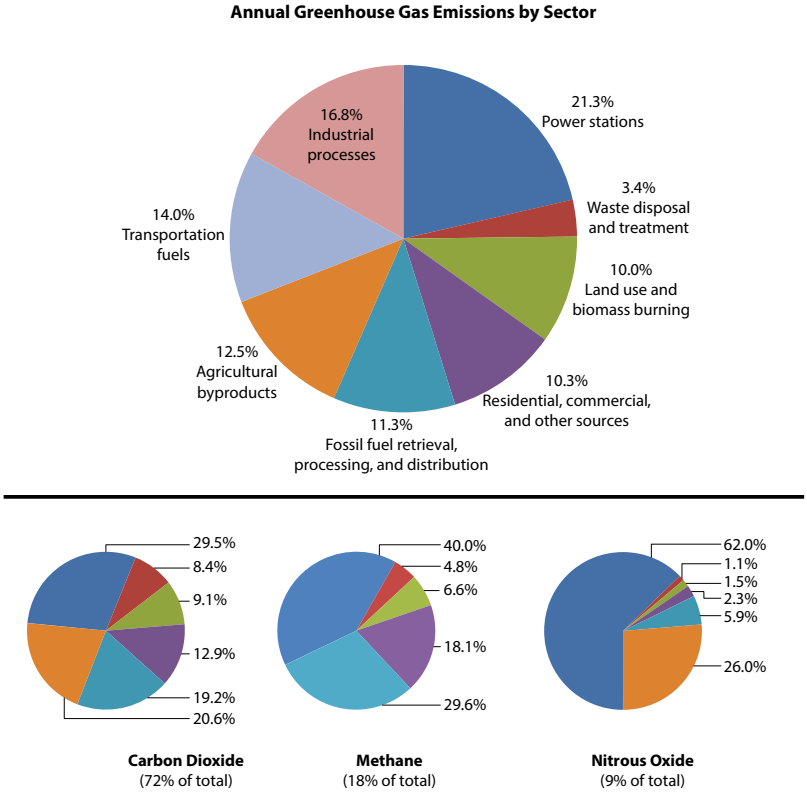
Bamboo is one of the fastest growing grasses that can acquire a length between 8 and 80 ft in just 120 days, and can help in large-scale carbon sequestration. Typically, a hectare of bamboo sequesters around 200 metric tonnes of CO_2 gas, per year. The use of other materials like steel, wood and concrete, contributes to the release of greenhouse gases (GHGs) and ends up adversely affecting the atmosphere. A bamboo pole reaches its maturity in about three to five years, and begins to dry, thereafter. The tenth year on, the decomposition of the bamboo pole starts, and slowly, all the carbon that it has sequestered, goes back into the atmosphere. However, if this bamboo pole is treated with a scientific method by using proper techniques, the process of biodegradation could get prolonged by at least 100 years. Another important characteristic of bamboo is that the more you cut its poles, the more is the possibility of the growth of new poles. This is why bamboo is considered one of the fastest renewable natural resources available on our planet today.

Using bamboo poles in construction can have a significant positive impact on our Mother Earth. Some bamboo species have a tensile strength equivalent to that of steel when we consider the mass to weight ratio. This is why, it is important to explore the possibility of introducing bamboo in architectural practices.

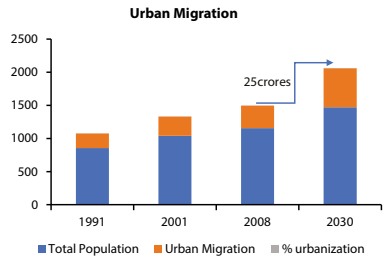
What are the current scenarios?

a) GHG emissions

A report shared by United Nations Framework Convention on Climate Change shows that both unsustainable development and large-scale deforestation have impacted the environment, contributing to 20.3 per cent of GHG emissions. The result of such activities is that the pollution level is drastically increasing, causing asthma, lungs problems and other hazards. In 2018, *The Times of India* published an article titled, "Pollution in Delhi Akin to Smoking 15-20 Cigarettes a Day" to indicate the growing levels of air pollution (see Figure 1).



» **Figure 1** A sector-wise analysis of greenhouse gas emissions



» **Figure 2** The growing rate of urban migration

b) Urban migration

In 2015, McKinsey published a report titled, "India Urban Awakening", in which it examined how the migration of a large population from rural to urban areas is increasing due to better livelihood opportunities and quality of life guaranteed in urban areas. This mass exodus is not only creating more problems for the already overpopulated cities of India (see Figure 2) and adding stress to its infrastructure, but more importantly, it is breaking the socio-cultural fabric of India which is the backbone of our country. Farmers are not able to get a sustainable and consistent income due to erratic changes in the rainfall patterns due to climate change. The Government of India is putting all efforts to increase the income of farmers, and bamboo being an agro-crop and a hardy species, can play a vital role in creating better livelihood opportunities for farmers without compromising with their existing plantation crop. Small land-holding farmers can plant bamboo on their bunds/boundaries, etc., thereby, helping them fetch additional income other than their usual crop.

