Shashwat

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Let Nature Be

Fostering Partnerships for Sustainable Habitat

A **GRIHA Council** Publication

COVER STORY

FACE-TO-FACE

THANKS TO OUR VALUED PARTNERS

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Message from the **President, GRIHA Council**

Dear Friends,

I am privileged to be writing this message at a special time as we organize the 10th edition of the GRIHA Summit. This year, as we reach out to international academia, the GRIHA Council is collaborating with the University of New South Wales, Australia, to co-create the 10th GRIHA Summit. We are honoured to felicitate Dr B V Doshi, the first Indian Pritzker laureate, during the summit.

I am pleased to see the steady adoption of the GRIHA rating system across the country. Multiple engagements, both with public and private construction agencies, have reinforced GRIHA as a robust and transparent tool to evaluate green development. Our constant interaction with various stakeholders, including those in the central and state governments, architects and building professionals, and building occupants, has helped to build the credibility of the rating system. I am informed that the GRIHA footprint now accounts for about 60 million sq. m of floor area, with approximately 1,200 registered projects.

Green buildings in India have constituted a very small fraction (less than 2 per cent to 3 per cent) of the current building stock in the country. With rapid urbanization, and with a large share of population demanding improved living standards and healthier neighbourhoods, there has been a marginal increased uptake of energy efficient and green buildings. However, green building certification continues to be challenged by a lack of awareness, high perceived first costs, and the perceived lack of demand from the end users.

The construction industry has significant environmental, social, and economic impacts on society. It has been established that the built environment can contribute to a more equal, inclusive, and cohesive society, if the places where we live, the facilities we use, our neighbourhoods, and meeting places are accessible, resource efficient, and user centric. At the global level, India has been ranked low in its efforts to deal with environmental issues, as per the 2018 Environmental Performance Index green rankings, released on the sidelines of the World Economic Forum at Davos. We look forward to new collaborations and strengthening our goals towards the betterment of the nation.

The theme for this year's summit, 'Fostering Partnerships for Sustainable Habitat', is aligned to achieve sustainable development through partnerships and collaboration, sharing of ideas and solutions, creating knowledge-exchange outcomes, and strengthening research both at the national and global levels. It shall be a platform to discuss opportunities, address challenges, and provide solutions amongst various policymakers, building practitioners, technology experts, academic researchers, and other stakeholders.

The 10th GRIHA Summit is being organized in the week of Energy Conservation Day, which is observed on December 14, each year. This year, the Bureau of Energy Efficiency and GIZ are partnering with the GRIHA Council to organize the 'International Conference on Green Buildings' on December 13, 2018, as a prelude to Energy Conservation Day. I am pleased that GRIHA will be launching a new rating, 'GRIHA for CITIES', aligned with the Government of India's target of providing better living conditions for the existing and future generations. This rating is specifically developed for CIvic bodies governing Towns, Industries, Existing and new Settlements to be designed or re-engineered by adopting a holistic and smart approach with a focus on sustainability of the ever-growing infrastructure.

I gratefully acknowledge the support of all our valued partners and their confidence in the brand GRIHA. I congratulate Team GRIHA for their wholehearted commitment for the achievements during the last year and wish them success in the year ahead.

With best wishes for the ensuing New Year, 2019!

Ajay Mathur
President, GRIHA Council and
Director General, TERI

GRIHA TIMELINE

2009

Committee of secretaries: 3-star GRIHA mandatory for all government buildings.

CPWD embraces GRIHA.

Acknowledged as an innovative region-specific green building assessment tool by the UN.

2010

- Evaluators' and Trainers' Programme.

2011

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

EC linked to GRIHA precertification.

- CREDAI

2015

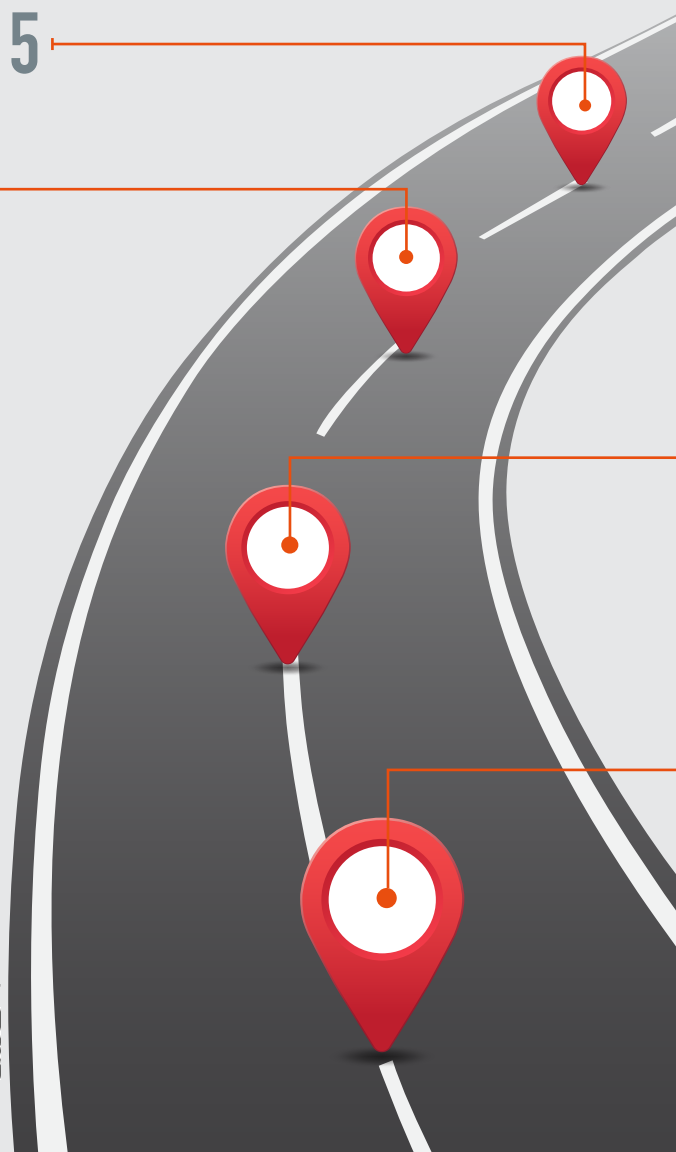
- GRIHA projects in Rajasthan, Pune, AUDA, and Uttar Pradesh.
- GRIHA projects in the Government of West Bengal, Department of Municipal Affairs.
- GRIHA V.2015 rating and GRIHA LD rating.

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

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.



Developed by

teri The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

Contact Details

GRIHA Council

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

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

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.

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.

Kerala State Housing Board adopts GRIHA.

2014

❍ GRIHA for day schools rating.

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

Sikkim mandates GRIHA.

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.

2018

■ PWD, Maharashtra and Orange County.

■ Extended with NASA, India.

❍ RWA Programme.

GRIHA Council awarded with Green Excellence Award, 2018.

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

आर. के. सिंह
R. K. SINGH

सत्यमेव जयते

विद्युत एवं नवीन और नवीकरणीय ऊर्जा
राज्य मंत्री (स्वतंत्र प्रभार)
भारत सरकार
Minister of State (Independent Charge)
for Power and New & Renewable Energy
Government of India

Message

I am glad to know that GRIHA Council is organizing its annual national conference – 'The 10th GRIHA Summit' on 11th & 12th December, 2018 at New Delhi with the theme 'Fostering Partnerships for Sustainable Habitat'.

Government of India (GoI) have undertaken a series of steps to cater to the growing 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 ecosystem.

Improving energy efficiency meets the dual objectives of promoting sustainable development and of making the economy competitive. In view of the formidable challenges of meeting the energy needs and providing adequate energy of desired quality in a sustainable manner and at reasonable costs, improving energy efficiency has become important component of our energy policy.

The Bureau of Energy Efficiency (BEE) have initiated a number of energy efficiency initiatives in the areas of appliances, household lighting, commercial buildings, small-medium enterprises and large industries. BEE has issued energy conservation building code for commercial buildings, which is adopted by 12 States & UTs and they are in the process of development of energy conservation building code for residential buildings.

The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India in the global effort to meet the challenges of climate change.

I am sure that the "10th GRIHA Summit" involving the partnership of reputed University of New South Wales (UNSW), Sydney, Australia will provide innovative solutions around the built-environment.

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

(R.K. Singh)

Shram Shakti Bhawan, New Delhi-110 001 Phone : +91-11-23717474, 23710411
Fax : +91-11-23710065, E-mail : raj.ksingh@gov.in

HIGH COMMISSIONER

AUSTRALIAN HIGH COMMISSION
NEW DELHI

I congratulate the GRIHA Council on reaching such a significant milestone with the "10th GRIHA Summit" from 11th to 13th December 2018. I am proud to see an eminent Australian institution, the University of New South Wales (UNSW), working closely with the GRIHA Council to deliver this year's event.

The summit's theme, "Fostering Partnerships for Sustainable Habitat" identifies one of the key pre-requisites of inclusive, sustainable development. That is, it requires partnership, collaboration and consultation. Partnerships can support the social contract between business, governments and civil society that engenders inclusive sustainable development. The Summit also affords the opportunity to bring together a diverse range of stakeholders from all sectors to discuss the issues that are central to sustainable development locally, nationally and at a global level.

The GRIHA Council is to be commended for successfully promoting and implementing the Green Rating for Integrated Habitat Assessment, the indigenous rating system for green buildings in India. The GRIHA has been acknowledged as a tool to evaluate reductions in emissions intensity. It can play an important part in mitigating emissions from India's building sector and support India's efforts toward meeting its mitigation target under its Paris Agreement contribution.

I wish the GRIHA Council and the UNSW every success at the Summit and look forward to seeing further successful collaboration among all stakeholders in this important initiative.

Harinder Sidhu

No.1/50 G Shantipath, Chanakyapuri, New Delhi 110-021, India
Telephone: + 91 11 413 999 00 Facsimile: +91 11 414 944 90

सत्यमेव जयते
आनन्द कुमार
ANAND KUMAR

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

Message

"Shashwat- Let Nature Be" GRIHA's Annual Magazine

It has been over a decade since the existence of indigenously developed tool – Green Rating for Integrated Habitat Assessment (GRIHA) for evaluating resource and operational efficiency of green habitat.

2. I am pleased to see that the tool which was developed as a result of joint collaborative effort of the Ministry of New and Renewable Energy (MNRE), Government of India and The Energy and Resources Institute (TERI) has now emerged and adopted as a National Rating System by premier construction agencies of the country.

3. The present policies of the Government emphasise on integration of renewable energy & resources while planning green and sustainable habitat. Our goal remains to construct Net Zero Energy Buildings (NZEB) which are not only energy efficient but also able to generate total electricity required through on-site generation using renewable resources.

4. It is heartening to see that the GRIHA Council has crossed national borders to partner with University of New South Wales (UNSW), Sydney, Australia, to host the "10th GRIHA Summit". I am sure, the Summit will witness significant contributions from both national and international experts towards sharing and exchange of knowledge, ideas & solutions for sustainable habitat.

7. I convey my best wishes to the GRIHA Council for the success of "10th GRIHA Summit".

[Anand Kumar]

अक्षय ऊर्जा से देश विकास
गांव गांव बिजली, घर घर प्रकाश

ब्लॉक नं. 14, केन्द्रीय कार्यालय परिसर, लोदी रोड, नई दिल्ली–110003
Block No. 14, CGO Complex, Lodi Road, New Delhi - 110 003
Tel. : 011-24361481, 24362772 • Facsimile : 011-24367329 • E-mail : secy-mnre@nic.in
website : www.mnre.gov.in

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

I am pleased to learn that the GRIHA Council has taken a leap to build vital relationships across national borders and is organizing the "**10th Annual GRIHA Summit"** with the University of New South Wales (UNSW), Sydney, Australia.

Stable economic growth, improved living standards and high pace of urbanization is leading to an increased demand for new buildings. The demand on urban infrastructure poses a challenge for all the urban practitioners to strike a fine balance between demand and supply. The Ministry of Housing & Urban Affairs has taken several steps to promote sustainable and inclusive development, which will improve quality of life through better services and world class infrastructure, create employment and enhance incomes for all, especially the poor and the disadvantaged.

The theme of this year's Summit – '**Fostering Partnerships for Sustainable Habitat**' aligns with the Sustainable Development Goal 17 which aims to strengthen the means of implementation and revitalize partnerships for sustainable development.

The Ministry congratulates team GRIHA on the launch of '**GRIHA for Cities (Civic bodies governing Towns, Industries, Existing and new Settlements)**' – a rating tool which adopts holistic and smart approach with a focus on sustainability of the ever-growing infrastructure.

I wish the "**10th Annual GRIHA Summit"** a huge success and convey my best wishes to the GRIHA Council.

(Durga Shanker Mishra)

New Delhi
29 November, 2018

Office Address: Room No. 122 'C' Wing, Nirman Bhawan, New Delhi-110011
Tel.: 011-23062377, 23061179; Fax: 011-23061459; Email: secyurban@nic.in
Website: www.mohua.gov.in

It is a great honour for UNSW to be the first university co-host of the GRIHA Summit. The 2018 Summit theme 'Fostering Partnerships for Sustainable Habitats' mirrors one of the central ideas governing UNSW's 2025 Strategy: to employ partnerships to maximise our impact on the communities we serve.

Whether it is partnering with international organisations such as the Red Cross to understand the impact of rapid urbanisation in the Asia-Pacific or undertaking our world-leading collaborative research in photovoltaics and solar energy, UNSW is committed to forming partnerships that enable our work to be translated in the most tangible and direct ways.

We are especially proud that, this year, we have become the first university in the world to commit to having 100 per cent of our energy on campus supplied by photovoltaic solar energy. It is an exciting step towards our goal of being carbon neutral on energy use by 2020.

At UNSW, we also place great emphasis on fostering a global outlook. Our partnerships with GRIHA, The Energy and Resources Institute (TERI) and the Indian Ministry of New and Renewable Energy (MNRE) are powerful reflections of our ambition to work more closely with our neighbours to address the sustainable development challenges of our region.

These are exciting times for the Australia-India relationship and I very much look forward to seeing our partnerships evolve as we deepen our research links in areas as diverse as clean energy and sustainable housing, waste water treatment and intelligent transport systems.

I also look forward to strengthening UNSW's ties with India more broadly. This year, we opened a new UNSW India Centre in New Delhi which will enable our institution to further build engagement, in both education and research, over the long-term.
UNSW is delighted to bring our partnership with TERI to life at the 2018 10th Anniversary GRIHA Summit. I am confident it will be a great success.

Professor Ian Jacobs
President and Vice-Chancellor
UNSW SYDNEY

UNSW SYDNEY NSW 2052 AUSTRALIA
T +61 (2) 9385 1000 | F +61 (2) 9385 0000 | ABN 57 195 873 179 | CRICOS Provider Code 00098G

PRABHAKAR SINGH
Director General

सत्यमेव जयते

भारत सरकार
Government of India

CPWD

केन्द्रीय लोक निर्माण विभाग
निर्माण भवन, नई दिल्ली-110011
Central Public Works Department
Nirman Bhawan, New Delhi-110011
Tel : 23062556/1317, Fax : 23061884
E-mail : cpwd_dgw@nic.in

MESSAGE

It gives me immense pleasure to know that the GRIHA Council is organizing its annual flagship event – **'The 10th GRIHA Summit'** in New Delhi from 11th to 12th December 2018.

The theme chosen for the summit **"Fostering Partnerships for Sustainable Habitat"** is very apt and aligned to the present Government Mission of holistic and inclusive development.

CPWD as a Principal Engineering Organization, has been in the forefront in adopting sustainable, energy efficient and new emerging green and clean technologies in its construction to create sustainable built environment. We have exhibited our deep commitment in implementing energy efficiency measures and installation of solar power plants on roof-tops in the Central Government Buildings.

As the world continues to urbanize, sustainable development depends increasingly on the successful management of resource consumption both while constructing as well as maintaining these urban spaces, especially in rapidly developing country like ours.

I applaud GRIHA Council for their efforts in sustainable development and extend them my best wishes for success of the Summit.

(Prabhakar Singh)

अभय बाकरे, आईआरएसईई
महानिदेशक
ABHAY BAKRE, IRSEE
Director General

सत्यमेव जयते

ENERGY IS LIFE
CONSERVE IT

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

Government of India (GoI) has undertaken critical steps to cater to the energy demand of its citizens and minimizing CO2 emissions, in terms of the commitments made to the UNFCCC. Under the Energy Conservation Act, Bureau of Energy Efficiency (BEE) is leading the government's efforts to set energy efficiency benchmarks and policies to reduce energy intensity of Indian economy.

With urban and industrial development, the demand for energy is expected to escalate three times by 2030. Energy Efficiency has a potential of saving 500 billion units of energy through avoided capacity of 100 gigawatts of power. In such a scenario, efficient use of energy resources and their conservation assume tremendous significance and are essential for sustainable development.

The increased demand for new buildings due to the high pace of urbanisation drives up consumption of energy to construct and operate these buildings. Buildings account for up to 40% of the total energy consumption in India. It is imperative for the Indian building sector that the projected energy growth is addressed through effective implementation of instruments like ECBC and the concept of Net Zero Energy Buildings (NZEB).

Green rating systems such as "GRIHA" is an important catalyst to promote ECBC.

I am glad to learn that the GRIHA Council is organising the "10th GRIHA Summit" in the week of the Energy Conservation Day marked on 14th December. The theme of "Fostering Partnerships for Sustainable Habitat" chosen for the summit has encouraged BEE to partner with the GRIHA Council in organising the International Conference on Green Buildings on 13th December, 2018 as a prelude to the Energy Conservation Day.

I am sure that the Summit would provide a platform to deliberate on issues and challenges affecting the promotion of energy efficiency and sustainable development in the built-environment.

I wish the GRIHA Council all success in its endeavours.

Abhay Bakre.

(Abhay Bakre)

चौथा तल, सेवा भवन, आर.के.पुरम, नई दिल्ली–110 066 / 4th Floor, Sewa Bhawan, R.K. Puram, New Delhi-110 066
टेली / Tel.: 91 (11) 26178316 (सीधा / Direct) 26179699 (5 Lines) फैक्स / Fax: 91 (11) 26178328
ई–मेल / E-mail : dg-bee@nic.in, abhay.bakre@nic.in, वेबसाईट / Website : www.beeindia.gov.in

The theme of the 2018 GRIHA Summit, 'Fostering Partnerships for Sustainable Habitats', resonates with UNSW Built Environment agenda.

Our vision is to shape future cities that are resilient, healthy and smart and that are connected, green, liveable and inclusive. Because of the rapid pace, scale and dynamic nature of urban expansion, we're focused on the challenges of our cities at every scale, and we appreciate the importance of collaborative partnerships in addressing these complex challenges.

We know that adapting to a rapidly changing world will demand substantial shifts in the planning, design, development and use of our cities. UNSW Built Environment recognises that innovation in our sector will be essential to ensure that our cities are more responsive and adaptive. Tomorrow's professionals will need to be not only highly technologically adept but also agile, being faced with the prospects of rapid shifts in technology, escalating global uncertainties, as well as numerous career reinventions over their lifetimes.

To be future focused, our educational paradigm is broad and deep. We value critical enquiry and speculation as well as skills development. Collaboration and a transdisciplinary mindset are considered critical. As such, interdisciplinary learning is fundamental to our pedagogy and research.

Our researchers seek to address our pressing urban challenges and have real impact, by improving people's lives through a better built environment. This vital research is focused around a number of research collaborations including the City Futures Research Centre (CFRC) and the Co-operative Research Centre for Low Carbon Living (CRCLCL), the Liveability Lab and City Analytics Lab. The CFRC is a national leader in scholarly applied urban research that specialises in housing, urban policy and development, urban analytics, urban health and well-being. The CRCLCL is a multi-sector partnership end user-driven research collaboration to address the global challenges of climate change by lowering carbon emissions in the built environment.

Within this context, UNSW Built Environment is building an agile platform for research and exchange that can respond to the changing needs of the professions while also anticipating the unknown; by developing skilled graduates and researchers that can positively engage, adapt and shape our future cities for the benefit of all people and the planet, firmly in mind.

It is a great honour for UNSW Built Environment to contribute to the GRIHA Summit and showcase the faculty's research expertise in India, to have a platform to strengthen existing research relationships and forge new ones. Together we can all contribute to shaping more sustainable, liveable and inclusive cities now and into the future.

Professor Helen Lochhead
Dean
UNSW Built Environment

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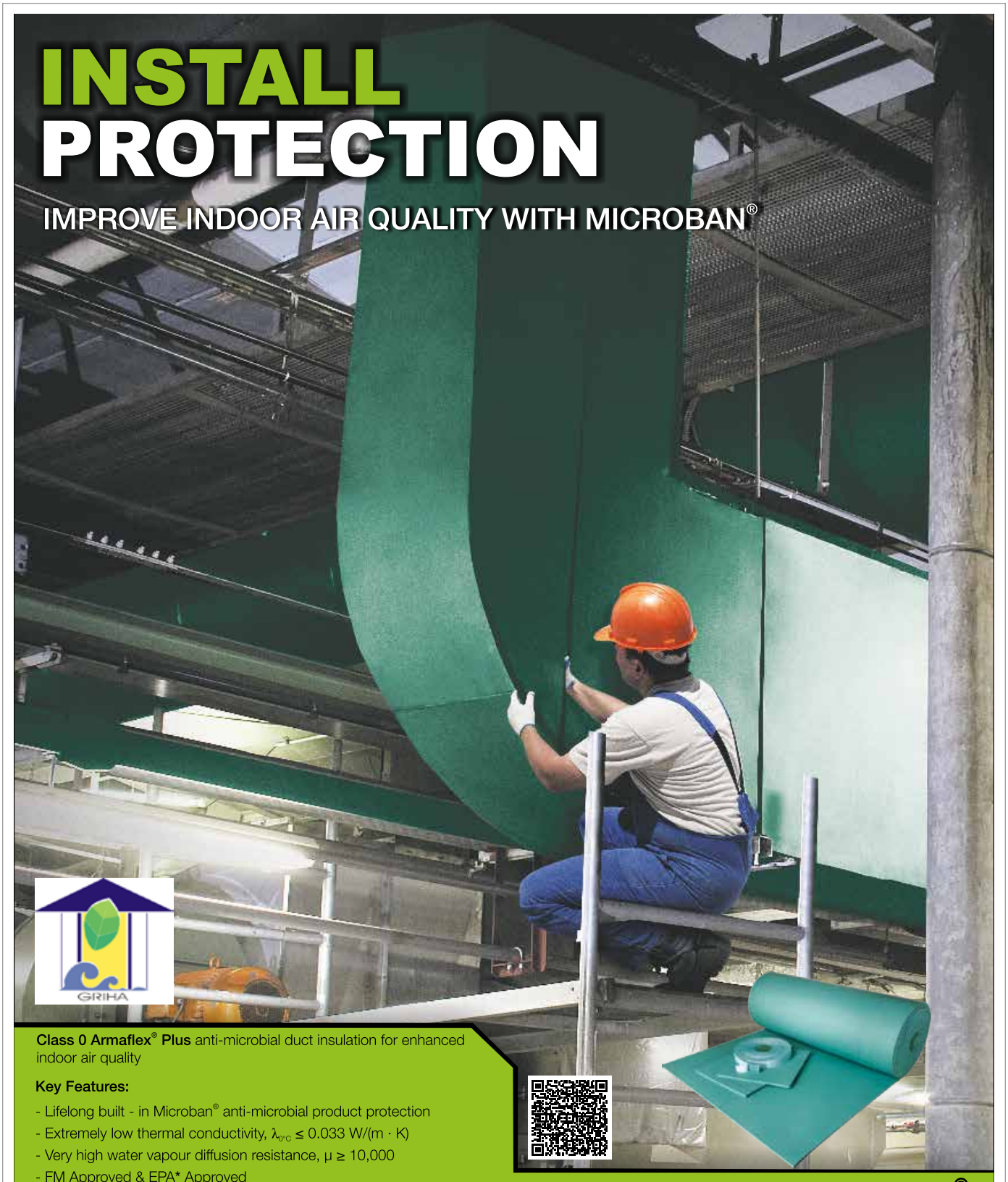

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Message from the CEO, GRIHA Council

Dear Friends and Colleagues,

Successful sustainable development calls for effective partnerships between governments, the private sector and civil society. Our planet faces imminent danger. Being cognizant of the threat, we picked this year's theme for the GRIHA summit as "Fostering Partnerships for Sustainable Habitat".

The partnership between GRIHA Council & University of New South Wales (UNSW) symbolises the relevance of education and research in linking social, economic, political and environmental concerns towards advancing the sustainable development agenda globally. Our collaborative efforts have had an immensely gratifying result: the 10th edition of GRIHA Council's annual flagship event 'The GRIHA Summit' is to be co-hosted by University of New South Wales (UNSW), Sydney, Australia.

We are equally delighted to inform that this year the BEE and GIZ have partnered with the GRIHA Council to organise the "International Conference on Building Energy Efficiency Transformation" as a prelude to the Energy Conservation Day observed on December 14 each year.

As we come together for the – 10th GRIHA Summit, it is a time to recognise the success & achievements of GRIHA and its many partners. The year 2018 has been a year of growth, transformation and achievements for the GRIHA Council.

A key milestone was the signing of the agreement between the GRIHA Council and Public Works Department (PWD), Government of Maharashtra in May 11, 2018. This unique agreement has a dual purpose – on one hand, the GRIHA Council creates a cadre of certified green building professionals within the PWD and on the other, there is an increase in the green footprint of GRIHA rated projects in the state. Since the signing of the agreement, Maharashtra has emerged as the leading state in the country, with the largest number of government projects registered with GRIHA. Subsequently, in November 2018, the State government has also notified a policy to promote green buildings, which provides incentives to both developers & buyers to invest in green buildings.

Friends, it is an honour for me to inform that the GRIHA Council was conferred "The Green Excellence Award 2018" on August 23, 2018 for its contribution to promote the Green Building Movement in India for the larger benefit of society by creating sustainable built environment for all.

The GRIHA Council also organised 2 regional summits – one in Mumbai on June 29–30, 2018, in association with Public Works Department (PWD), Government of Maharashtra and Sustainability Initiatives and another in Bengaluru on October 4–5, 2018. The thematic areas around which discussions were held focussed on selecting the most optimal building materials, technologies and construction techniques to minimize impact on our environment, economy and communities, critical to sustainable development.

The simple equilibrium of demand and supply will always dictate market dynamics and unless the user demands to go green the market will not deliver green.

Our resolve to constantly endeavour to make the world greener and sustainable for future generation is stronger than ever. We strive to make progress through a reduction in the carbon footprint of buildings and by constructing all new buildings with green building technology. Despite the fact that green buildings can reduce the energy consumption by up to 40 per cent, water usage by 25 per cent, increase people productivity and significantly reduce waste generation by extensive recycling, the first cost barriers intimidate the market. Unfortunately, the biggest challenge is ignorance. The simple equilibrium of demand and supply will always dictate market dynamics and unless the user demands to go green the market will not deliver green.

GRIHA has been a catalyst for promoting green development movement in India and is seen as an effective agent of change for addressing issues related to air-quality, protecting bio-diversity and reducing green-house gas emissions. It has evolved as a tool to evaluate resource efficiency at the design, construction and operations stages catering to both new and existing built environment.

May I also take this opportunity to acknowledge our esteemed clients and industry associates with whom we have built inclusive partnerships based upon principles and values, shared vision, and shared goals. As we move towards 2019, we know GRIHA will continue in its mission and zeal to ensure sustainability not only in the built environment but also lead people to a sustainable lifestyle.

Success is driven by talent and a committed team's passion to make a difference. I thank the enthusiastic and dynamic team of professionals at GRIHA for their faith & confidence in our work and their commitment & drive to do more.

On behalf of the GRIHA Council and our partners from UNSW, BEE & GIZ, I welcome you all to the 10th GRIHA Summit.

Wishing you all a Merry Christmas and a wonderful year 2019!

Sanjay Seth
Chief Executive Officer
GRIHA Council

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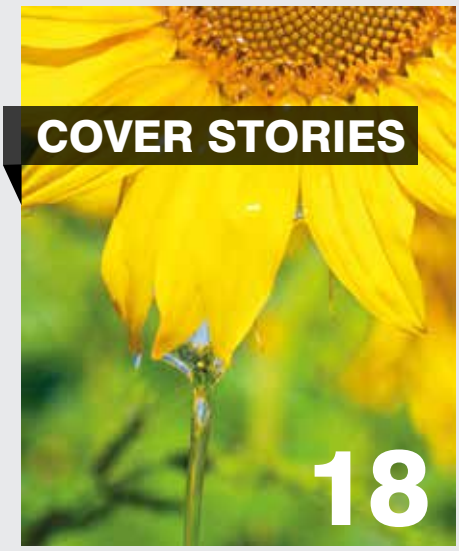

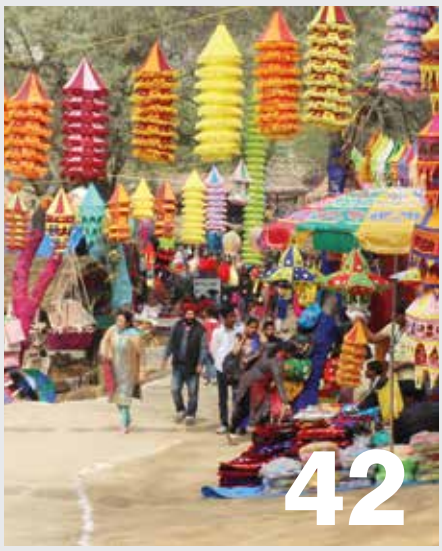

An annual magazine of the GRIHA Council, (Published in English)

CHIEF EDITOR
Sanjay Seth
CEO, GRIHA Council

EDITORIAL TEAM
GRIHA Council
Shabnam Bassi | Ashu Dehadani
Prathama Dolas | Aakriti Sachdeva

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GRIHA COUNCIL
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Carbon Balance

The Kyoto Protocol was adopted as part of the United Nations Framework Convention on Climate Change as a binding agreement that commits the signatories to develop and execute national programmes to reduce greenhouse gases. In this article, **Deepa Parekh** discusses the urgency to meet the climate-mitigation targets and explains the different mechanisms that can be deployed to carry out such changes.

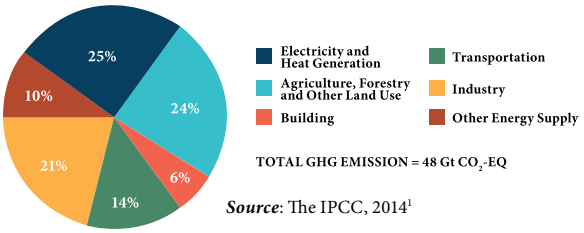
Deepa Parekh is an architect with over seven years of experience in green building consulting, policy, and education. Having conducted over 30 training programmes, she leads the Sustainability Education Programme at Environmental Design Solutions Pvt. Ltd as a senior project manager. As an ECBC Master Trainer, she strives to bridge the gap between theory and practice, through her work, she is currently developing courses for e-learning. She can be reached at deepa@edsglobal.com

Capping carbon emissions is essential to mitigate global climate change. This, however, is easier said than done in a fossil fuel-based economy. Trading carbon credits—one of the many ways to meet the Kyoto targets—might not necessarily function as a deterrent to reduce carbon emissions; it is only a way of balancing the global carbon levels. Someone somewhere is emitting more than the permissible limit, while another is emitting way less. This has been a way of balancing the carbon credit scale.

However, the technology transfer and employment opportunities that the new projects create in the developing countries are significant along with reducing the environmental impact. While this creates a win-win situation, it is important to deliberate on the matter.

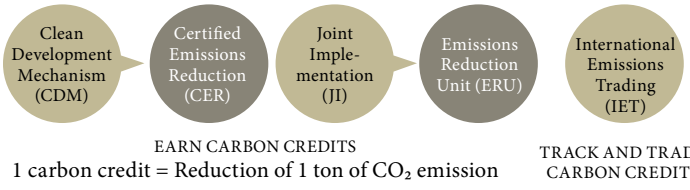
Background

The United Nations Framework Convention on climate change adopted the Kyoto Protocol on December 11, 1997, with the objective of addressing the concerns posed by global warming. The Kyoto Protocol identified six main greenhouse gases that needed to be controlled, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and the recently added nitrogen trifluoride (NF_3). Additionally, for the second commitment period between 2013 and 2020, the member countries have committed to a reduction in greenhouse gas emissions by at least 18 per cent below the 1990 levels.



Source: The IPCC, 2014[1]

» **Figure 1** Sector-Wise Global Greenhouse Gas Emissions, 2010



» **Figure 2** Kyoto Mechanisms to Balance Carbon

Source: The UNFCCC[2]

How do you Meet the Commitments to Emissions Reduction?

The member countries meet their targets primarily through national measures. However, the Kyoto Protocol offers an additional means in the form of market-based mechanisms; these have been listed below.

1. Clean development mechanism (CDM)
2. Joint implementation (JI)
3. International emission trading (IET)

Such instruments and mechanisms stimulate sustainable development through technology transfer and investment that also encourage the private sector and help the developing countries to contribute to the emission-reduction efforts.

GREENHOUSE GASES CONTROLLED UNDER KYOTO PROTOCOL

Methane (CH_4)	Carbon dioxide (CO_2)	Nitrous oxide (N_2O)
Hydro fluorocarbons (HFCs)	Per fluorocarbons (PFCs)	Sulphur hexafluoride (SF6)
	Nitrogen trifluoride (NF_3)	Added in the Second commitment period

Source: The UNFCC; recreated from https://unfccc.int/resource/docs/publications/beginner_en.pdf; last accessed on October 5, 2018.

Clean Development Mechanism

The CDM is mentioned in Article 12[3] of the Kyoto Protocol, which allows a (Kyoto Protocol ratified) developed country to implement a clean energy project in the developing countries. In return, the developed country earns certified emissions reduction (CER) credits. Each credit is equal to a tonne of CO_2 emissions and is counted towards meeting the protocol targets. These saleable credits can be used by the developed countries to partially meet their emission-reduction targets under the protocol.

[1] IPCC, 2014. Summary for Policymakers in Climate Change 2014, Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change

[2] Retrieved from https://unfccc.int/resource/docs/cop3/07a01.pdf#page=28; last accessed on October 5, 2018.

[3] Retrieved from https://unfccc.int/resource/docs/convkp/kpeng.html; last accessed on October 5, 2018.

The CDM projects largely include installation of renewable sources of energy. Thus, as the cost of clean technology continues to fall, the CDM projects continue to be a more viable solution towards emissions reduction. Some examples of the CDM projects are discussed below.

Himachal Pradesh reforestation[4]

This is the world's largest CDM project with investments from India, Spain, Sweden, Japan, and Canada through the World Bank's Bio Carbon Fund. The project entrusts people with the task of growing and protecting plantations. It aims to protect watersheds, regenerate native flora, and conserve biodiversity in the Himachal region. The project is expected to sequester 5 million tonnes of CO_2 equivalent over the first crediting period of 20 years.

Kenya Agricultural Carbon Project (KACP)[5]

The objective of this project is to remediate land using a wide range of methods to increase the soil organic content. This should improve the soil's water absorption, nutrient supply, and biodiversity, and should also help prevent erosion. Better soil yields better crops and improves food security, thus making agriculture more resilient to climate change. The project has formed the basis for developing one of the first methodologies for accounting emissions reductions from the application of sustainable agricultural land management practices.

Joint Implementation

According to Article 6[6] of the Kyoto Protocol, developed countries can carry out emissions reductions or removal-enhancement projects in other developed countries under the JI mechanism. In exchange, countries implementing these measures can earn emission reduction units (ERUs), each equivalent to one tonne of CO_2, which in turn can be counted towards the developing countries meeting their Kyoto targets. The JI mechanism offers parties a flexible and cost-efficient means of fulfilling a part of their Kyoto commitments, while the host party benefits from foreign investment and technology transfer.

The following are examples of projects under the JI mechanism.

Use of waste sawdust as fuel in Romania[7]

This project by Denmark seeks to improve the environmental conditions in five towns in central Romania through fuel switching in the district heating system. The project uses waste sawdust and wooden chips as fuel to power five new boiler plants. Hot water is then distributed to the residents of the towns via a network of pipes installed as part of the project. The sawdust substitutes for the natural gas, oil, and coal that were previously used in the district heating systems, thus reducing the environmental impact.

Sunflower and rapeseed biodiesel fuel production and use for transportation in Bulgaria[8]

In this project, biodiesel derived from sunflower and rapeseed crops are

[4] Retrieved from http://www.forestcarbonportal.com/project/himachal-pradesh-reforestation-project--improving-livelihoods-and-watersheds; last accessed on October 5, 2018.

[5] Retrieved from https://wbcarbonfinance.org/Router.cfm?Page=BioCF&FID=9708&ItemID=9708&ft=Projects&ProjID=58099; last accessed on October 5, 2018.

[6] Retrieved from https://unfccc.int/resource/docs/convkp/kpeng.html; last accessed on October 5, 2018.

[7] Retrieved from https://ji.unfccc.int/about/multimedia/ji_highlights.pdf ; last accessed on October 5, 2018.

[8] Retrieved from http://ji.unfccc.int/JIITLProject/DB/7RG4MHQTV9W72E5VGT66Y W3JA4W10K/ details; last accessed on October 5, 2018.

used as a substitute for petroleum and diesel. The biodiesel is distributed on the basis of contracts with independent buyers who are contractually bound to use it only in Bulgaria. The biodiesel plant will have the capacity to produce 60,000 tonnes per year. This project aims to create new jobs and employ farmers to grow the oil seed crops. Between the years 2008–2012, the ERUs were expected to be 677,216 tonnes of carbon dioxide.

International Emissions Trading

It is imperative to track carbon credits in order to manage the climate change conundrum. Article 17[9] of the protocol defines international emissions trading as a system that allows countries with spare emission units to sell this excess capacity to countries that have completed their targets. The process of carbon credits transaction between two parties under the Kyoto Protocol is referred to as carbon trading.

As per provisions laid out under the protocol, a buyer pays a seller in cash to buy carbon credits. In return, the buyer gets clearance to emit more carbon dioxide into the atmosphere. The standards for this are outlined by the International Emissions Trading Association.

Carbon dioxide is the principal greenhouse gas and is traded and tracked like a commodity. This is known as the carbon market. The units which may be transferred under the scheme, each equal to one tonne of carbon dioxide, are as follows:

1. Removal unit (RMU): This is decided on the basis of land use, land use change, and forestry activities such as reforestation.
2. Emission Reduction Unit (ERU): This is generated from the JI.
3. Certified Emission Reduction (CER): This is generated from the clean development mechanism project activity.

Thus the RMU, ERU, and CER all are different forms of carbon credits. The main objective of this system is to make certain that the member states comply with their protocol commitments.

An international transaction log is used to track units and record them through registry systems under the protocol. This ensures a secure transfer of emission reduction units between countries. In order to prevent overselling the units, each party is required to maintain a reserve of ERUs, CERs, or RMUs in its national registry.

One of the advantages of carbon trading is that it allows emission reduction to take place wherever abatement costs are the lowest, regardless of international borders. Carbon trading appeals to the private industry, since firms look at profit that can be obtained by selling excess greenhouse gas allowances.

Carbon Tax

There is another method used in the carbon market to limit the emissions: carbon tax is imposed on each unit of greenhouse gas emissions and gives firms (and households, depending on the scope) an incentive to reduce pollution. The tax is set by assessing the cost or damage associated with each unit of pollution and the costs associated with controlling that pollution. If the tax is priced correctly, it can be an effective way to actually curb emissions.

While carbon trading is uncertain when it comes to the cost of emissions, carbon tax overcomes this by ensuring everyone knows the price being paid for each unit of carbon dioxide emitted. This is a form of carbon pricing and a method to limit emissions. However, there continues to be uncertainty about the actual emission levels. Conversely, carbon trading provides certainty about the quantity of emissions but uncertainty about the cost of achieving these reductions.

Final Thoughts

Global climate change caused by greenhouse gases is the single greatest environmental challenge of our time. On the one hand, there are ongoing deliberations over the level of emission reductions by various countries, on the other hand there are several policies and regulations across different sectors that keep a check on the environmental impact.

A top-down approach, such as policies, has a large impact but usually take time to be implemented. However, a bottom-up approach, such as a market-based mechanism, allows businesses to promptly start acting on emissions reductions through different avenues.

The carbon credit and trading mechanisms allow collaborations and technology-sharing between different countries, thereby creating a mutually benefitting situation. This does not necessarily control emissions from a country but only balances the global carbon emissions. □

[9] Retrieved from https://unfccc.int/resource/docs/convkp/kpeng.html; last accessed on October 5, 2018.October 5, 2018.

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Recycling and Reuse of C&D Waste

Monalisa Behera *works with the CSIR-Central Building Research Institute, Roorkee (Uttarakhand), as a scientisit. She is a civil engineering graduate from the College of Engineering and Technology, Bhubaneswar. She has over six years experience in the utilization of waste for developing building materials and construction technology. She can be reached at monalisabehera7@gmail.com.*

Dr A K Minocha *works as a chief scientist and group leader, Environmental Science and Technology and Clay Products Groups, CSIR-Central Building Research Institute, Roorkee (Uttarakhand). He has more than 25 years of experience in the monitoring and analysis of different air pollutants and environmental chemistry related to building science. He can be reached at minochaak@yahoo.com.*

A Paradigm in Construction Industry

Waste that is generated during the construction, renovation, and demolition stage is known as construction and demolition waste (C&D). Debris from this, such as bricks, concrete, wood, and so on, constitutes this waste. In this article **Monalisa Behera** and **Dr A K Minocha** discuss the various aspects of sustainability in the construction sector and how C&D waste can be recycled and reused to mitigate the growing concern surrounding C&D waste management.

Sustainability in the Construction Sector

In light of the sustainability achievements in the construction sector, the importance of recycling and reusing C&D waste as new construction materials is undeniable. Sustainability in the construction sector is a multifaceted idea which aims at resource optimization, waste minimization, reducing environmental impact, and ensuring the comfort of occupants and serviceability throughout the building's life.

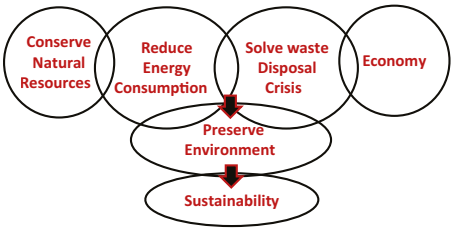
The issues related with the sustainability of the construction sector are as follows:

- The need for constructing a new infrastructure is at an all-time high as the world population is increasing at an alarming pace.
- As each country is competing with others to achieve rapid economic and industrial growth, it has resulted in the over exploitation of non-renewable resources.