Bamboo: A Poor Man's Timber?

In India, bamboo is found in abundance, mainly in its wild form, and this can be properly grown as a farming option in most areas of India. In our country, bamboo is perceived as a "poor man's timber", a material for temporary or inferior use and hence, the ecosystem for the use of bamboo

to make contemporary structures has not been created or considered. JANS has attempted to defy this myth and positioned bamboo as a world class material for those who have sensitivity to environment. So far, JANS has been able to break barriers and has designed and built world class structures for its varied clientele, both in India as well as abroad. So, from its perceived use to build small and temporary huts or use for scaffolding, JANS has been able to demonstrate the use of bamboo for large structures covering an area over 10,750 ft^2, and used bamboo to build structures that are sought after by the people who are looking for aesthetics, luxury and longevity.

Constructing contemporary structures with bamboo

In 2004, work began in a small *taluka* (district) called Kudal, situated in the quiet part of Konkan belt of India, with the understanding for value-added structures, on how the right species and quality of bamboo could be used and made available. With technical support from International Network for Bamboo and Rattan (INBAR), an NGO called KONBAC started educating the farmers on planting selective bamboo species and growing them using scientific cultivation techniques. With proper care, these species became suitable for harvesting from 2008 onwards, and an entire ecosystem was created from sustainable harvesting, age-grading, proper treatment for longevity, design and development of structures. This could sustain itself for some time and a lot of R&D was carried out to perfect the different techniques of bamboo construction, unfortunately, these activities couldn't be scaled up later. In 2016, JANS started with a mission to bring about a change in the mindset towards usage of bamboo in the construction sector, through sealing the gaps and bringing in the resources, design capability, better management skill and technical manpower. Eventually, the scenario started to change positively, with a significant scaling up of activities. JANS began building large, beautiful and contemporary structures and offered a value-for-money proposition

to its clients. Today, JANS has successfully carried out work for government institutions, private builders, and hospitality industry to name a few. Although this work started quite late in India as compared to other countries like Indonesia, China, Colombia and Vietnam amongst others, JANS has been able to spread its wings internationally as well. It built one of the most intricate and beautiful structures using Indian bamboo, with the help of artisans and techniques, for Waldorf Astoria, a top international brand in Maldives. *CNN Travel* recognized the property as one of the top 16 must-visit waterfront restaurants in the world. Such recognition helps establish the strength of bamboo construction in India with respect to aesthetics, quality and competitiveness.

Floating Dining Pods for Waldorf Astoria

Hilton Hotels & Resorts is one of the biggest brands in the world. The brand targets both the business and leisure travellers in various vacation destinations with more than 5,800 properties spread across 114 countries. Waldorf Astoria is the luxury resort brand of Hilton. It opened its first luxury family resort consisting of 122 villas in Maldives on July 1, 2019. The floating dining pods christened "Terra" is one of the three specialty restaurants at this island resort. The concept was to create one of the finest dining experiences, which would be both sustainable and classy. Bamboo was the chosen material for this work. Terra, which means to "earth" or "land" in Latin, is the highest point on this island. This signature venue had been sectioned into a series of platforms with vast island views, catwalk entrances and semi-private dining cocoons. These cocoons, made up of bamboo, are hidden in dense bamboo forests, and are layered for optimizing views for the guest.

The concept sketch was given by an architectural firm called Stickman Tribe and JANS was commissioned to design and build this bamboo structure.

The process started with the understanding of the intricacies of the design, its strength and limitations. The work on the design was completed within a month. The detailing was done and the use of steel, as ribs for strength, was eliminated and the entire design was conceptualized with the knowledge that the structure would be built using 100 per cent bamboo, including the structural load as well. This was appreciated by the client, the architect and the operator at Hilton, and after seeing a full-scale mock-up at site, the entire design was unanimously approved by the authorities. In fact, other areas like walkway trellis, hand railings for support, etc., which were earlier planned in stainless steel, were eliminated, and it was decided that the entire structure would be constructed using only bamboo. JANS managed the entire ecosystem efficiently, procured high-quality bamboo from the farmers in India, age-graded it, treated it using vacuum pressure treatment, conforming to IS 9096:2006, straightened the bamboo poles using heat treatment, carried out the bending of bamboo poles, bunched the different poles and prefabricated all the components at its factory in Kudal, Maharashtra. These components were first shipped to Maldives, and later assembled by Indian artisans at the resort site. The work was carried out with great speed, since only the installation was to be done on site, and finally, the structures were constructed in a record time of two-and-a-half months.

Conclusion

The bamboo pods at Ithaafushi have helped in the following ways:

- Sequestered 22,210 kg of CO^2 from atmosphere
- Created 1,650 man-days of work for the entire process
- Generated better livelihood for more than 200 farmers

Hence, building structures using bamboo ends up benefitting our environment, while generating better livelihood options across the socio-economic pyramid. Now, should we seriously start thinking of including bamboo structures in every part of our construction practices? ◻

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