- If things go unchecked, our future is at a risk of facing a severe scarcity of resources.
- The new construction rejects, renovation, and demolition of the existing structures have generated large volumes of C&D waste (see Figure 1). The handing of this waste has become a constant worry.
- The immense shortage of natural resources due to rapid urbanization and industrialization has become another resisting parameter in the nation's development.

» **Figure 1** Construction and demolition waste

Bearing in mind all these concerns, the scarcity of these building materials can be fulfilled by adopting new technology of source paradigm for the construction sector. In this regard, the use of recycled aggregate (RA) processed from C&D waste in different civil engineering infrastructure would make a major contribution to sustainable development in the construction industry. The benefits of recycling and reuse of C&D waste are shown in a pictorial representation in figure 2.



» **Figure 2** Benefits of recycling and reusing C&D waste

Need for Recycling and Reuse

Concrete, which is widely used, is made of naturally occurring materials. The aggregates form the major part of this, that is, 60% to 75% of the total concrete volume. Out of this, coarse aggregate consists of 60%–67% and fine aggregate consists of 33%–40%. As per the prediction of Building Materials and Technology Promotional Council (BMTPC), in India the demand for aggregate will be 400 million cubic meters by 2021–22. As per the current Indian government policy, the 'Housing for All' (2022) mission has become a great challenge to accomplish as it needs 30 million houses by 2022. In the twentieth century, an exponential growth in population has resulted in the over-exploitation of non-renewable resources, thereby resulting in several sustainability issues. Moreover, issues such as the escalating prices of natural resources, immense shortage of quality sources, and environmental concerns have left the houses unaffordable. The extraction and manufacturing processes of the conventional building material invariably emit greenhouse gasses.

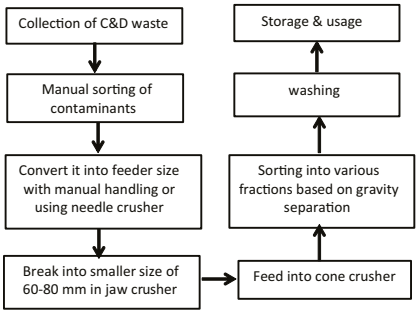
As a developing nation with high aspirations to become a world leader, the construction industry in India is expanding at a fast pace. The rapid growth in population and the expanding Indian economy have led to large-scale industrialization and urbanization to fulfill the demand or capacity requirement. As a result, it produces large quantities of C&D wastes due to the inefficiency of the existing infrastructure. Currently, most of the C&D waste generated across India and in other developing nations are used as back filling material for low-laying areas or to illegally fill up water bodies and wetlands around urban centers for real estate and infrastructure development. This is detrimental for the environment and our ecological system.

Moreover, 15 billion tonnes of sand is used each year around the world. The Indian government's ban on quarrying near river banks is an effort to reduce climate change and to preserve the natural resources. Given this, the construction industry faces an immense shortage of natural, fine aggregates. Thus any alternative to the natural coarse and fine aggregates in terms of processed aggregates, such as RA, can be a good substitute for natural aggregates.

Recycled Aggregate and its Processing Technique

RAs are processed from the demolition of concrete structures and other construction debris, such as waste concrete, rejected precast concrete members, broken masonry, concrete road beds, asphalt pavement, leftover concrete from a ready mix concrete plant, and the waste generated from different laboratories. RAs, therefore, can be of different types, such as brick aggregate, glass aggregates, asphalt aggregate, concrete aggregates, tiles and marbles from flooring, finishes, and ceramic products. The aggregates typically processed from the recycling of old concrete, such as demolished concrete and rejected concrete from laboratories and ready-mixed concrete plants are known as recycled concrete aggregate (RCA).

Recycling is a process used for the further development of new value-added building products. The main principle behind the recycling process includes the breaking of the rejected and old concrete into smaller-size fragments by subjecting it to a series of procedures, such as removal of contaminants, different stages of screening, and sorting. The commercial recycling plants use advanced technology for the recycling of C&D waste. The production process of the commercial recycling plant has been shown in Figure 3.



» **Figure 3** Recycling process of C&D waste

National Scenario

The recycling of demolition waste was first carried out in Germany after World War II. Research work carried out in several countries has demonstrated a sufficient premise for developing C&D waste as a new constituent for concrete. Globally, cities generate about 1.3 billion tonnes of solid waste per year. This volume is expected to increase to 2.2 billion tonnes by 2025, says a 2012 report by the World Bank.[1] In India, 14.5 million tonnes of construction waste is generated as reported by the Central Pollution Control Board, Delhi.[2] According to a report by *the Hindu*, as of March 2007 India has been generating 23.75 million tonnes of demolition wastes annually, which is not a negligible amount, and out of which only 3%–4% has been reused for embankment construction purposes.[3] According to the Technology Information, Forecasting and Assessment Council's report, a new construction generates 40–60 kg of C&D waste per sq m, then taking an average of 50 kg per sq m, must have generated 50 million tonnes (MT) of C&D waste in 2013. At this rate, over the last eight years, it would have produced 287 MT of C&D waste. This estimate only accounts for new construction. Demolition and renovation/repair-related waste of the older stock generates additional waste. If it is assumed that 5% of the existing building stock gets demolished and rebuilt annually, then about 288 MT more of C&D waste would have been generated in 2013

alone because of demolitions. These are only conservative figures estimated by various environmental monitoring agencies. The reality is that the total C&D waste generated in India will be more than all other types of solid waste put together. As per the recent data given by the Ministry of Environment and Forests, India generates nearly 530 million tonnes of C&D waste annually, which is very high. As a rough estimate, some of the major Indian cities generate quite a significant amount of C&D waste; this has been mentioned in Table 1.

Table 1 C&D waste generation in India

Major Cities	C&D Waste (MT tonnes/day)
Mumbai	3,000
Delhi	5,000
Bengaluru	500
Hyderabad	750
Chennai	1,500
Ahmedabad	300
Pune	750
Surat	400
Kolkata	2,000
Bhubaneswar	150

Research and Development at the CSIR-CBRI

A systematic R&D work has been initiated at the CSIR-CBRI, Roorkee, on the utilization of RA for the development of building products and in construction. Some of the building products, such as tiles, bricks, blocks, and

[1] The World Bank. 2012. 'What a Waste: A Global Review of Solid Waste Management'.

[2] Sonawane, T R and S S Pimplikar. 2013. 'Use of Recycled Aggregate in Concrete'. In *International Journal of Engineering and Technology* **2**(1): 1–9.

[3] Sonawane, T R and S S Pimplikar. 2013. 'Use of Recycled Aggregate in Concrete'.

structural concrete have been developed at this lab as shown in Figures 4 and 5.

- The concrete paver blocks of Grade M-30 and size 200 x 160 x 75 mm have been prepared by a compaction technique in two layers using different proportions of cement, sand, and coarse aggregate. The natural aggregate was replaced with RA. The fabrication of paving blocks was carried out using the compaction method, following the procedure as described in IS 15658: 2006 to achieve a target strength of 36.7 MPa on the 28th day.
- Bricks are made out of recycled fina aggregate (RFA) and cement and the properties, such as compressive strength and water absorption values were evaluated as per the existing IS standard and found within the specified limits. Similarly, flooring tiles were also fabricated using the same technique as the paver block in two layers for achieving the desired strength. Tiles were made with the RFA and RCA and the cement and the compressive strength of tiles were achieved up to 6–10 MPa.
- Structural concrete has been made with RCA and RFA. Various concrete mixes were designed at different replacement levels of RCA. The target strength of the concrete made with RCA was 40 MPa. The strength achieved by the control concrete was 52 MPa and 42.1 MPa with 100 per cent RCA. Structural concrete was also developed with RFA to achieve a strength of 35–40 MPa at its 100 per cent replacement level. Recently, work is on going on the development of prefabricated building components, such as roofing panels and wall panels made of self-compacting concrete (SCC) with RFA. The target was to achieve a 650 mm slump flow and 30 MPa strength. The various requirement of the SCC has been evaluated and fulfilled to develop the precast products.

Conclusion

It can be concluded that the use of RA from C&D waste is contributing towards a sustainable development model in the construction industry. Recycling and reusing C&D waste as aggregates in concrete is a logical step, which laso includes the conservation of materials and energy, preservation of the environment, and cost reduction. Based on this, it is concluded that RA has a considerable potential to be used as a construction material in several applications, namely, for the production of structural concrete, paver block, tiles and bricks, and so on. □

» **Figure 4** Paver blocks, tiles, and bricks, respectively

» **Figure 5** Structural concrete and SCC made with RCA and RFA

Authors are thankful to the Director Dr N Gopalakrishnan, CSIR-Central Building Research Institute, Roorkee, for his permission to publish this article.

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The Need for an Extended Producer Responsibility

Who is truly responsible for the unprecedented rise in climate change? Is it the big, fossil fuel-guzzling industries, the states and by extension the government, or individuals? The answer albeit rhetorical is all three. In today's product-saturated market scenario, wastage is as big a problem as curtailing resources. In this article, **Ronak Shetty** discusses how producers ought to undertake a bigger, more informed life cycle approach towards product creation, dissemination, and use, thereby putting forward a sustainable model of product-driven industries.

Ronak Shetty has completed a bachelor's and master's degree in environmental engineering. For the past two years he has been working in the field of sustainability and is engaged in creating a sustainable policy for the department of tourism, of Karnataka. He can be reached at shettyronak1508@gmail.com.

The Acceleration of Climate Change

The problem of climate change has been accelerating faster than our efforts to negotiate it. The UN Climate Change Annual Report, 2017, revealed that the carbon dioxide levels of the atmosphere have been higher than the past 800,000 years. The planet has experienced 17 of the 18 warmest years on records. The past three years have been the hottest began.[1]

The catastrophic effects of this have become evident in some countries. According to the World Resource Institute, Europe had its second-warmest June in 2018. On a similar note, the UK too, experienced its third-warmest June in 2018. Oman saw its highest low temperature on the June 26, 2018. More than 22,000 people were taken to the hospital in Japan after a heatwave hit the country on July 25, 2018. The country also hit its highest rainfall[2] in the same year.

The Paris Agreement

The world's nations in 2015 had foreseen these impacts when they recognized the urgency to adopt the Paris Agreement on climate change with a target to reduce the global temperature rise to below 2 °C. The problem was Paris was a beginning, not an end. The world is currently not on track to achieve the Paris targets. A change in these patterns requires actions to be taken at every level. Public and private actions across all sectors are necessary. Investing in climate change has not only benefitted the global environment but has also opened new markets, new jobs, and new opportunities.[3]

If we trace back the causes for global climate change, the picture becomes clearer. Actions that have led to such catastrophic effects have been a huge governing factor. With an increase in technological advancement and businesses in the world, there is a huge change in the scale at which these impacts have started affecting us. Imbibing a sense of responsibility towards climate change in the various social, public, and private sectors has become the key. In this respect, the United Nation has come up with a sustainable development goal entitled, Responsible Production and Consumption. This is one of 17 goals that are laid down by the UN for transforming the world.

Product Responsibility

It is the consumer market that drives producers. However, this does not cover the fact that the product in the market is the creation of the producer and all direct and indirect impacts that the product has on the surrounding communities, resources, environment, and health. This also has both tangible and intangible impacts on the business in terms of the long-term operation and reputation of the business. Hence it is important for every business model to understand why a product needs to be thought over from the perspective of a life cycle. This actually means that any product introduced in the market by a business or an industry must deal with issues relating to the environmental, the social impacts the product may have from the extraction of raw material, its transport, and concerns relating to the use and disposal of the product. This forms a basis for a more widely used term—'extended producers' responsibility'.

An extended producer responsibility holds the brand owners and manufacturers responsible for the end-of-life of products. This essentially means producers have to bear the costs of collecting, transporting, recycling or reusing, and the responsibly of disposing of their products and materials at the products' end of life. It is focused on a life cycle approach with the intention to minimize the impact a product may have. Adhering to this approach will eliminate the process of waste generation and resource scarcity, promote efficient processes, and lead to a more sustainable form of development.

[1] Retrieved from https://unfccc.int/sites/default/files/resource/UNClimateChange_annualreport2017_final.pdf; last accessed on October 23, 2018.

[2] Retrieved from https://www.wri.org/blog/2018/08/month-climate-science-extreme-weather-glaciers-losing-mass-and-ecosystems less?utm_source=linkedin&utm_medium=world%20resources%20institute&utm_campaign=socialmedia; last accessed on October 23, 2018.

[3] Retrieved from https://unfccc.int/sites/default/files/resource/UNClimateChange_annualreport2017_final.pdf; last accessed on October 23, 2018.

Sustainable Chemistry for Efficient Processes

The resources that go into a product help decide the value that is invested in a product, both environmentally and economically. A branch of chemistry called sustainable chemistry looks into chemical processes with an intention to maximize the amount of inputs in a process that gets converted to output. This in turn reduces the generation of waste or byproducts and avoids the use of non-renewable and hazardous resources. This also creates products that have a mix of non-toxic or non-hazardous elements, hence making it easier to deal with. DuPont Canada, a company that manufactures a wide range of products has demonstrated a good commitment to sustainable chemistry. The company does not source any chemical that is environmentally unsafe. They removed harmful toxins, such as volatile organic compounds and nonylphenol ethoxylates from their manufacturing chain of cleaning products without compromising their product quality. Traditional cleaning products contain chemicals that may cause skin irritation, watery eyes, and chemical burns. Some chemicals may produce fumes that are harmful to lungs, as is the case with chlorine bleach and ammonia. Parts of these chemicals are difficult to breakdown in wastewater treatment. DuPont has worked on improving efficiency and minimizing the excessive and unnecessary exposure to particular chemicals, thereby protecting human health and environment from potentially toxic chemicals.[4]

Life Cycle Analysis of Products

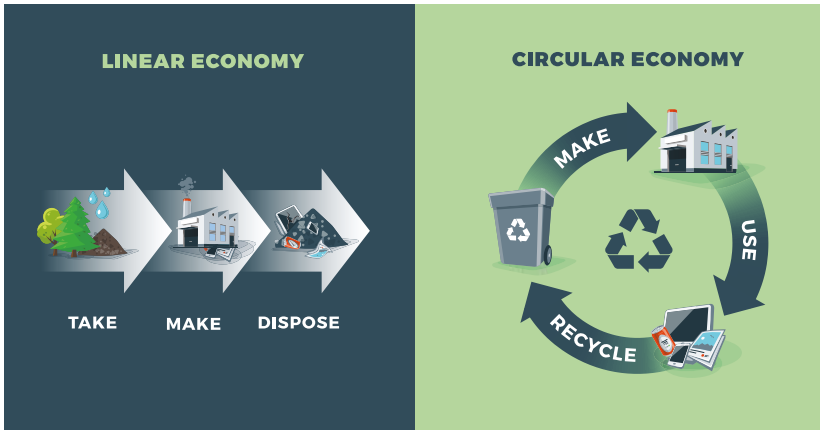
The selection of inputs in a product is a significant aspect in making a product. A product's life cycle assessment gives an even clearer picture as to what should be the impacts of the different inputs, ranging from the stage of extraction of raw materials to the stage of final disposal after use. The producer, however, needs to understand why such an analysis is needed. Such an analysis is not only associated with economic and environmental benefits but also helps the owner to position himself in the market in a better way. Interface, which is one of the largest designers of carpet tiles in the world, produced significant global emissions and around 5 billion pounds of carpet waste in the USA each year. The Environmental Protection Agency reported a 1 per cent or less recycling of the carpets. However, incorporating a sense of responsible practices at Interface allowed the company to reduce its global emissions by 60 per cent. Additionally, there was a 66 per cent reduction in water consumption, 80 per cent reduction in the amount of waste sent to landfills, and 45 per cent reduction in fossil fuel consumption. All these practices helped reduce the amount of fresh resources required, reduced the carbon footprint of their product chain, and enabled a better market presence. Today, Interface is a world leader in carpet tiles with annual sales reaching $1 billion.[5]

[4] Retrieved from https://www.acs.org/content/dam/acsorg/greenchemistry/industriainnovation/DuPont-business-case-study.pdf; last accessed on October 23, 2018.

[5] Retrieved from http://stars.library ucf.edu/cgi/viewcontent.cgi?article =1082&context=honorstheses; last accessed on October 23, 2018.

Looking at Waste As a Resource

Exploring the embodied energy of materials and the carbon footprint of a product or a service will provide deeper insights on the scale at which the products impact the environment and society. The amount of waste generated throughout the entire product life at every level helps visualize the impacts. The problem with waste is the creation of waste in the first place, thus leading to the equally pressing concerns of waste management. Apple has a recycling plan for its phones where they help recycle Apple products for free. They have an efficiency robot that recovers



important parts from the phone.[6] This not only reduces the requirement of fresh resources but also considerably reduces the waste from entering landfills. Creating a model on how and where consumers can recycle their used products make things convenient for consumers. This leads to a cradle-to-cradle model where waste becomes a resource. This in turn will reduce the load on municipalities and taxpayers for managing products, minimizing the quantum of waste, and enhancing rates of recycling.

Incentivizing Sustainable Practices

Government subsidies and incentives aligned to extended product responsibility can promote this model throughout the different product chains. Certifying producers based on product life cycle chain could promote products that are safe both to the surrounding community and the environment and also have potential economic benefits. Collaboration amongst the different businesses can help build a model where the waste from one industry can be used as an input for another. The sugar industry produces black molasses, which acts as an important ingredient for making alcohol in the distillery sector. This helps in creating a sustainable model for product-driven industries.

> Producers have to bear the costs of collecting, transporting, recycling or reusing, and the responsibly of disposing of their products and materials at the products' end of life.

Aligning with SDGs

Industry-wide stakeholder participation and the alignment of business objectives to sustainable development goals (SDGs) enhances producers' connect to global issues. Mapping product-related actions to SDG targets can help incorporate different SDGs and can even help in visualizing the impacts the choices that producers make on a global level. Doing so will help in gauging the economic sustenance of a business and the impacts on the environment and society. A policy approach is the most efficient way of implementing extended producer responsibility with the business. Setting targets and periodically reviewing these will create a roadmap towards achieving more product responsibility and will help synchronize businesses with the climate change targets set by the UN. ◻

[6] Retrieved from https://www.apple.com/in/recycling/; last accessed on October 23, 2018.

Upcoming Campus

Nālandā UNIVERSITY

NET ZERO CAMPUS

The sprawling 455 acre Nalanda University campus, being modern and state-of-the-art, will undeniably follow the path of sustainability while being comfortable and efficient for the occupants and visitors alike. The campus is under construction with a unique water, energy and waste management design which essentially emphasizes upon sustainability and environmental sensitivity at all levels.

The key sustainability features for developing a Net Zero Campus include, net zero energy, net zero water, net zero waste and net zero emission. This hybrid concept featuring renewable energy sources with the indigenous approach and its integration with various innovative technologiesmay exemplify rational approaches to construction ofother upcoming projects/campuses and community construction models in future.Some of the most important and indigenous aspects and palette of concepts for passive methods operating at different scales are

- Use of Desiccant Evaporative (DEVAP) technology for cooling/heating of the buildings.
- Use of Compressed Stabilized Earth Blocks (CSEB) blocks instead of common burnt clay bricks.
- Use of integrated boxes of masonry to achieve seismic stability.
- Use of thick cavity walls to increase thermal resistance.
- Climate appropriate landscape design to reduce potable water demand.
- Decentralized Water Treatment (DeWAT) systems,
- Strategies for efficient waste management system,
- Biogas operated Combined Heat & Power (CHP) engine,
- Solar PV captive power plant,
- Cooling as well as cleaning of the air through use of selected native plants, etc.

The campus combines state-of-the art technologies with planning principles of the ancient Nalanda University to create a carbon neutral and zero waste campus. The whole master plan in itself is transitional, as it demonstrates the integration of the campus into a large eco-system of the site.

The Nalanda University Project is registered with GRIHA Council, under Green Rating for Integrated Habitat Assessment – Large Developments (GRIHA LD). The GRIHA Council has awarded the integrated water management system of this campus as an exemplary winner during 9th GRIHA summit held in 2017.

AN AVANT-GARDE INTERNATIONAL UNIVERSITY UNDER MINISTRY OF EXTERNAL AFFAIRS (GOI)

PROF. SUNAINA SINGH
Vice Chancellor

Rajgir, Nalanda (District)
Bihar, India - 80311624,
Tel: +91-6112-255330

#201 Ashoka Estate
Barakhamba Road
New Delhi, India - 110 001
Tel: +91-11-23358131/32

www.nalandauniv.edu.in

Plastic Waste Pollution

A Minute to Make, But Years to Break

Over the past decades, global plastic production and consumption have witnessed a meteoric rise. While the harmful effects of plastic utilization are many, we seem incapable of weaning ourselves away from it. In this thoughtful article, **Ar. Aakriti Sachdeva** reminds us of the damage that has been done to the environment and discusses the ways in which we can collectively curb its usage, monitor its disposal, and, if possible, avoid using it altogether.

Ar. Aakriti Sachdeva is a practising architect and has a master's degree in environmental architecture from Dr Bhanuben Nanavati College of Architecture for Women, University of Pune. She has been part of the GRIHA Council for a year and is passionate about working in the field of waste management. She can be reached at aakriti.sachdeva@grihaindia.org.

Right from its discovery in 1907, plastic has played a critical role in our lives and continues to assert its presence even today. A so-called wonder product of the twentieth century, this entity is gradually choking our environment and polluting our mountain ranges and seas.

Nobody knows the exact time over which plastic disintegrates; it may take up to 450 years or even more. Due to its low cost, its production is high and its dangerous, toxic qualities are ignored. According to statistics, less than one-fifth plastics are recycled globally, leaving more than 80 per cent of the production to find its way into landfills or oceans.

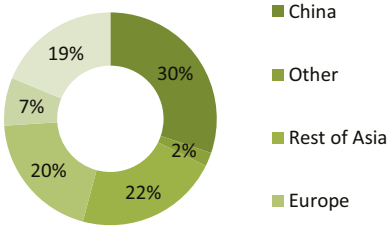
Plastics are killing mammals directly through entanglement or ingestion or are infiltrating the food chain and killing plant life, and by extension us. In a year, more than 100,000 marine creatures die from plastic entanglement.[1] Tens of thousands of whales, birds, seals, and turtles are killed every year due to plastic bags being disposed of in the marine environment, as they often mistake plastic bags for food. Researchers have found that 95 per cent plastics are entering the oceans by flowing through major rivers, out of which eight are found in Asia.[2]

The dilemma as to why a complete ban on plastics has failed is because the entity often provides functionality that cannot be easily or economically replaced by other materials.

The Major Concerns

Plastic is durable, easy to produce, lightweight, unbreakable, odourless, and chemically resistant. Its low manufacturing cost and durability are the two main factors responsible for the industry's rapid growth.

Asia is the biggest plastic manufacturer constituting half of the world's production (See Figure 1). In 2010 the global plastic production was around 275 million tonnes, out of which 220 million tonnes have been discarded in landfills or oceans.[3] As the use of plastics has increased over the years, they have become a larger part of our nation's municipal solid waste. India alone generates 25,940 tonnes of plastic waste a day, which accounts for more than 10 per cent contribution towards the generation of plastic.[4] Clearly, the problem lies not in its extensive production but in our mismanagement as consumers, the ineffective recycling policies, and lack of producer responsibility. Moreover, the pace of upgradation, innovation of waste management infrastructure is not at par with the rapidly increasing levels of plastic waste.



» **Figure 1** Half the world's plastics are made in Asia

Source http://www.news.ucsb.edu/2017/018137/plastic-planet; last accessed on November 19, 2018

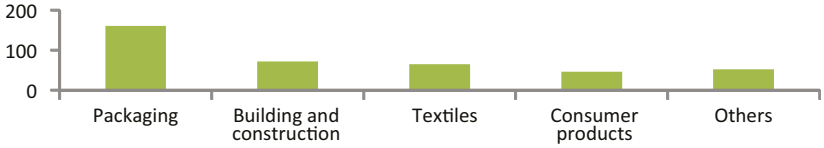
With the help of an informal chain of ragpickers and *kabaadiwallah*s or scrap dealers, plastic bottles, jars, containers, etc., find their way back into the reusing and recycling economy. However, there is a concerted effort to increase the recycling of rigid plastic packaging by companies as well but there are other single-use plastics, such as bags, candy wrappers, tobacco sachets, soap wrappers, and shampoo sachets, which are either too difficult or not lucrative enough to collect. Another example is the increasing packaging waste with the introduction of the e-commerce industry, which is evident from the fact that almost 40 per cent of the entire production, is for

[1] Foundation, O. C.2010. 'Ocean Crusadors'. Retrieved 2018, from http://oceancrusaders.org/plastic-crusades/plastic-statistics/; last accessed on November 19, 2018.

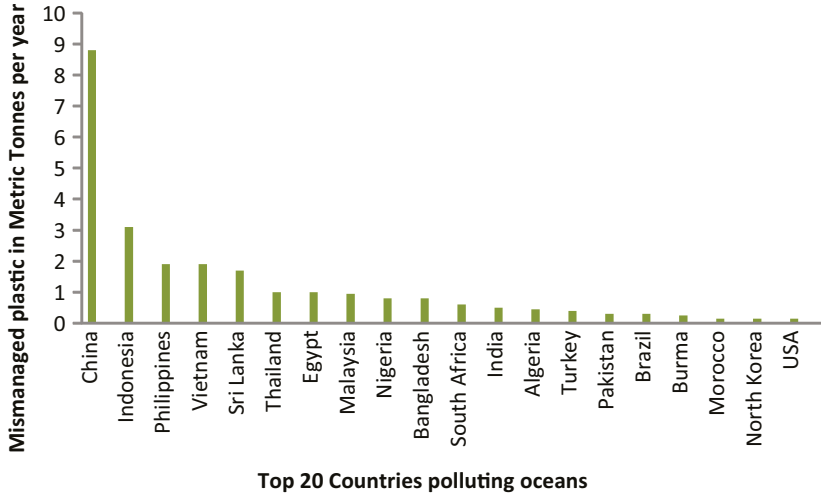
[2] Shivali. 2017. 'Shocking Report Reveals that 95% of Plastic Polluting the World's Oceans Comes from Just Ten Rivers, including the Ganges and Niger'. Mailonline.Retrieved from https://www.dailymail.co.uk/sciencetech/article-4970214/95-plastic-oceans-comes-just-TEN-rivers.html; last accessed on November 19, 2018.

[3] Roser, H R. 2018. 'Plastic Pollution'. Retrieved from https://ourworldindata.org/plastic-pollution; last accessed on November 19, 2018.

[4] Dabas, M. 2018. 'Delhi Is the Largest Contributor to India's 25,940 Tonnes of Plastic Waste'. Retrieved from https://www.indiatimes.com/news/india/delhi-is-the-largest-contributor-to-india-s-25-940-tonnes-of-plastic-waste-every-day-and-govt-is-just-sitting-idle-340186.html; last accessed on November 19, 2018.



» **Figure 2** Global plastic production by Industry (million tonnes)
Source http://www.news.ucsb.edu/2017/018137/plastic-planet; last accessed on November 19, 2018



» **Figure 3** The Growing plastic pollution contribution
Source http://www.news.ucsb.edu/2017/018137/plastic-planet; last accessed on November 19, 2018

packaging.[5] The consumer base of the e-commerce industry is growing as it is inexpensive, convenient, time saving, and so on. Any item ordered online comes packed in a plastic bag, which adds to the increasing plastic waste. Fundamentally, high levels of recycling with reduction in use, reuse, repair, or remanufacturing can allow for a given level of product service with comparatively lower material inputs.

Various Nations Approach Plastic Pollution, the Current and Future Plans

Over the years, initiatives have been taken at a global level to reduce or eliminate the consumption of single-use plastic, which are gaining momentum. China, the highest producer of plastic in Asia, has banned all thin plastic bags and started charging retailers a tax on thicker bags. The Chinese government has said to have seen a 66 per cent drop in plastic bag use.[6]

» **Figure 4** Plastone, a new, sustainable technology
Source https://www.theguardian.com/world/2018/jul/09/the-man-who-paves-indias-roads-with-old-plastic; last accessed on November 19, 2018.

Understanding the gravity of the situation, the Government of India commemorated the World Environment Day, 2018, in its truest essence, that is, through a series of activities and events that aim to generate a substantial public interest as well as participation.

The pledge includes transforming 100 monuments across the country into plastic- and litter-free zones.[7] Even the tourism ministry rose to the occasion by pledging to avoid plastic straws at public places. India as a fast-growing economy, and with a population of 1.3 billion, is a significant contributor to ocean plastic. It is also struggling to manage its waste streams. The ban on plastic cannot be a success until each one of us is determined and willing to give up using plastic. Prime Minister Shri Narendra Modi has launched a mission to eliminate the single-use plastic in the country by 2022 and it is every individual's duty to bring a positive change in the environment.[8]

[5] PlasticsEurope. 2017. 'Plastics: The Facts 2017'. Retrieved from https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf; last accessed on November 19, 2018.

[6] Institute, W W. 2018. 'Vision for Sustainable Future'. Retrieved from http://www.worldwatch.org/node/6167; last accessed on November 19, 2018.

[7] Lekshmi Priya, S. 2018. 'The Better India'. Retrieved from https://www.thebetterindia.com/144223/news-india-pledge-beat-plastic-pollution-2020-5-steps-fast-tracking-process/; last accessed on November 19, 2018.

[8] Gupta, R. 2018. 'India Will Abolish All Single-Use Plastic by 2022, Vows Narendra Modi'. The Gaurdian. Retrieved from https://www.theguardian.com/environment/2018/jun/05/india-will-abolish-all-single-use-plastic-by-2022-vows-narendra-modi; last accessed on November 19, 2018.

The urgency to decline plastic is now being given its due attention by the government and the public.

Deals at a nation-wide and organizational level have been undertaken to reduce plastic pollution by 2025. Coca-Cola has announced its new sustainable strategy wherein the recycled content in their bottles will be increased from 25 per cent to 50 per cent by the year 2020.[9] Similarly, PepsiCo, Amcor, and Unilever have also pledged to convert to 100 per cent reusable, recyclable, or compostable packaging by 2025. Shifting consumers from conventional plastic to recycled plastic is further escalating the growth of the plastic waste management market.

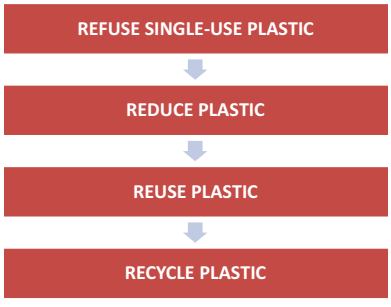
Professor Rajagopalan Vasudevan, a professor of chemistry at Thiagarajar College of Engineering, Madurai, also known as the India's 'Plastic Man' has created a stone block with a plastic coating known as 'plastone' (See Figure 4). Each plastone block comprises 300 plastic carry bags and around six PET bottles.[10] One of the foremost advantages of plastone is its non-porous nature and the ability to prevent water penetration, and hence finds its use in road constructions.

Banning plastic is not the only solution as it will affect the lives of many people, especially the lower-income group. Retailers have started replacing plastic bags with jute/ cloth/ paper bags along with bioplastics that might play a major role to bring a change in our daily lives. The other alternatives are paper packaging, cardboard packaging, bamboo cutlery, etc., which ought to be well researched and implemented.

A Collective Effort

Along with focusing on eliminating plastic, we should also be concerned about its mishandling and the ways in which recycling and reuse can be made mainstream. Widespread awareness and clean-up campaigns should be launched globally along with targets so as to map the progress.

Biodegradable plastic and the 'zero-waste' philosophy are being embraced by the government and the people. Given this, the plastic recycling industry is slated to boom in the coming years. This revolution will also enable more sustainable ways of preserving raw materials, reduce the landfill problems, and consume less energy in the manufacturing of plastic.



» **Figure 5** The four Rs—refuse, reduce, reuse, and recyclev

With the help of various eco-friendly alternatives, one can make a shift to a plastic-free lifestyle through the use of items, such as bamboo toothbrush, edible cutlery, biodegradable bags, biodegradable sanitary napkins, wheat straws, and so on.

The best way to deal with the problem of waste is to create a feasible plan in which things after they have been used should be returned to the retailer, who in turn will return it to the manufacturers. This reverse cycle once established will be a great success. Nothing can change without collective efforts and reform at the grassroots level. Such measures, no matter how small, will definitely contribute towards reducing plastic pollution and will go a long way in saving our Mother Earth. ◻

[9] SKODA, E. 2018. 'Packaging Europe'. Retrieved from https://packagingeurope.com/coca-colas-sustainable-packaging-strategy-one-year-on; last accessed on November 19, 2018.

[10] Ministry of Environment, F. a. (n.d.). 'Beat Plastic Pollution'. Retrieved from http://www.moef.nic.in/sites/default/files/press-releases/Lo_Book02.pdf; last accessed on November 19, 2018.

Biomimicry

Learning from Nature to Solve Human Problems

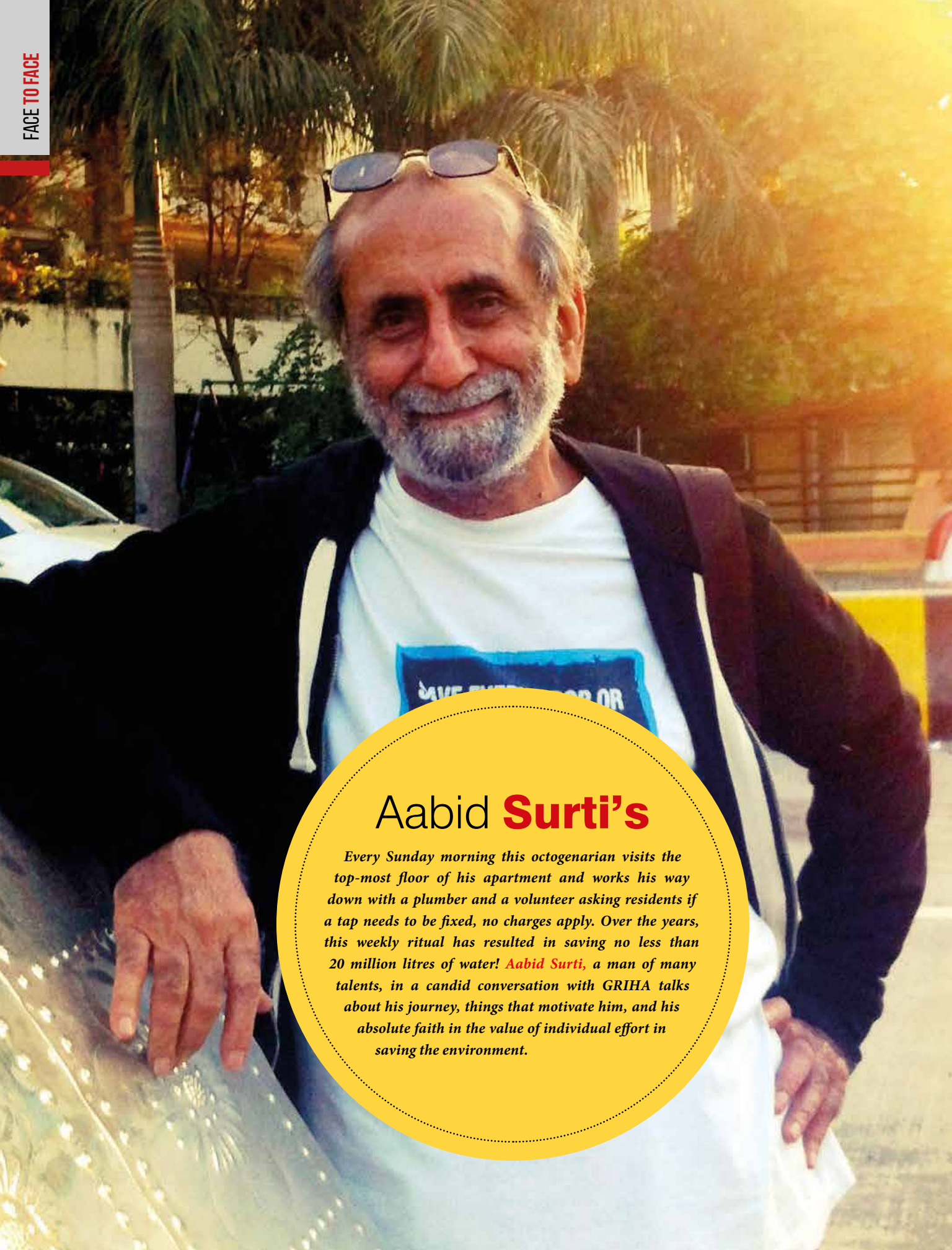
Reema Nagpal,
LEED AP, GRIHA CP, WELL AP, ILFI Ambassador
Senior Sustainability Consultant
AECOM
Mobile +918570883361
Email reema.nagpal@aecom.com

We are part of a brilliant planet, where nature's time-tested genius patterns and strategies have evolved elegantly over billions of years. However, unfortunately, we all seem to have forgotten the brilliance and the fact that we are not the first ones to build or to try to heat or cool a structure; we are not the first ones to make paper or process cellulose either. Other organisms are doing things very similar to what we need do, in-fact they are doing things in a way that has allowed them to live gracefully on this planet. Biomimicry, the term first coined by Janine Benyus, means the science of studying nature's models and taking inspiration from it to solve human problems.

Across the globe, there has been a significant increase in the use of biomimetic innovations to help design products and services in more sustainable ways. There are several examples of such innovations: the Eastgate Building in Zimbabwe, which takes inspiration from the self-cooling mounds of African termites. Despite a daily fluctuation from 40 °C to less than 0 °C, the termites are able to maintain a constant inside temperature of 30 °C. By employing the same design principles followed by termites, the Eastgate Building was built with only 10 per cent of the typical ventilation costs for the area, thus resulting in 35 per cent less energy costs. Another great example is the Calera's cement recipe which is borrowed from the coral reefs in our oceans. Corals use the dissolved CO_2 in the oceans, to build the largest biological structures on earth. Using the same process as corals, Calera captures CO_2 to make cement. While a typical cement manufacturing is highly emissions-intensive, Calera has been able to reverse the equation and is instead sequestering CO_2.

Inspired by a Kingfisher's beak, West Japan Railway's Shinkansen (bullet train) is another example of a solution inspired by nature. The bird dives at high speed from one fluid (air) to another that is 800 times denser (water) with barely a splash; the shape of its bill allows the bird to cut so cleanly into water. By turning the train's nose into a bird's beak, the design reduced the sonic boom effect, which was so forceful earlier that it was heard by residents 400 metres away. This design solution also allowed the train to run at higher speeds and still adhere to the standard noise level of 70 dBA.

Biomimicry is a winning strategy because every living creature that exists today is here because it tackled a number of challenges. We are surrounded by solutions and ideas that are vital for a transformation to a more sustainable world. We need to constantly remind ourselves of nature's genius and learn how to live on Earth gracefully.



Aabid **Surti's**

Every Sunday morning this octogenarian visits the top-most floor of his apartment and works his way down with a plumber and a volunteer asking residents if a tap needs to be fixed, no charges apply. Over the years, this weekly ritual has resulted in saving no less than 20 million litres of water! Aabid Surti, a man of many talents, in a candid conversation with GRIHA talks about his journey, things that motivate him, and his absolute faith in the value of individual effort in saving the environment.

From being a screenwriter, poet, painter, cartoonist to the 'The Man who fixes taps', how has the journey been?

Unbelievably satisfying. Whatever was lacking emotionally in my life was fulfilled through this initiative. As a child, I neither got love from my father, nor from my mother. They struggled to bring us up in extreme poverty. Working night and day to make ends meet, my mother had no time for us kids, and my father was bedridden with a mental disorder. With this initiative, I got an abundance of love and respect from every house I visited.

'Save every drop, or drop dead', how did this come into existence?

Mostly, I have seen that people end up feeling helpless and frustrated because they dream too high—they want to clean up the holy Ganges or stop the massacre of forests or save wildlife, but they can't. These problems are huge and complex. So I decided to do something that is within everyone's reach. If I cannot save the holy Ganges, I can at least save a few drops. Because every drop is a gift of God and if we fail to save even this then we are bound to drop dead without water. In third-world countries, people have already started dropping dead due to drought and water scarcity.

How important do you think is to partner and work towards sustainability?

It is the need of the day. The situation globally is to do or die. In India it is the worst. We have not left a single river unpolluted. In search of clean water, people living on the banks of rivers have started migrating. Shah Jahan would not have imagined building the Taj Mahal on a stinking sewer called Jamuna.

What is the story behind visiting people door to door to fix leaking taps?

My ears are sensitive to the dripping sound of water as I have seen fights for every bucket of water on the community tap during my chawl days. Although the childhood has been left behind, I can still hear the sound of dripping water. So whenever I visited a friend's house, my ears would prick up at the sound of dripping water coming from the kitchen or washroom taps. Requesting them to get a plumber and to get the tap repaired mostly fell on deaf ears. Looking at this I decided to hire a plumber and in a day corrected the faulty taps in all my friends' houses. Doing that job for a day was so satisfying that I decided to do it every Sunday.

What keeps you motivated towards this cause even at 84?

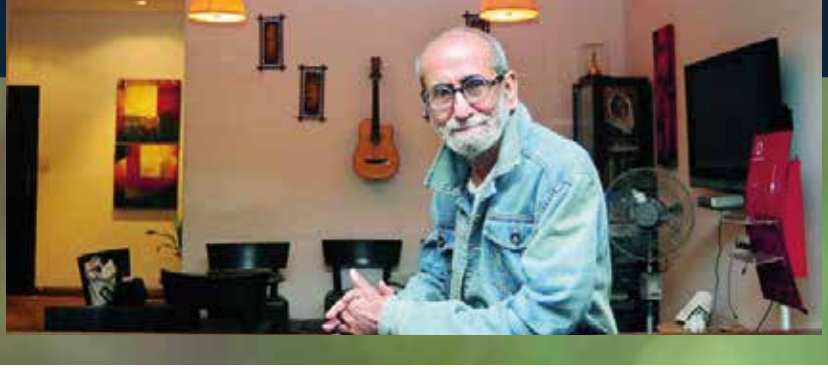
I believe we all have to do something or the other for our country, and to be able to repay society for what it has done for us is a job that will take a lifetime. We are getting free rainwater, the oxygen from trees, free air; what have we given in return? If you do not wish to save water, at least plant a tree, put a bowl full of water in the window for sparrows … there is lot we can do to repay the obligation that is on us all.

How many more litres of water do you target to save in the next five years and in what ways?

My initiative is not time bound. There are no definite targets or five-year plans. Though single handedly I have saved 20 million litres of water in 10 years, but that was not the target. It just happened. So I say, just do it. If you can't work for the environment every day, just work once a week. Like me, at least you can manage to spend a few hours on Sundays correcting the faulty taps or visiting lonely senior citizens or cleaning the temples, beaches, parks and set an example without preaching. Your actions will speak for themselves.

What is your message to the youth?

If you want to be happy, follow your heart. The conflicts start when your heart tells you to be the greatest musician but the mind points a finger towards an engineering or medical college, where the future is bright with a secure income. If there is no happiness in life, then the latest car, or a fancy villa, or even a seat in parliament will feel like nothing but toys used and discarded by a child.



The Ecological

Revival of Surajkund and Its Surroundings

Ar. Rajesh Shukla *completed his master's degree in landscape architecture from the School of Planning and Architecture, New Delhi, in 1989. Soon after he established his consultancy firm, Quintessence, and ever since he has been actively involved in a variety of projects throughout the country. He has won several national and international design competitions and is a member of the Technical Expert Committee of the NABET working towards developing an accreditation scheme for qualified building environment auditors under the MoEFCC, Government of India. He can be reached at qla.india@gmail.com.*

Dr Saumya Shukla *is an assistant professor of economics at Maharaja Agrasen College, University of Delhi (DU), and has more than 27 years of teaching experience. She graduated in economics from Lady Shri Ram College for Women, DU, and obtained her MA and MPhil degrees from the Centre for Economic Studies and Planning, Jawaharlal Nehru University. She was awarded a PhD for her work on the 'Economics of Green Buildings in India', with a special reference to LEEDs guidelines at the Department of Business Economics, DU. She can be reached at saumyashukla.du@gmail.com.*

A major disaster is silently unfolding behind the widely known Surajkund mela grounds, south of Delhi, in Faridabad, Haryana. The site has two of Delhi's oldest and significant historical structures dating back to the eight and tenth centuries, which are inaccessible and in a state of disrepair. While the Anangpur dam was built by the Tomar King Anangpal, who is also credited with carrying out the initial fortification of Lal Kot, Surajkund was built by the Tomar King Surajpal in the tenth century. The two structures are fine examples of the wisdom of the rulers, who realized the strategic importance of the Aravallis from a defense perspective; understood the potential and limitations of the region (that of being a fragile ecosystem); and built the first rainwater harvesting structure to support the population.

Surajkund, literally meaning 'lake of the sun', is an ancient artificial reservoir built in the backdrop of the Aravalli hills with an amphitheatre-shaped embankment. Its bed is about 130 m in diameter. Towards the west side of the kund, on an elevated platform, stood a sun temple. Though the temple no longer exists, the kund-side walls and steps are well protected. In recent times, the dry bed of the kund has become symbolic of environmental degradation. This region is the quartzite table band of the Aravallis in the Tughlaqabad–Gurugram stretch with an average elevation of 243 m above sea level.

The Anangpur dam, a 150-year old construction in Faridabad, has been supplying water to the Surajkund lake for decades. Additionally, the dam was also built to recharge groundwater and preserve the biodiversity of the Aravallis. With the dam drying up, symbolic of environmental distress, the kund, too, has disappeared. In this article, **Ar. Rajesh Shukla** and **Dr Saumya Shukla** discuss the importance and significance of the two constructions and suggest a robust set of policies and guidelines that can be followed to resuscitate the historical structures.

The Anangpur dam 103-m long, 12-m high, and 20-m wide was designed and built with the least damage to nature, which created a vast lake (nearly 300 hectares) formed by the impounding waters shaped by the topography, and had a large catchment area of the Aravallis. It is quite likely that the underground aquifers created springs which fed the kund, 28 feet below. Drying of the recharge area has resulted in the kund drying up as well.

Today the lake is nowhere visible and the dam can only be reached with difficulty. Even the Archaeological Survey of India notifications have been erased and it presents a dry bed. The lake bed upstream has become plotted and roads and houses have been built over it. Downstream, the agricultural fields have destroyed the topography. This article aims to investigate the reasons that that have led to the drying of the two structures, namely, the reservoir of Anangpur dam and Surajkund, despite heavy rains in the past.

The article also focusses on understanding and re-establishing the relationship which existed between these structures and the Aravallis and how the understanding of this region on the basis of watershed analysis can help restore the ecosystems that have been disturbed by various human activities and incorrect planning policies.

Along with the two structures, even the Peacock Lake adjacent to Surajkund has become dry due to

various reasons, such as illegal mining, encroachment, eutrophication, invasive plant species, unchecked exploitation of ground water, and so on.

The reasons why the two structures have become symbolic of environmental deterioration should be a cause for concern as they do not merely point towards one aspect of water but are indicative of a widespread destruction of the Aravallis. Even Badkal Lake today faces the same problems and is on the verge of being dead. The article points out that the only way to solve the problem is to restore the ecosystem which once supported it. This model based on watershed analysis would foster a protection of the Aravallis.

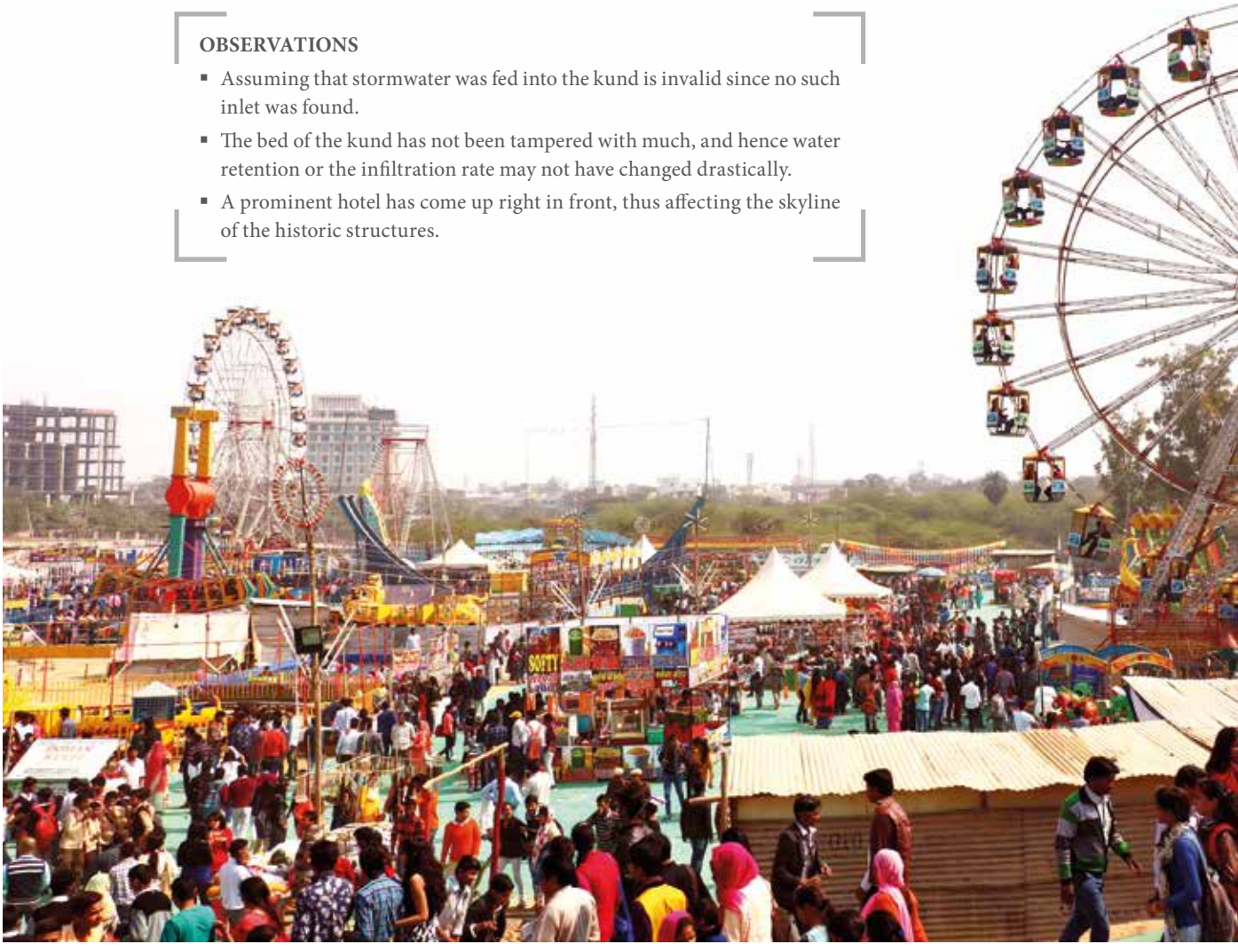
Efforts are already being made to restore the Aravallis. This article can help planners to identify the root cause and devise a methodology for protecting sites of historical importance. The aim is to understand how these historical structures have become the indicators of environmental degradation of the Aravallis and how their conservation is important, involving the conservation of the entire watershed areas around these structures along with restoring the Aravalli ecosystem. Understanding how our erstwhile rulers understood the importance of the fragile ecosystem of the Aravallis, and the wisdom with which they interacted with nature, is best explained by studying the Anangpur dam, its reservoir, and Surajkund.

The design and construction of the Anangpur dam proves that it was cleverly designed and well built. 'Investigations carried out proved that the design is far superior to modern day from the perspective of storage capacity, water spread area, foundation design, run-off pattern, water tightness of reservoir basin, hydrograph of worst flood, etc.'[1] Considering that the major dams were designed to be durable for at least a hundred years, the Anangpur dam has stood since the eighth century.

[1] Garg, Sandeep. 1999. 'Dams: An Engineering Analysis of Alternatives'. *Indian Journal of History of Sciences* 34(4): 289–315.

OBSERVATIONS

- Assuming that stormwater was fed into the kund is invalid since no such inlet was found.
- The bed of the kund has not been tampered with much, and hence water retention or the infiltration rate may not have changed drastically.
- A prominent hotel has come up right in front, thus affecting the skyline of the historic structures.



Parameters for siting and designing a dam

- *Water tightness of the surrounding hills*
- *Storage capacity*
- *Water spread area*
- *Basin water tightness*
- *Run off patterns*
- *Narrowness of the valley at the proposed dam site*
- *The region's susceptibility to earthquakes*
- *Material availability*
- *Impact downstream*

» **Figure 1** Anangpur Lake in the eight century as per the terrain, this is with reference to the maximum dam height (+763 feet)

» **Figure 2** Anangpur Lake in the mid-twentieth century showing the shrunkan lake

The 'traditional' science, wherein the study of side effects is intrinsic to the solution being obtained is contrasted with 'modern' science, wherein the study of side effects is not intrinsic to the solution.

The Aravallis are one of the oldest mountain ranges in the world having evolved over 1,500 million years. For centuries they have helped as a green barrier and have shielded against desertification. They have helped in the recharging of groundwater, holding of forest water, control of air pollution, providing a habitat to wildlife and various indigenous plant species.

However, in the last three decades, extensive destruction has taken place. Barren lands, degraded forest, loss of soil cover, filling of natural lakes, lack of wildlife and native plant life, and so on have emerged as symptomatic of bad planning. Extensive deforestation of valleys and foothills of Aravallis have caused widespread erosion. Mining tampers with the hydrology of

» **Figure 3** Anangpur Lake in current times, showing the dry lake, and hence the dry Surajkund lake

the area, which has been established over centuries. Mined areas often puncture aquifers which then become loose sand below the quartzite rocks. Water from aquifers, drains out into the empty mine pits, thus leading to massive water evaporation. Since the quartzite bed rock does not have porosity, the exposed mine surfaces are non-permeable and water harvesting does not happen.

Other problems include conversion of lake beds into agricultural fields; the effect on the natural water flow as a result of new constructions such as hotels and other plotted developments. Additionally, vegetation like *Prosopis juliflora* has destroyed the native vegetation and dried wetlands. Initially, this tree belonging to South America and the Caribbean islands was seen to be appropriate for the drought-prone areas. It provided fuelwood and fodder. But it was later observed that its ability to tolerate arid conditions and saline soil makes it extremely invasive. Its roots can go up to 15 m in depth and has increasingly dried the wetlands and absorbed soil moisture. The leaves are acidic and, over a period of time, make soil unfit for the growth of other vegetation.

A major associated problem in this region is the deep mining for coarse sand. Sand is available at a great depth under the rocky strata. This also happens to be the area which

held confined aquifers. Mining for sand has exposed these aquifers, especially since the rocky strata do not facilitate infiltration of water into ground. As a result, the large lakes, too, are soon polluted, illegally pumped out, or evaporated. Indiscriminate pumping of groundwater through bore-wells has resulted in the water table dropping massively.

Lakes and reservoirs and their respective watersheds are under different agencies without any coordination. There are no policies to scientifically plan for water and supervise the mining of quartzite and sand. No effort has been made to restore the mined areas, which were illegal. The Supreme Court of India had banned the mining activities in 1996; however, such activities have not abated as the boundary mapping of the Aravallis has not been properly defined.

The Draft Development Plan of Faridabad mentions the area around Surajkund as a Natural Conservation Zone (NCZ). However, the extent of village land and the issue of Chhota Arangpur village, which sits over the dry bed of the historical lake, are not addressed. Proposed activities in the NCZ provided in the draft development plan may include agriculture, horticulture, social forestry, plantation, and regional recreational activities with no construction exceeding 0.5 per cent of the area. It is vital to enforce this since both the cities, Faridabad and Gurugram, are dependent on groundwater for over 60 per cent of their requirements. In this scenario, the protection of the Aravallis gains further importance as this is the only major recharge area in the region. These are unsuitable land uses since the zone falls right into the catchment area of the Anagpur dam. Also, the NCZ of Faridabad should be clubbed with the Asola-Bhatti Wildlife Sanctuary to make it a comprehensive ecological establishment.

The only way to restore the problem is to restore the ecosystem which once supported it. This requires a strict implementation of the recommended policy guidelines.

A lack of understanding of the ecology of the region, which includes the lakes, watershed areas, hydro geology along with fragile vegetation and soil cover of the Aravallis and their indiscriminate exploitation has led to a crisis. This in turn has greatly impacted life in Faridabad and Gurugram. Necessary remedial action needs to be carried out before any future planning exercises are done. The following are some policies and solutions that can be implemented to improve the situation:

- Carry out an aquifer mapping of the region.
- Since the Aravallis are categorized as forest lands, a proper mapping is long overdue so as to establish its importance.
- Both the lake and its watershed areas should be brought under a single government agency.
- Further land use change, mining, encroachments, etc., must be stopped till an ecological plan is made based on the findings.
- Indiscriminate pumping of groundwater, whether for mining or construction, must be stopped. All tube wells must be mapped and the overall availability of groundwater must be assessed. This exercise must be carried out in a systematic, planned manner.
- Mines must be rehabilitated so as to improve the extent of the ground recharge, prevent evaporative losses, and convert such areas into robust ecosystems.
- The maximum damage has been caused by the plant species *Prosopis juliflora*—they are the cause of disappearing wet lands due to a deep-root system. These plants have to be gradually removed and the afforestation of the native vegetation at the Aravallis should happen.
- A wide range of ecosystems, including trees, shrubs, grasslands, and zones from where the soil is depleting must be established and protected.
- Since mining cannot be banned completely, with the help of detailed studies one can identify pockets where controlled mining can be done legally. In the future, one must act with haste and stop activities that may be depleting water resources. Blasting must be completely banned, especially for mining, construction-related activities.
- A timeline needs to be established so that hotels and resorts that have come up in the vicinity can be removed in a planned manner.
- A reconstruction of the sun temple, which was present in the fortified area of the elevated west, can also happen after a proper study and documentation have been carried out.
- There should be a connectivity of green cover between the Asola-Bhatti Wildlife Sanctuary and the fronts of the Aravallis surrounding the kund and dam.
- The historical lake that existed due to the Anangpur dam must be cleared of fields and construction. The area should be de-silted to improve its catchment potential and the soil can be used to rehabilitate the stone quarries. Likewise, Peacock Lake must be also be restored with vegetation.
- Groundwater springs had earlier fed the kund. Once the Anangpur dam is restored, it is likely that the kund, too, will retain water round the year. In this scenario, even the second spring in the vicinity, the Siddhi kund, can become a tourist destination. □

The authors would like to acknowledge Priyanka Chawla, Vijay Pal Singh, and Shahbaz Khan for their help in developing this article.

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EMPLOYEE RESIDENTIAL BUILDING, BANGALORE ITC MUD FORT, GRIHA'S FIRST **5-STAR-RATED RESIDENTIAL BUILDING**

EDS (Global) has been closely associated with GRIHA for over a decade through several projects, and has indeed been a rewarding experience in terms of knowledge enhancement of green buildings.

The ITC Mud Fort residential project has achieved the distinction of being the first residential complex in the country to acquire a '5-star' GRIHA rating.

The GRIHA rating system had holistically guided our project team through all the stages, right from the inception stage to the execution and operational stages. The guidelines of GRIHA certification had helped us to lay a disciplined path for the entire construction process. The well-defined criteria of the GRIHA rating covered the entire life cycle of the project.

Incorporation of passive design strategies through building an envelope design development had been a prime focus for the design team. The GRIHA criteria further helped to develop an understanding of the impact of the same on the overall project energy efficiency.

Achieving efficient energy performance index (EPI) through the various energy efficiency measures, use of renewable energy, use of solar water heating systems, motors and pumps, energy and water metering and efficient lighting systems were some of the highlights.

Raksha SR

Yashita Golwala

Harshal Gupta

The use of sustainable building materials and good construction practises, mentioned in the GRIHA manual, further enhanced the sustainability quotient of the project and helped the execution team to discipline itself. Periodic site audits from the GRIHA team kept the project on track. As a green building consultant, it's always been an uphill task to maintain the true intent of sustainability in the process of making a building. But with the GRIHA certification and the ITC Ltd as client, it has been a pleasure to see the true meaning of sustainability maintained throughout the project. ◻

Gentrification in Mumbai

Gentrification is an important aspect of urban planning. While it seeks to redevelop deteriorated neighbourhoods, it also tends to displace the original inhabitants. Mostly, it is the economically weaker sections that get displaced by the middle class. Shedding light on this debate, **Meghna Bandelwar** in this article discusses the specific case of Mumbai's gentrification.

Meghna Bandelwar, is a student at the Department of Energy and Environment, The Energy and Resources Institute, School of Advanced Studies, New Delhi, India. She can be reached at meghna.bandelwar@teriuniversity.ac.in.

Redeveloping Mumbai

In the past decade, gentrification has emerged as a point for discussion in urban, social, and economic literature. The term gentrification was first coined in 1964 by Ruth Glass, a sociologist, for explaining the replacement of the working-class community by middle-class individuals in London.[1] Ever since, there have been discussions around the causes and effects of gentrification. Lees L [2] defines gentrification as 'the transformation of a working class or vacant area of the central city to a middle-class residential and/or commercial use'. Of late, gentrification has been a major topic of discussion in the western countries. It is only in the last decade that a wave of interest has emerged in documenting the gentrification process across cities in the Global South.[3]

Different theories have evolved around the causes and working models of gentrification. Neil Smith (2002) proposed the 'production-side theory' for the causes of gentrification, stating the capitalist movement as the reason. Different theories of the gentrification working model classify it into four broader categories: gentrification with reinvestment (retrofitting/back to the city), gentrification by complete demolition in public/private land (redevelopment), vacant gentrification (green/brown field development), and forced gentrification.[4]

Definitions and theories of gentrification have evolved along with the process itself. Smith (2002) discusses gentrification as not only residential rehabilitation but also economic, social, cultural, and spatial restructuring. Gentrification was initially understood as the rehabilitation of decaying and low-income housing by middle-class outsiders in the densly populated areas of any city. In the late 1970s, a broader conceptualization of the process began to emerge, and by the early 1980s, new scholarship had developed a broader meaning of gentrification, linking it with processes of spatial, economic, and social restructuring.[5] Gentrification, generally speaking, is not inclusive and is, therefore, considered to be a negative process. It also has social and cultural impacts on a community due to displacement and changes in land use, ranging from residential to commercial.[6] In a way, gentrification defines the direction of urban growth in an unfair manner.

Since gentrification is an urban process, which takes place over a significant period of time, it is difficult to assess the same. Therefore, in order to identify and trace the process, certain indicators should be involved. The report of Southwest Housing Committee in 2002 by the Urban Institute, Columbia Policy Forum, 2011, had identified five indicators, namely, low-priced areas adjacent to high-priced areas, low-priced areas with good metro access, low-priced areas depicting the historic architecture of that region, low-priced areas with large housing units, and low-priced areas with recent appreciation. Canadian census indicators, such as changes in neighbourhood income, changes in social

[1] Hamnett, Chris. 1997. 'The Blind and the Elephant: The Explanation of Gentrification'.

[2] Lees, L. 2012. 'The Geography of Gentrification: Thinking through Comparative Urbanism'. *Progress in Human Geography* **36:** 155–71.

[3] Smith, N. 2002. 'New Globalism, New Urbanism: Gentrification As Global Urban Strategy'. *Antipode*, **77(3)**: 427–50.

[4] Eldaidamony M and Shetawy A. 2015. 'Gentrification Indicators in the Historic City of Cairo'. *Conservation of Architectural Heritage,* **225**: 107–118.

[5] Sassen, S. 1991. *The Global City: New York, London and Tokyo.* Princeton: Princeton University Press.

[6] Ocejo, R E. 2011. 'The Early Gentrifier: Weaving a Nostalgia Narrative on the Lower East Side'. *City & Community*, **10**: 285–310.

class/status, changes in the location quotient of artists, average monthly rents, and the average cost of living were considered as gentrification indicators. An analysis of the city of Cairo was done based on the Kennedy and Leonard indictors, which include 14 indicators. Through this study it was found that the city is exposed to gentrification and will evolve extensively over the next five years. It is important to look at the types of gentrification and study the process and impacts accordingly. This will enable a strong understanding of the policy as well as the implications.

There are 10 typologies of gentrification in Indian cities, namely,[7] classical, commercial, recreational, policy, global, state led, mega event led, rural, newly built, and the gentrification of urban villages. Slum removal to convert the land for a better commercial project, beautification projects, and so on are termed as gentrification. In the Indian cities, mass displacement of the lower classes is because of slum demolition. Around half a million of the population was displaced from Mumbai and a million in 2000 from Delhi's squatter settlements. [8] Slum rehabilitation is an example of policy gentrification adopted by India as a tool to deal with illegal slum settlements across cities. After the decline of the textile mills in Mumbai, large-scale redevelopment started taking place to convert the abandoned landmass into commercial centers; this is an example of urban commercial gentrification. Mumbai has been undergoing a dual gentrification, that is, policy gentrification and commercial gentrification.

Various schemes, such as improvement, clearance, and redevelopment scheme and the slum upgradation programme were initiated by the government and different bilateral agencies in Mumbai. The Slum Rehabilitation Authority was formed in 1995 with a view to implement slum rehabilitation schemes through a single-window clearance. The scheme provides housing for slum dwellers free of cost. The residual land is for the builder to construct and sell. Although the slum dwellers are provided with physical infrastructure, the social connection and cultural fabric of the community is lost in the 20-storey high-rise. Lifeless corridors flanked by units on both sides with no light and ventilation and the loss of communal identity, are the harsh realities of these buildings and the people living in it. Housewives, children, and the elderly are the most vulnerable to health hazards due to poor building design. A study by the IIT Bombay and Doctors For You carried out in three rehabilitation buildings found an increased rate of tuberculosis and mortality due to limited space availability and poor access to natural light and ventilation. Residents of various rehabilitation buildings have complained of numerous health problems due to bad design and ignorant site-selection process for the rehabilitation of buildings.

One of the residents, Mr Sawant, residing in one such rehabilitation building in Dadar narrates his story: 'We had no other option but to take these allotments. On one hand we got the privilege of a permanent address in a high-end area of Dadar and on the other, we lost sunlight and sea breeze. We [the men] are most worried for the children. They might develop deficiencies when they grow up. Earlier, the women used to get together by the *galli* (a narrow lane), have a good chat, but nowadays, they meet only on festivals or occasions. The housewives stay indoors all the day; we are not used to it. We feel claustrophobic here.' When asked whether they would choose to stay in slums after getting the allotment their response was, 'Many of the tenants have done this. They [have] put the rooms on rent and stay in slums. But we have greater security and safety here. There is no point in doing this and then blaming the government for not doing effective work. However good or bad, we have now accepted this as our home.' There are many families who have the same opinion as that of Mr Sawant.

The case of gentrification in Mumbai, from slum areas to high-rise, high-density development, is a classic example of how gentrification is not an inclusive process. In the case of Mumbai, it also proves to be unsustainable socially, culturally, economically and have added to the health problems of the rehabilitated families. □

[7] Kumar, Ashok. 2014. 'A Framework for Gentrification of Indian Cities'. Institute of Town Planners, India (January–March): 19.

[8] Doshi S. 2013. 'The Politics of the Evicted: Redevelopment, Subjectivity, and Difference in Mumbai's Slum Frontier'. *Antipode* **45**: 844–65.

GRIHA Western Regional Summit 2018

Choosing sustainable, building sustainable

The 8th Regional GRIHA Summit in association with the Public Works Department, Government of Maharashtra (PWD, GoM), was organized in Mumbai from June 29–30, 2018. The theme of the summit 'Choosing sustainable, building sustainable', was aligned so as to focus on the selection of the most optimal building materials and technologies to minimize the impact on our environment, economy, and communities that are critical for sustainable development.

Audience addressed during the ***SUMMIT***

Dr Ajay Mathur, *President GRIHA Council along with* ***Shri Chandrakant Dada Patil,*** *Hon'ble Minister of the Public Works Department, Government of Maharashtra and* ***Mr Sanjay Seth,*** *CEO, GRIHA Council, on the dais at the curtain raiser event.*

Dr Ajay Mathur, President GRIHA Council along with Shri. Chandrakant Dada Patil, and Mr Sanjay Seth, CEO, GRIHA Council launch the GRIHA product catalogue during the curtain raiser event.

Mr Abhijeet Gawade, Head Business Development, Godrej construction, talking about the efficient use of construction and demolition waste to manufacture recycled concrete blocks and pavers for the construction industry.

Address by Ar. Anagha Paranjape-Purohit, Trustee Sustainability Initiatives

Nidhi Gupta, Sustainability Consultant, Auroville Consulting, Auroville discusses choosing green interior materials.

Rainwater Harvesting

An Approach towards Sustainability

Collecting rainwater or stormwater and storing it for later use refers to the practice of rainwater harvesting (RWH). Oft-practised forms constitute harvesting rainwater from roofs, paved surfaces, subsoil drainage, and so on. In this article, **Dr (Mrs) Parveen Dhamija** discusses the importance and advantages of RWH while shedding light on the steps that have been taken to achieve this.

Dr (Mrs) Parveen Dhamija works as an advisor to the Skill Council for Green Jobs (SCGJ), New Delhi, for skill development in renewable energy and sustainable development. She worked in the MNRE for the planning and execution of national programmes in biogas, improved chulhas, women and renewable energy, and the promotion of new technologies. She also coordinated renewable energy, improving energy efficiency, and climate change activities in Delhi as the Head of the State Nodal Agency. She has authored many books on environmental education. She can be reached at polhamija.greenjobs@gmail.com

Water is at the core of sustainable development. From food and energy security to human and environmental health, water contributes to improvements in the social well-being and inclusive growth, affecting the livelihoods of billions. Interlinkages between water and sustainable development reach far beyond its social, economic, and environmental dimensions. In fact, water is associated with four different facets, namely, social, economic, political, and environmental; however, human health, food and energy security, urbanization, and industrial growth as well as climate change are critical challenge areas where policies and actions at the core of sustainable development can be strengthened (or weakened) through water. A lack of water supply, sanitation, and hygiene (popularly known as WASH) takes a huge toll on the health and well-being and comes at a large financial cost, including a sizable loss of economic activity.

The annual precipitation, including snowfall, in India is of the order of 4,000 billion cubic metre (BCM) and the natural run off in the rivers is computed to be about 1,869 BCM. The utilizable surface water and replenishable groundwater resources are of the order of 690 BCM and 433 BCM, respectively. Thus the total water resources available for various uses on an annual basis are of the order of 1,123 BCM.[1] The water availability, both in terms of quality and quantity, has declined to such an extent that many parts of India, rural and urban, today face a drought-like situation.

Water Management: Sector Analysis by the SCGJ and KPMG

SCGJ along with KPMG, India, has carried out sector analysis, skill requirements, occupational mapping, and process flow in the domain of water management in India. This report specifically focusses on growth projections, job numbers and key job roles associated with RWH, sewage treatment, and watershed management.

RWH defined as 'the gathering and storage of water running off surfaces on which rain has directly fallen', could be a potential alternative in small communities that cannot be served by more centralized water supply schemes. Harvested rainwater is a renewable source of clean water, which can be used for domestic purposes, garden watering, and small-scale productive activities. It also contributes to reducing flood risks and the load on sewer systems. The greater attraction of a rainwater harvesting system is the low cost, accessibility, and easy maintenance at the household level. Though the capital costs are high, neither the operation nor maintenance usually involves significant expenditure. RWH seems to be a beneficial method for minimizing water scarcity in developing countries. Although RWH has been practiced for several years, it is only in recent years that countries have given it a serious thought with several passing legislations and incentives are offered to promote the concept.

Industrialization and a growing population have given rise to a severe freshwater shortage in many countries. RWH, which involves the collection and storage of rainwater, is an affordable and sustainable solution to this problem. A significant driver for the RWH market in India has been the

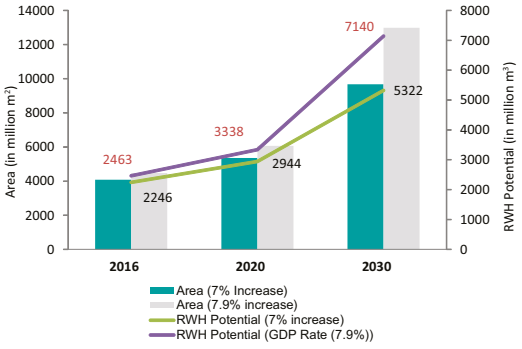
[1] Source: Aquifer Systems of India, CGWB, 2012 Report, retrived from http://cgwb.gov.in/AQM/India.pdf, last accessed on October 22, 2018.

state-level legislations that have made RWH mandatory for all new buildings in certain states, as per the report on market prospects, the global RWH market is expected to grow at a CAGR of 4.8 per cent during the period 2016–2020.

In urban areas, roof rainwater harvesting (RRWH) was earlier being practiced as a matter of necessity, mostly in the low-rainfall areas of the country with an annual rainfall less than 500 mm per year. This rainwater falling on the surface/rooftop was being channelized to bore wells or pits or new/old abandoned wells through small-diameter pipes to recharge the underground water. The main goal of RWH is to minimize the flow of rainwater through drains to the rivers without making use of the same. The rainwater that is harvested through RWH can also be used to recharge aquifers through artificial recharge techniques, which help to restore supplies from depleted aquifers due to excessive groundwater development.

Majority of the Indian states have passed legislations making the installation of RWH systems in all buildings mandatory. The state of Tamil Nadu was amongst the first to take this initiative and has witnessed considerable success. Figure 1 gives the estimated increase in building area and the corresponding RWH potential in the country.

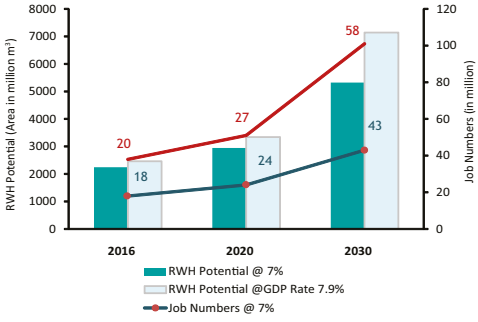
Corresponding to this growth, a large number of persons would be required for the installation and procurement of RWH systems and



» **Figure 1** Projected Growth in Rainwater Harvesting Potential (RWH)

experts in the water management field. Based on the consultations with stakeholders, an estimated six persons are required, that is, two masons and four helpers for 120 man-days for constructing an RWH system with a collection area of 100 meter square (sq. m). Estimating 1 person works for 270 man-days, the total number of persons required is provided in Figure 2.

There are a lot of prospects for providing employment opportunities in this sector in addition to the benefits of increasing water availability and reducing the impact on climate change through facilitating future precipitation forecast. However, there are issues and challenges related to its benefits, design, quality considerations, and economic and social aspects. It is highlighted that significant cost cutting can be achieved by a proper design of the RRWH system. It is important to be conscious of water quality-related issues, especially if harvested water is used for drinking purposes. It should be properly evaluated for meeting the drinking water specifications.



» **Figure 2** Projected Growth in Jobs corresponding to RWH potential

In order to ensure that the advantages of RWH are widely spread, there is a need to extend the states legislations for the existing stock of old buildings, which would also help in generating numerous job opportunities. At the community level, there is a need to create awareness amongst water users so as to ensure compliance. Different categories of stakeholders need to be trained for the proper implementation of RWH programmes. A major focus for an effective implementation is to impart multi-trade skills for entrepreneurship development through professional trainings on RWH installations/maintenance and stormwater drains maintenance. The SCGJ is providing an impetus and opportunity for this sector to facilitate the creation of a pool of skilled manpower, which will aid sustainable growths and reduce water-related emission footprint. ◻

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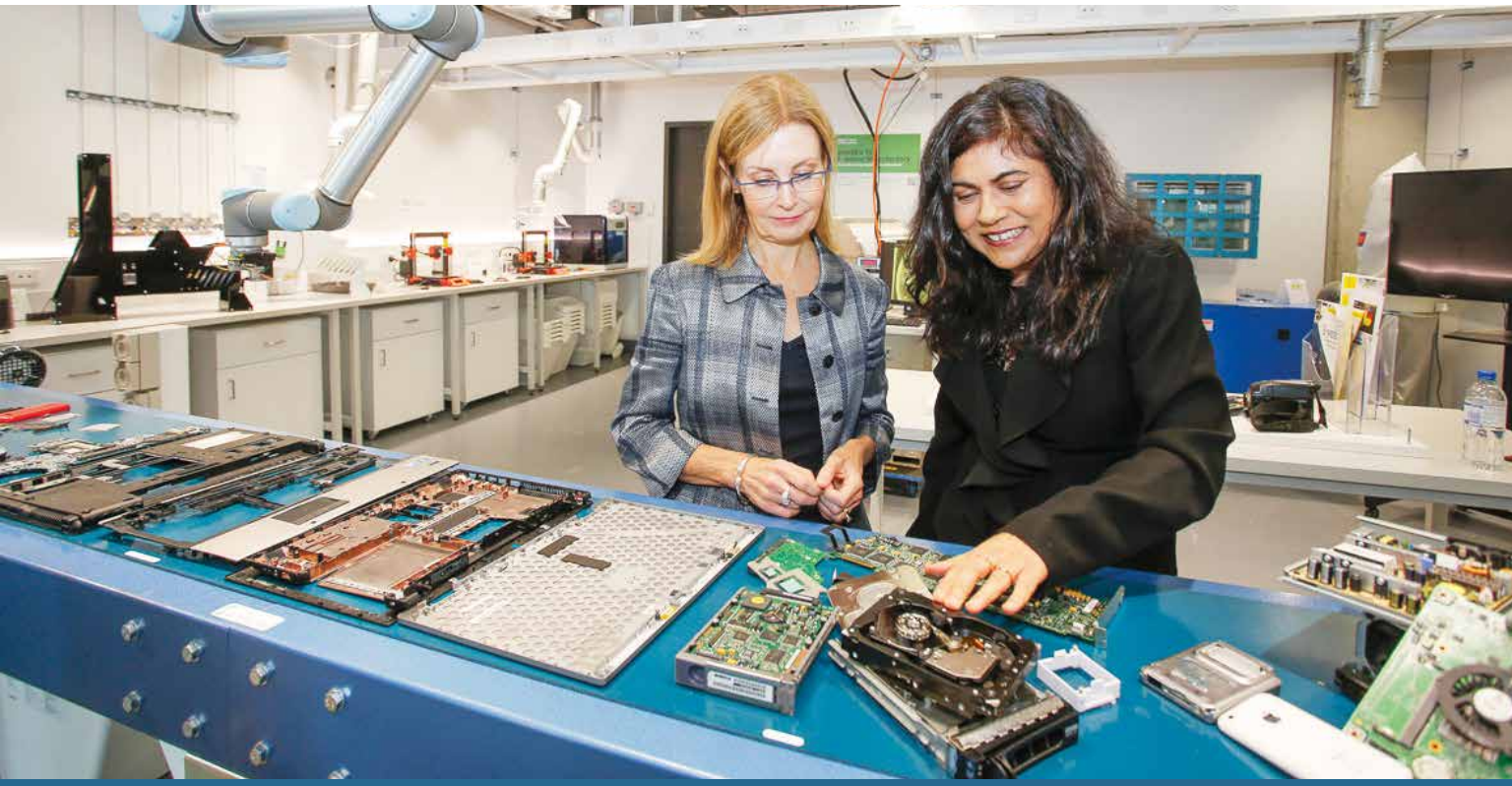
How Microfactories Help Ease the Waste Problem

How often do we discard a phone or a laptop not because it has reached the end of its shelf life but because we desire a change? Given the digital age in which we live, a technological upgrade often implies devices being thrown away. In this scenario, managing the ever-increasing pile of e-waste is a formidable concern. In this article, **Professor Veena Sahajwalla** not only draws our attention to problems caused by e-waste but also positions the importance of microfactories in tackling this problem.

Scientia Professor Veena Sahajwalla *FTSE HonFIEAust directs the Centre for Sustainable Materials Research and Technology (SMaRT) at UNSW, Australia. Her expertise include making technologies (HIsmelt process, direct reduction of iron DRI/HBI); new developments in blast furnace iron-making technology, ferrous and non-ferrous foundry processes; and kinetics of reactions occurring in the above-mentioned processes. She can be reached at veena@unsw.edu.au*



The Problem of Waste

The vast recycling problem facing communities around the world and what to do about it has been a ticking time bomb. The advent of electronic technologies, such as mobile phones, laptops, printers, and so on are contributing to the ever-mounting recycling challenge in the form of electronic waste, or e-waste. In fact, United Nations researchers have warned that e-waste is the fastest growing waste problem in the world and must be addressed urgently.

A report from the Global E-Waste Monitor, a collaboration by the United Nations University (UNU) and hosted by UNU's vice-rectorate in Europe, the International Telecommunication Union, and the International Solid Waste Association, found that the world generated 44.7 million metric tonnes of e-waste in 2016. That is equal to 4,500 Eiffel Towers, with only 20 per cent of these materials collected and recycled. The report forecasts this to increase by 17 per cent, that is, to 52.2 million metric tonnes by 2021.

Australia, New Zealand, and other nations of Oceania are the highest per capita e-waste generators. The average person in these countries produced about 17 kg of e-waste with only six per cent formally collected and recycled. Europe, including Russia, was found to be the second-largest e-waste generator per inhabitant with an average of 16.6 kg per inhabitant. Europe still had the highest collection rate at 35 per cent.

The Americans generate 11.6 kg per inhabitant and collect 17 per cent, while Asia collects 15 per cent and generates 4.2 kg per inhabitant. India generated nearly 2 million tonnes of electronic waste in 2016.

The major challenges in e-waste recycling involve issues related to burning and dumping waste that contains materials that can (and should) be transformed into value-added materials that result in products that are in high-demand by industry and consumers. There are major adverse health and environmental impacts of burning waste and growing landfill, such as exposing communities to dangerous toxins. Other challenges are around creating partnerships to commercialize this technology, such as working with local councils to collaborate and take on new solutions like this.

A solution is at hand in terms of the technology to deal with this problem, and to treat the problem at the sites where the stockpiles are growing. The solution would not only address the waste and recycling problem but would create a revenue stream from the materials reformed from the waste.

Technology developed at UNSW Sydney's Centre for Sustainable Materials Research and Technology (SMaRT) Centre enables waste streams such as plastics and glass from e-waste to be reformed into valuable resources for manufacturing.

Unlike traditional recycling processes, the e-waste microfactory — launched in April 2018—recognizes

that in complex products such as mobile phones, computers, laptops, and printers, there is not just one type of material; there are many individual components, materials, and parts that can be reformed into high-value outputs. Traditional recycling cannot deal with that complexity and results in low-value output. Microfactories are unique in that the aim is to reduce the number of landfills and reducing the impact of burning waste, by treating the materials as renewable resources.

The process of burning waste, typically to create energy, means that recyclable materials are lost forever as renewable resources. Metals can be repurposed over and over and even many plastics can be reformed and reused a number of times.

Microfactories, the Way Forward

In a recently published paper in the *International Journal of Cleaner Production,* the SMaRT Centre reveals the latest research on a cost-effective new process for transforming mixed waste glass into high-value building materials without the need for remelting.

This new recycling process has the potential to deliver economic and environmental benefits wherever waste glass is stockpiled and is modelled on the SMaRT Centre's recently launched world's first e-waste microfactory.

UNSW's SMaRT Centre developed microfactories to safely transform hazardous domestic and industrial e-waste. These transformed materials include metal alloys and a range of micromaterials. The micromaterials can be used in industrial-grade ceramics while the specific quality plastics from computers, printers, and other discarded sources can be put through another module that produces filaments suitable for 3D-printing applications, while the metal alloys can be used as metal components for new or existing manufacturing processes.

Each microfactory contains a range of modular factory components and devices. They involve relatively lower operational and maintenance costs as compared to conventional processes, which depend on resources that might be obtained from suppliers located far away or even overseas. The new e-waste microfactory consists of a series of small machines and devices that use patented technology to turn discarded e-waste products into new and reusable products.

Microfactories involve a number of small machines that fit into a small room. The discarded devices are first placed into a module to break them down. The next module involves a special robot to extract the useful parts. Another module uses a small furnace to separate the metallic parts into valuable materials, while another reforms the plastic into a high-grade filament suitable for 3D printing. Microfactories can operate on a site as small as 50-sq. m, about the size of a triple-car garage, and can be located wherever waste is stockpiled. This can be done at remote and regional locations and is perfectly suited to the systems that are already in place in India. The formal e-waste recycling sector in India is currently being developed in major cities. However, informal recycling operations have been in place for a long time. According to a UN report, over 1 million poor people in India are involved in manual recycling operations.

Working with the informal sector and the people involved are crucial in developing relationships and introducing the technology involved. The ideal would be working with the waste warriors, the *kabadiwala*s (junk or scrap dealer), to be able to add value to new recycling methods that provide a way to lift the quality of life for people in low socio-economic groups. By training local operators to not just be collectors but genuine recyclers, even manufacturers with the microfactory outputs, builds on the already-existing system. The microfactory model is relevant for India. At the local level these microfactories can create more ways for people to generate income and more *kabadiwalas* can become manufacturers.

India and the world need a safe, low-cost recycling solution for e-waste. The approach by the SMaRT microfactory is to enable local communities to transform their waste into valuable materials, such as metal alloys, instead of sending their old devices to landfill or where the existing recycling processes result in low-value outcomes. Building and developing the world's first microfactories is creating a new recycling and reformation process that has the potential to deliver economic and environmental benefits worldwide. Wherever waste glass or waste are stockpiled, microfactories not only produce high-performance materials and products, they also reduce the necessity of expensive machinery, reduce further extraction of natural materials from the environment, and lessen the impact of burning waste and dumping it in landfill. In this sense, these new processes and technologies can have a global impact through local change.

UNSW, through its ARC Green Manufacturing Hub, has developed this technology with support from the Australian Research Council and is in partnership with several businesses and organizations, including recycler TES and manufacturer MolyCop. And through the Commonwealth-funded CRC-P initiative, SMaRT is partnering with Dresden (manufacturer of spectacles) in the use of recycled plastics.

We all need to think about converting waste into resources and not limit ourselves to conventional recycling. Microfactories are a truly sustainable solution to a growing waste problem, which also offers economic benefits available to local communities and a commercial opportunity that can lead to job creation. ◻

HEXPRESSIONS

Ready to Assemble Green Homes

Hexpressions, founded by Shilpi Dua and Abhimanyu Singh, is all about providing affordable, fast, modular, and sustainable homes to all sections of the society with a new-age construction material called Composite Paper Honeycomb Panel. It is an evolutionary product that replaces non-eco-friendly materials such as wood, poly urethane foam, rock wool, mineral wool, and expanded polystyrene in their respective applications, while preserving the key virtues of their usage in the concerned applications. Composite Paper Honeycomb Panel is an eco-friendly, versatile, flexible, and lightweight material that has excellent compatibility with other materials and an excellent strength-to-weight ratio. It combines with plywood, steel, plastics, fibre-reinforced plastic, and many other materials as its sandwich faces to form some of the strongest composite panels for its weight and dimensions. It is also more economical than most materials, thereby making it an ideal choice. As a product made from recycled paper and eco-friendly glue, it is a boon to Earth as a 100 per cent biodegradable and non-polluting material.

Social Impact

The aim of this start-up is to support underserved communities with a permanent shelter. The solution empowers people by providing training and skill development to build their own homes and live a dignified life.

Accolades

1. Won Samsung GSAP(Global Startup acceleration program) at Bengaluru in August 2018.
2. Won Media pitch competition at Bikaner Digifest in July 2018
3. Won Indo-German Entrepreneurship pitch competition at Mumbai in July 2018
4. Won Women Entrepreneurship Program at NSRCEL, IIM Bangalore in May 2018
5. Won ET power of ideas 2017 competition at IIM Ahmedabad in March 2018
6. Won Startup Jalsa 2017 competition at Chandigarh in December 2017
7. Won First prize in 'Green Summer School' at Konstanze, Germany in October 2017.
8. Incubated by MENT Europe, a program for Immigrant entrepreneurs in Milan, Italy during July-Sept, 2017.
9. Won special mention for social impact at Smart City Expo, Jaipur in September 2018
10. Selected in top 25 entrepreneurs for Action for India forum in October 2018.

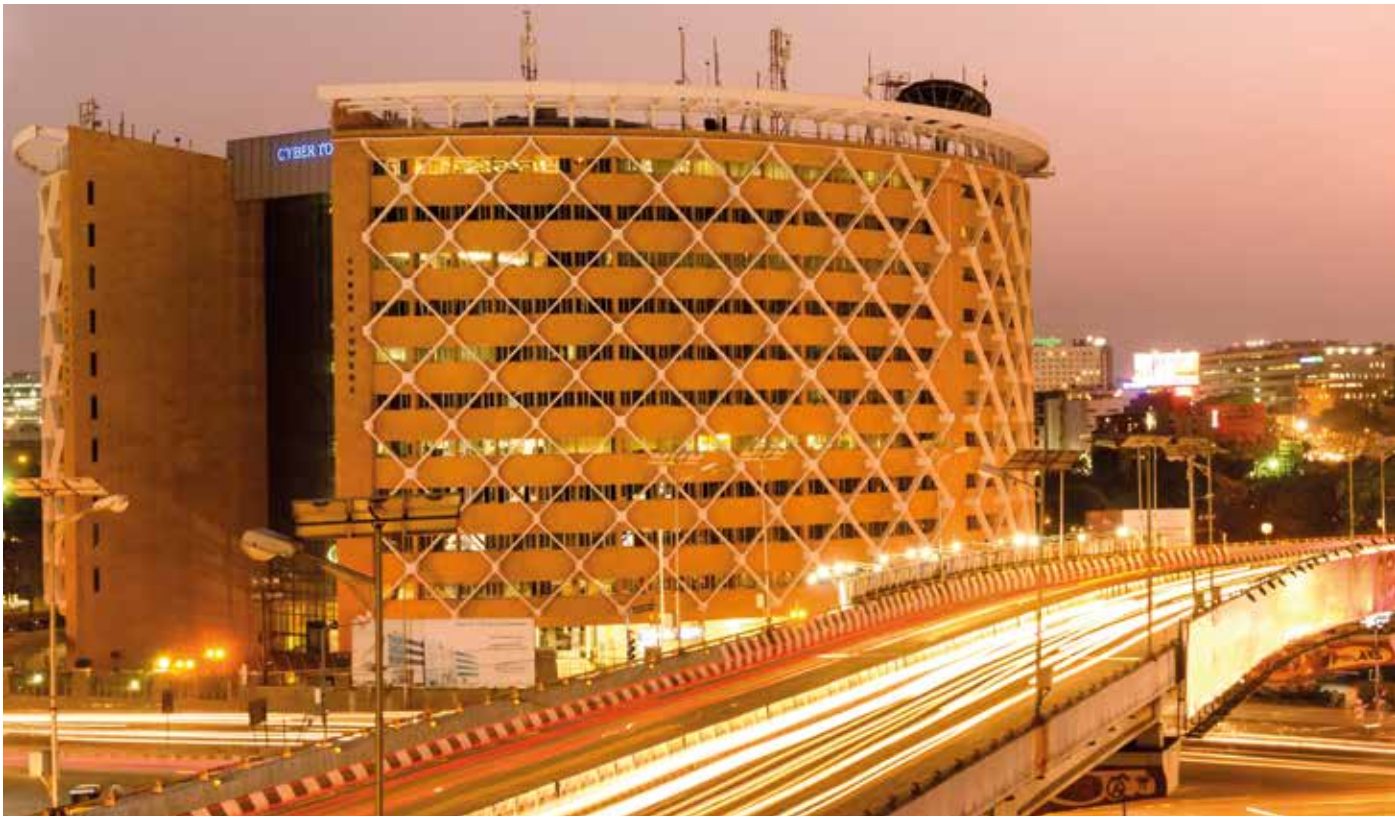
Future Plans

Hexpressions has won several awards and achievements and in order to yield large-scale results, the organization wants to align itself with the honourable Prime Minister's 'Housing for all by 2022' mission—Pradhan Mantri Awas Yojana. The team envisions a green and sustainable environment for the future generations to come. ◻

Liveability of Indian

Turning Urban Legend into Reality

'Livability' of late has become an inherent part of planning. Not only is the meaning varied, the context, too, in which it appears seems to be as mutable. Encompassing fields such as holistic community development, transportation, and sustainability, livability is gaining currency as a way of life. In this article, TERI researchers **Adishree Panda** and **Palak Thakur**, draw attention to the much-needed debate on the quality of life and how this aspect can be weaved in at the grass-roots level.



Adishree Panda *is a research associate at the Centre for Urban Planning & Governance at TERI. She is an urban development planner from the Development Planning Unit of University College London (UCL), United Kingdom. She has been working on urban planning and governance issues with a focus on policy research and capacity-building activities related to sustainable and smart urban development, mainstreaming of urban issues, and climate change mitigation and adaptation. She can be reached at adishree.panda@teri.res.in*

Cities

Palak Thakur, an infrastructure planner with the Transport and Urban Governance Division, TERI, is primarily engaged in policy advocacy for promoting clean fuel technology-based intermediate public transport. She is also actively involved in developing the Urban Mobility Model for India. She has been involved in several technical studies. She can be reached at Palak.Thakur@teri.res.in

The concept of 'liveability' has been present for a few decades and its commonly accepted features promote the socio-cultural, economic, and metal well-being of citizens (see Table 1). Improving the quality of life of citizens is also an important objective of the current urban missions of Indian cities, such as of the Smart Cities Mission and AMRUT. However, a relevant challenge has been the adaptation of this global concept into the Indian context and mainstreaming it into the urban policy and planning framework of the cities. Through initiatives such as the Ease of Living Index, 2018, of the Ministry of Housing and Urban Affairs (MoHUA), urban practitioners and policymakers along with the Government of India are now actively working towards the reality of enhancing liveability of Indian cities.

What Is 'Liveability'?

The 'liveability' concept was popularized for cities in 1999 with the Gore/Clinton Livability Agenda and gained momentum as a framework for 'new tools and resources to preserve green space, ease traffic congestion, and pursue regional "smart growth" strategies'.[1] The concept has since been developed further based on what was considered as important features of having a balanced life. For instance, Mercer's Quality of Living Survey ranks cities based on 39 holistic factors, including economic, environmental, personal safety, health, education, transportations, and other public service factors.[2] Moreover, the Economist Intelligence Unit's (EIU) Global Liveability Index Report, 2018, ranked cities according to five parameters of stability, healthcare,

'A livable community is one that is safe and secure, has affordable and appropriate housing and transportation options, and offers supportive community features and services. Once in place, those resources enhance personal independence; allow residents to age in place; and foster residents' engagement in the community's civic, economic, and social life.

Source AARP Public Policy Institute, 2017, https://policybook.aarp.org/policy-book/livable-communities/chapter-9-introduction; last accessed on November 19, 2018.

[1] Herrman, T. and Lewis, R. 2017. Research Initiative 2015-2017: Framing Livability - What is Livability? University of Oregon. Retrieved from https://sci.uoregon.edu/sites/sci1.uoregon.edu/files/sub_1__what_is_livability_lit_review.pdf; last accessed on October 17, 2018.

[2] Mercer. 2011. 'The 2011 Quality of Living Worldwide City Rankings'. Retrieved from http://www.mercer.com/qualityoflivingpr#city-rankings; last accessed on November 19, 2018.

culture and environment, education, and infrastructure.[3] As can be observed in Table 1, the performance of the highest- and lowest-ranking cities as per the five parameters can sometimes have a stark contrast due to their existing internal and surrounding external conditions.

The emphasis in the framework of the Centre of Liveable Cities, Singapore, for liveable and sustainable cities is on a high quality of life which needs to be achieved alongside a competitive economy and a sustainable environment and inculcates a focus on integrated planning and development and dynamic urban governance.[4]

Table 1 Comparison between the highest- and lowest-ranking city in the Global Liveability Index Report 2018

Parameters	RATING (100 = Ideal)	
	Vienna (Rank 1)	Damascus (Rank 140)
Stability	100.0	20.0
Healthcare	100.0	29.2
Culture and Environment	96.3	40.5
Education	100.0	33.3
Infrastructure	100.0	32.1
Overall rating	99.1	30.7

Source EIU, 2018

In line with the global parameters for enhancing liveability, the Ministry of Housing and Urban Affairs (MoHUA), Government of India, launched the Ease of Living Index in January, 2018, to support cities in systematically assessing their performance against national and global benchmarks and to work towards an 'outcome-based' approach of urban planning and policymaking. As illustrated in Figure 1, the Ease of Living Index assessed the quality of life of 111 cities (including smart cities, state/UT capital cities, and population hubs) in India across 4 pillars and 15 categories using 78 indicators, of which there were 56 core indicators and 22 supporting indicators. Interweaving the social, institutional, economic, and physical pillars, this comprehensive ranking by MoHUA enabled Indian cities to take a huge leap towards imbibing liveability in their urban framework.

» Figure 1 Indicators provided in India's Ease of Living Index Report, 2018 (MoHUA, 2018b)

Key Challenges and Enablers of 'Liveability' for Indian Cities

Urban planning and development activities in India have mostly focused on three approaches: (i) master plans and town planning schemes, wherein a city-level developmental agenda and land use plans are prepared; (ii) centrally-sponsored National Urban Development schemes, such as the Smart Cities Missions, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and Swachh Bharat Mission-Urban (SBM-U), which focus on infrastructure development and improving quality of life; and (iii) international partnerships and funding that include funding from international agencies and networks such as the World Bank and European Union for addressing the emerging issues of environmental sustainability, climate change, and infrastructure development, and so on.[5]

However, these approaches by the central government have been considered as 'piecemeal' efforts at the city level as the centrally-sponsored urban development schemes provide ad hoc solutions, which tend to lack contextualization in some cases. There is a need for identifying aspects of enhancing liveability that can be mainstreamed at the Urban Local Bodies (ULBs) level itself which can further transform the floating concept of 'liveability' into a tangible reality.

To this end, the Regional Policy Dialogues conducted by TERI, with support from the Royal Embassy of Denmark and the International Urban Cooperation programme of the European Union,[6] in three geographical regions of India identified key challenges and enablers based on which the urban policy and institutional frameworks of cities can be strengthened to enhance their liveability. Addressing the key challenges and issues of efficiently utilizing the enablers would ensure active engagement of stakeholders in the decision-making processes as well as help in monitoring the performance of the Indian cities.

[3] Economist Intelligence Unit. 2018. 'The Global Liveability Index Report 2018', in The Economist. Retrieved from https://www.eiu.com/public/topical_report.aspx?campaignid=Liveability2018; last accessed on November 19, 2018.

[4] Chye, K T. 2012. 'The CLC Framework for Liveable and Sustainable Cities', in *Urban Solutions* (1): 58–63.

[5] TERI. 2018. 'Making Liveable Cities: Challenges and Way Forward for India'. Policy Brief, TERI Regional Policy Dialogues. .

[6] TERI. 2018. 'Making Liveable Cities'.

During the focused group discussions, it was mentioned that the concept of liveability is not integrated well with the existing urban planning policies and guidelines. The key parameters of liveability are generalized for all the regions but as emphasized in the dialogues, due to vast variation in the regions with respect to topography and socio-economic development, the same approach is not applicable to all the regions. There is also a lack of active citizen engagement and capacity building of the ULBs. Moreover, there is a lack of continuous funding from the central government and it was observed that there exists a wide gap between the budgeted amount and funds allocated. There is also a low presence of innovative approaches to attract public–private partnerships in the long-term risk-intensive projects. The need for robust mechanisms for developing partnerships, and emphasizing clear roles and responsibilities of all stakeholders to ensure their accountability was also highlighted.

The Urban Policy and Planning aspect was considered as a key enabler for making liveable cities as it includes the need for planning at strategic and local levels and exploring suitable design concepts to promote liveability and holistic urban growth. The strengthening of Local Urban Governance incorporates the technical and financial capacity building of and clear mandates to ULBs for effective service delivery and governance. In terms of financing and implementation, it is relevant to address challenges of existing financial and implementation mechanisms and identifying sustainable mechanisms for meeting infrastructural demands of cities. Urban innovation includes the promotion of innovative solutions through the private sector, research and academia participation along with improvement in institutional capacities and knowledge sharing between different stakeholders. The strengthening of partnerships is thus a supplementing enabler that highlights the significance of collaborations between cities and stakeholder participation to improve capacities of partner cities.[7]

Mainstreaming 'Liveability' in the Indian Policy Framework

In order to understand the key performance indicators for liveable cities and to contextualise the understanding of liveability with respect to particular regions, TERI organized the Regional Policy Dialogues in the Southern, Eastern and North-Eastern, and Western regions based on the key enablers, as identified above. As there is a vast diversity in the regions with respect to socio-economic development, geography and the challenges faced by these regions, the themes for these policy dialogues were identified based on the challenges faced by these regions. The Southern dialogue focused on the theme of 'Urban Planning and Governance', the Western dialogue focused on 'Infrastructure Development', and the Eastern and North-Eastern dialogue focused on 'Environmental Sustainability and Climate Action' for liveable cities.

The policy dialogues were thus a medium to understand the local challenges with respect to enhancing liveability and to provide contextualized inputs to the National Urbanization Policy being drafted by MoHUA. The objective was to bring the ULBs and other stakeholders on the same platform to discuss the barriers in achieving sustainable urban development and to explore innovative mechanisms for effective implementation. The policy dialogues were also aligned with the national urban missions to encourage capacity building and active participation of implementers, academia, and other think tanks and mainstream the liveability of cities.

[7] TERI. 2018. 'Making Liveable Cities'.

Way Forward for Indian Cities

The key recommendations that were provided in TERI's Regional Policy Dialogues to inculcate and continue working towards the 'liveability' concept in Indian cities were, first and foremost, to give high priority to mainstream the liveability pillars and indicators in the urban planning and policy framework of India. Further, it is relevant to develop urban planning frameworks and guidelines that have space for contextualized approaches of cities and can be adapted easily. There is also a need to integrate citizen participation and capacity building of the ULBs as mandatory mechanisms to achieve liveability in Indian cities. In order to ensure least disruption in the implementation and monitoring processes, consistent funding options and technical training need to be provided. The development of city-to-city partnerships and active stakeholder participation at both the international and national levels would supplement these urban mechanisms to provide an avenue for exploring innovative solutions. Such sustainable solutions would thus imbibe the 'liveability' concept in the urban policy framework of India.

Acknowledgements

The series of Policy Dialogues on 'Making Liveable Cities: Challenges and Way Forward' was organized by TERI with support from the Royal Embassy of Denmark, India, and the International Urban Cooperation programme of the European Union. The authors would like to thank Raina Singh, Area Convenor, TERI, for the guidance and insights provided by her for the article. ◻

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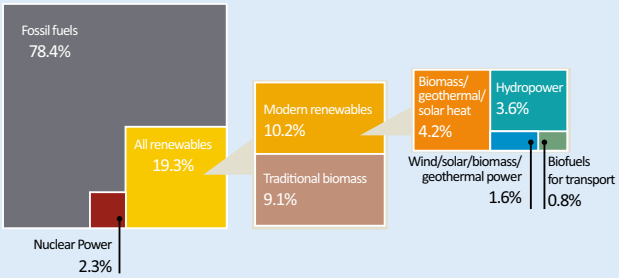
BIPV

A Promising Architectural Trend for the Indian Cities

Photovoltaics have been in use since the 1970s. Today, given the climate change crisis, the need to use it has gone up further. **Ar. Khushal Matai** in this article discusses the urgency to incorporate photovoltaic systems that are built into constructions. Focusing on the need to make this fundamental change, the author suggests the different ways in which photovoltaics can be constructed at the initial stages along with a building's design plan.

Ar. Khushal Matai is a practising architect and faculty at the School of Planning and Architecture, New Delhi. He has more than nine years of experience in the fields of sustainability, energy efficiency, teaching, and design. Khushal has published various research papers on subjects, such as renewable energy, landscaping in arid areas, sustainable tourism, to name a few. He can be reached at arkhushal@live.com.

It is in cities, and not the countryside, where the human creative flame has burnt most brightly. For millennia they have been the centres and drivers of commercial, scientific, political, and cultural life, exerting a major influence on countries and regions.[1] It has been estimated by the United Nations that in 2007, for the first time in history, half of the world's population were living in urban areas.[2] Today's cities are strong engines of growth and job creation, accounting for some 80 per cent of the global GDP. [3]



» **Figure 1** Estimated renewable energy share of the total energy consumption, 2015

Cities have a high ecological footprint, covering 2 per cent of the land area, containing 50 per cent of the population, and consuming 75 per cent of all resources.[4] With a population of more than 1.2 billion, India is projected to be the world's most populous country by 2025. By 2050, it is estimated that India's urban population will constitute nearly half of the country's total population, straining an already stressed urban infrastructure. However, urbanization is also an indicator of positive economic development. With improved urban planning, India can tackle urbanization challenges and increasing populations to create a country that is poised for sustainable growth. Additionally, urbanization creates environmental concerns, changes in consumption patterns, and increasing energy demands. These issues are further aggravated by the disparities existing in this diverse country. With all of these factors, focus is being given to green cities, smart cities, eco cities, resilient cities, liveable cities, and sustainable cities, to name a few.

Climate change has taken the form of a crisis, which has already impacted 70 per cent of the cities. Over 90 per cent of all urban areas are coastal. This by implication means that most cities on Earth are at a risk of flooding from rising waters and storms. Solutions are being developed at a micro and macro level to ensure climate change mitigation and adaptation.

Energy is an integral part of all these solutions as it drives the engine of development and growth. It runs the equipment; the lights; provides cooling and heating; and fuels the industries. India has immense power needs and despite all efforts to generate more power, there are 2.5 billion people who have unreliable or no access to electricity, thus accounting for the 10 per cent deficit.[5] This is estimated to get further aggravated as the energy consumption is projected to rise by 35 per cent by 2035.

The Sustainable Development Goal 7 focusses on affordable and clean energy. Renewable energy is a sustainable and renewable form of energy, which provides energy independence. Further, it reduces carbon emissions caused by thermal power plants. Renewable energy consists various types of energy, such as solar, wind, biomass, hydrogen energy, geothermal, and ocean energy.

Wind energy is harnessed through wind turbines, whereas solar energy is mostly harnessed through solar photovoltaic and solar thermal systems. Geothermal energy is harnessed from the heat contained inside the Earth, be it from the shallow ground, hot water, or hot rock. This is in contrast to bioenergy, which is a form of renewable energy made available from materials derived from biological sources. Through a variety of processes, feedstocks can be directly used to produce electricity or heat, or can be used to create gaseous, liquid, or solid fuels. Ocean energy is a term used to describe all forms of renewable energy derived from the sea. Generating technologies for deriving electrical power from the ocean include tidal power, wave power, ocean thermal energy conversion, ocean currents, ocean winds, and salinity gradients. Ocean energy technologies are still at an early stage of development, with deployments limited to a small pilot scale in Australia.

Wind energy is leading the pack with 3,423 MW capacity installation by 2015/16, closely followed by solar energy with 3,019 MW.[6] India has a huge solar energy potential of 748 GWP with a majority of areas getting plenty of sunshine, especially in summers. The Ministry of New and Renewable Energy, Government of India has set an ambitious target of 100 GW of solar energy installations by 2022, out of which 3 GW of solar panels have already been installed.

According to the 2011 census, India has 140 million houses with proper roofs (concrete/asbestos),

[1] Leon, A David. 2008. 'Cities, Urbanization and Health'. *International Journal of Epidemiology 37*(1): *4–8. Available at https://doi.org/10.1093/ije/dym271;* last accessed on October 25, 2018.

[2] 2004. The United Nations, World Urbanization Prospects: The 2003 Revision.New York: The United Nations.

[3] 2011. 'Urban world: Mapping the Economic Power of Cities'. McKinsey Global Institute.

[4] Calcott, Alan and Jamie Bull. 2007. 'Ecological Footprint of British City Residents'. WWF

[5] Energy Access Outlook 2017, International Energy Agency, OECD/IEA 2017. Available at https://www.iea.org/publications/freepublications/publication/WEO2017SpecialReport_EnergyAccessOutlook.pdf; last accessed on October 30, 2018.

[6] Retrieved from http://pib.nic.in/newsite/PrintRelease.aspx?relid=155612; last accessed on October 19, 2018.

which can be utilized for rooftop installations. Doing so will yield a number of benefits, such as cost-effectiveness, convenience in maintenance, low gestation period, and no additional land requirement. Rooftop installations are also decentralized, which leads to decrease in transmission costs and losses. The biggest disadvantage of such installations is that they cover the useful roof area, which is used for services installation, recreational activities, and so on. Indian cities, especially cities, such as Jaisalmer, Jodhpur, Jaipur, etc., have rooftops which are culturally an integral part of the social fabric.

Building integrated photovoltaic panels (BIPV) has emerged as a solution to the problem of occupying rooftops. With the help of BIPV technology, buildings are transformed from being energy consumers to energy producers. In contrast to conventional Building Adopted Photovoltaics, which describes the additive installation of a PV system to an already finished building envelope, BIPV is understood as an integral building component as it is a functional unit, as well as a construction element replacing conventional material.

The BIPV aspect is increasingly being incorporated into the construction of new buildings as a principal or ancillary source of electrical power, although the existing buildings may be retrofitted with a similar technology. The BIPV also functions as a weather protection, thermal insulation, noise protection, etc. The advantage of integrated photovoltaics over more common non-integrated systems is that the initial cost can be offset by reducing the amount spent on building materials and labour that would normally be used to construct a part of the building that the BIPV modules replace.. The BIPV technology reduces the total building material costs and mounting costs, since these do not require brackets and rails.

The design considerations for the BIPV are as follows:

- **Adequate ventilation has to be ensured behind the panel so that the heat can dissipate easily.**
- **The design must be carried out according to the local climate and environment.**
- **A BIPV must be designed for potential wind and other atmospheric conditions.**
- **Installations located in dry, dusty environments will require regular washing to limit efficiency losses.**
- **Obstructions on the arrays, such as shading from trees or other buildings must be avoided in design.**
- **The orientation and angle of arrays must be considered while designing.**

Table 1 Comparative analysis of different BIPV Solutions

Product	Specific advantages	Specific disadvantages	Applications	Key Segments
Standard in roof Systems	▪ Suitable for old and new roofs ▪ Well established applications ▪ Easy to handle ▪ Under the scope of French and Italian BIPV definition ▪ Very competitive ▪ High efficiency and performance	▪ Limit aesthetic value due to level of visibility ▪ Scope of application is limited to certain roof types ▪ The multifunctional aspects of PV are not fully exploited	Pitched roofs	Residential and commercial buildings
Translucent system (Glass/ Glass mould)	▪ Most unobtrusive and probably most aesthetic BIPV solution ▪ Ideally suited for prestigious buildings with well-visible façade and skylight ▪ Marginal daylight elimination/ capacity to diversify light intake ▪ Cell shapes can be attractive ▪ With thin film cells they have uniform appearance, suitable for flush mounting	▪ The units can be very heavy ▪ The prices are normally high since they are tailor-made made products ▪ As they can be seamlessly integrated the public may not notice the presence of PV modules. ▪ Difficulty in hiding the cables ▪ Limited size and shape of cells ▪ Silver tabbing crosses the transparent spaces between the cells	Translucent Façade Skylight Shading systems	Commercial and public buildings

Product	Specific advantages	Specific disadvantages	Applications	Key Segments
Cladding Systems	▪ Well suited if PV system is to be recognized (green image owner) ▪ Different images and colours can be included ▪ High efficiency systems	▪ Lower system performance (due to design restriction) ▪ The lower parts of façades are normally not used due to possible shadows ▪ Installation cost can be very high	External building walls Curtain walls	Commercial and public buildings
Solar tiles and shingles	▪ Aesthetic solution, mainly for residential pitched solutions ▪ High efficiency products ▪ Very light product which eases the installation	▪ Small unit size lead to longer installation time ▪ Unfavourable cost performance ratio. ▪ High risk of breakage	Pitched roofs	Residential buildings and old buildings
Flexible laminates	▪ Very light weight (Suitable for weak roofs) ▪ Easy handling and installation Low BOS cost No roof penetration Curved installation possible	It doesn't replace the other functions of building components functions: BIPV status at stake Very low efficiency which results in larger system areas	Flat and curved roofs	Commercial and industrial buildings

Source EPIA

There are four major types of BIPV, that is, roofing, façades, shading devices, and glazing. In rooftop, the PV is embedded in the roof. It is particularly useful in sloping roofs. Similarly, in façades, it replaces the walling material. At some places, the PV is projected out of the wall, which provides shading and acts as a thermal barrier. It could also be installed as a solar canopy for shading the roof, pedestrian pathways, or parking lots. Further, it could also act as a skylight or vertical glazing. Shading devices are another way in which the BIPV is being utilized.

In the Indian context, the BIPV technology must overcome issues, such as obstructing cross-ventilation, which can lead to the interiors heating up. The absence of integrated codes, standard, and regulations with regard to solar PV façade systems is also a challenge. Furthermore, trained personnel are required for the execution. Regular cleaning of the BIPV elements is a must in maintaining the output. One of the most crucial points is for the customer and the project team to remember the importance and relevance of this technology so that it can be an integral part of the design and construction stages.

The BIPV technology is a promising addition to the renewable energy-generation technology mix. Although the deployment of the BIPV is relatively low, opportunities remain promising. Decreasing module costs, increasing consumer interest in solar energy, and policy schemes that support distributed generation systems have the potential to increase the rates of BIPV's market growth. The commercialization of solar products that have the full functionality of building materials has been very limited, but systems are increasingly being developed to account for design aesthetics and installation-related cost reductions. This continuum of integration leads to more solar products that may fully replace traditional building materials.[7] Technical development is rapidly increasing so as to keep up with the various challenges developing due to climate change, greenhouse gas emissions, and depleting resources. Developing countries are already suffering from the impacts of climate change and are the most vulnerable to future change. A focussed approach on all fronts is required to adapt to the changing weather patterns and decreasing resources. Renewable energy is an integral part of the solution. Responding to climate change is about making choices while facing risks. Any course of action carries potential risks and costs; however, doing nothing poses the greatest risk. ◻

[7] James, Ted, Alan Goodrich, Michael Woodhouse, Robert Margolis, and Sean Ong. 'Building-Integrated Photovoltaics (BIPV) in the Residential Sector: An Analysis of Installed Rooftop System Prices. Available at https://www.nrel.gov/docs/fy12osti/53103.pdf; last accessed on October 30, 208.

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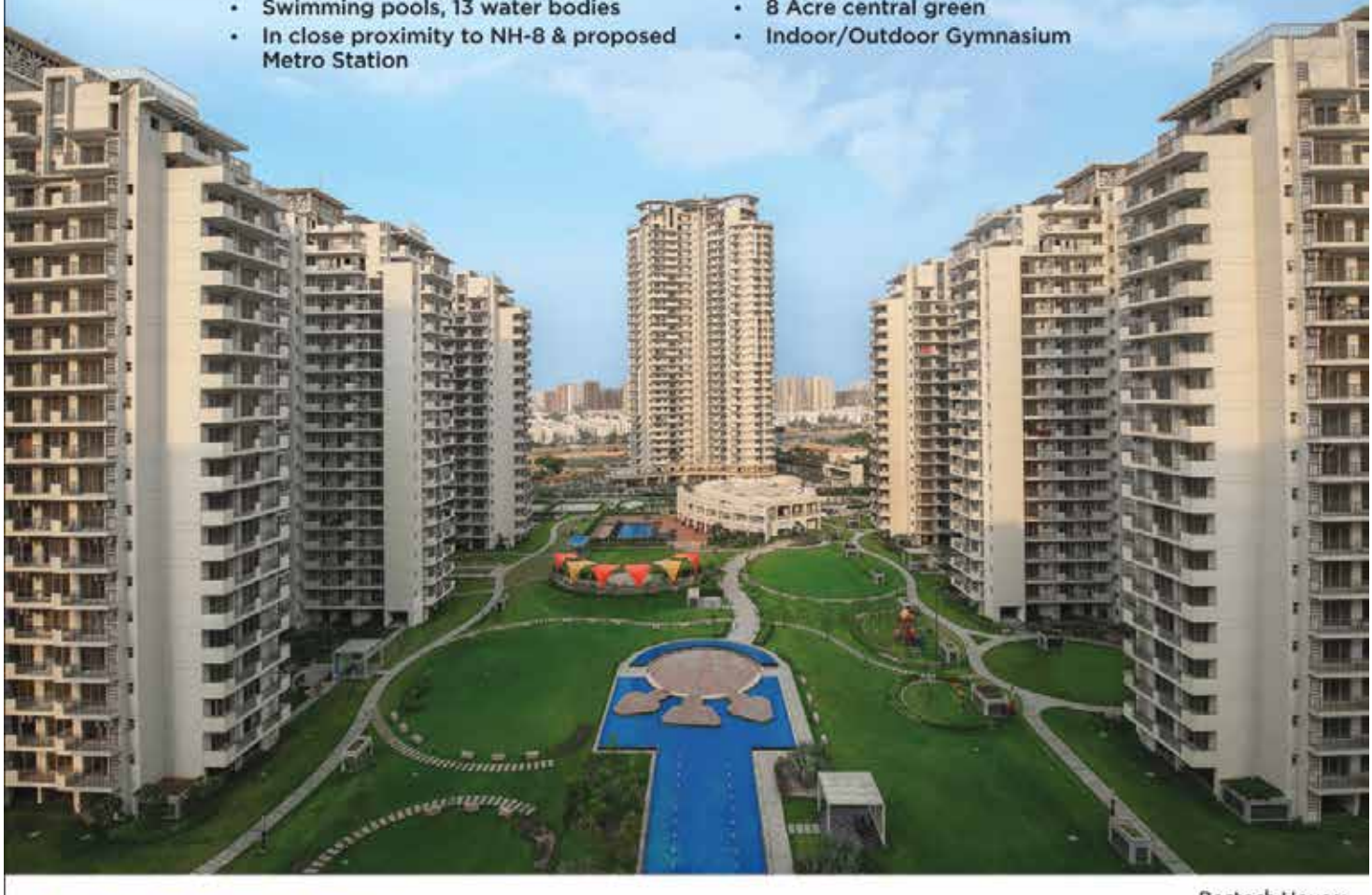

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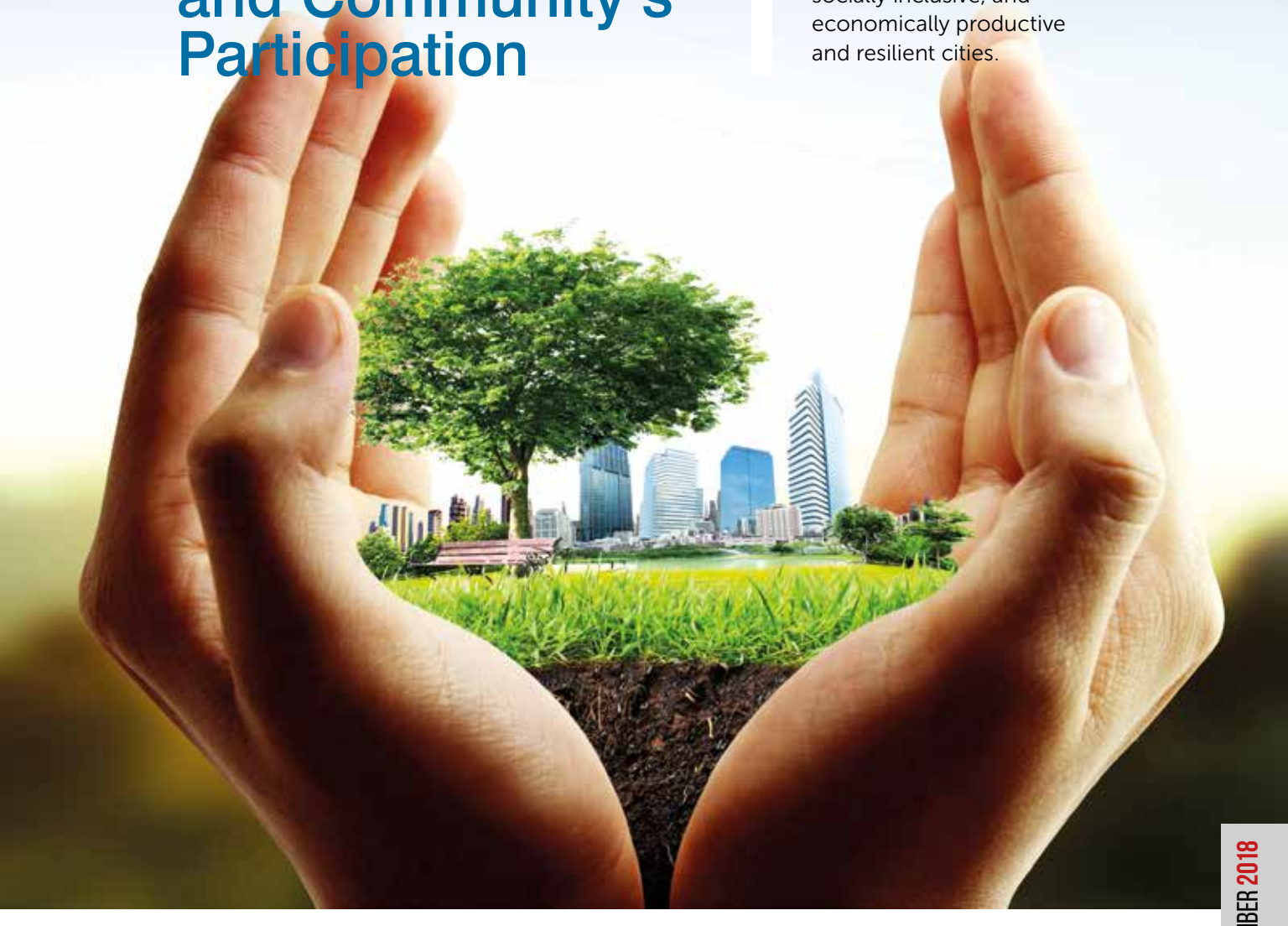
India and the SDGs

Goal towards Sustainable Cities and Community's Participation

Goal 11 of the Sustainable Development Goals (SDGs) relates to sustainable cities and communities with an aim to make cities and human settlements inclusive, safe, resilient, and sustainable. In this article, **Pratidnya Bhuite** discusses the significance of Goal 11 of the SDGs for India and what the country needs to do further to realize the targets of the Goal 11 for environmentally sustainable, socially inclusive, and economically productive and resilient cities.



Pratidnya Bhuite, *has a master's degree in construction management from the University of Birmingham, United Kingdom. Her dissertation, critically analyses and compare the sustainability performance of buildings in India with those in developed countries. Her academic interests include construction management and the implication of sustainability in the construction industry. She is currently working as a project officer with the GRIHA Council. She can be reached at pratidnya.bhuite@grihaindia.org*

Transformation towards sustainability can shape new forms and strategies on global environmental control. As the human impact on the environment exceeds the planetary boundaries, utilization of the SDG framework will help address a variety of global issues, such as access to clean water, improving health and well-being, climate change mitigation, and many such issues. In September 2015, the United Nations (UN) General Assembly adopted the 2030 Agenda for Sustainable Development to replace the Millennium Development Goals (MDGs), for achieving 'indivisible and integrated' SDGs across three aspects, namely, social, environmental, and economic. To achieve this agenda comprising 17 SDGs and 169 targets, national, regional, and local efforts across all the sectors of society will be required.

India and the SDGs

A declaration on the 2030 Agenda for Sustainable Development was signed by India along with other countries at the UN's Sustainable Development Summit in September 2015. Being the fastest-growing economy of the world, India is uniquely placed to deliver on its commitments for inclusive and sustainable development. Externally, India has played a crucial role in shaping the SDGs around economic, social, and environmental aspects. Within the country it has taken a step forward by launching programmes such as the Mahatma Gandhi National Rural Employment Guarantee Act, Jawaharlal Nehru National Urban Renewal Mission, the Aadhaar Act, and others to progress towards these goals.

Sustainable Cities

Urbanization and economic development are closely intertwined. Half of the world's population lives in cities and it is predicted to grow up to 70 per cent by 2050. This rapid urbanization, coupled with increasing rural-to-urban migration, has brought with it enormous challenges, including inadequate housing, lack of access to basic services and infrastructure, and increase in air pollution. These challenges can be overcome by improving resource use; access to basic services, energy, housing, and transportation; and focusing on reducing pollution and poverty. For instance, Tianjin Eco-city in China houses 3,50,000 people and is built on the world's most polluted seas , which indicates the possibility of cleaning up a polluted area and making it useful and livable.1 Rizhao in China is a fully solar-powered city as 99 per cent of the households use solar water heaters. Also, the traffic signals, street lights, and park lights are powered by photovoltaic (PV) solar cells.2 As per the World Cities Report 2016, the current urbanization model is unsustainable and it needs to be changed in order to better respond to the challenges and issues, such as inequality, climate change, and the unsustainable forms of urban expansion. Many of these challenges are faced by urban India

[1] Vince, G. 2012. China's eco-city: Sustainable urban living in Tianjin.

[2] Bai, X. 2007. China's Solar-Powered City. Renewable Energy World.

today. A glance at the SDGs shows that these are the same challenges that the SDGs and the targets intend to address. Hence, not only Goal 11, but all the other 16 goals, matter to India.

In India, 31 per cent of the population lives in urban areas, of which 17 per cent lives in slums. Goal 11 of the 17 SDGs focuses on making cities and human settlements inclusive, safe, resilient, and sustainable. The Ministry of Urban Development has been identified as the nodal ministry for coordinating the countries' efforts to achieve targets under Goal 11 of the SDGs. For interlinking SDGs with urban development, the ministry

has designed suitable sectorial policies. To improve the urban spaces, the Government of India has launched the Smart Cities Mission, the Jawaharlal Nehru National Urban Renewal Mission, and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT). Similarly, to achieve affordable housing for the low-income group and the economically weaker sections by 2022, the Pradhan Mantri Awas Yojana has been launched.

These missions focus on comprehensive urban development rather than just making them technologically advanced. These missions encapsulate urban improvement by retrofitting, redevelopment of areas, ensure adequate robust sewage networks and water supply, and city extension by using innovative planning and financing with the provision for affordable housing for the poor. These programmes mention 'sustainability' as a part of their vision. However, an imperative question such as how to measure the sustainability quotient is not clearly articulated. For example, a sustainable city cannot be only measured through its economic success or environmental efficiency. It also includes factors, such as gender equality, food security, biodiversity, socio-economic agenda, environmental spaces, and ensuring healthy lives to all the different sections of people, which is left out in the urban sector.

Target 11.7 of SDG 11 focuses on universal access to safe, inclusive and accessible, green, and public spaces. Public and green spaces offer opportunities to enrich health and the quality of life for people living in cities. Strengthening our communities, making our cities attractive to live and work in, and improving our physical and psychological health, are just some of the benefits. Target 11.7 also contributes to SDG 3 (ensuring healthy lives) by providing resilient places for people to be physically active and to SDG 7 (ensure energy for all) by increasing or preserving green spaces, which can particularly help mitigate the urban heat island effect (UHIE). Lastly, these designed green and public spaces provided livelihood options for the urban poor to earn a living through vending products and services, which in a way contribute to SDG 8 (economic growth).

Preserving, protecting, and valuing green and public spaces play an important role in making sustainable cities. For this reason a strong commitment from governments would be required, or these spaces will be lost forever. For the same reason, green rating bodies in India have mandated preservation of the natural landscape such as trees and inclusion of biodiversity in their system. The Green Rating for Integrated Habitat Assessment (GRIHA), India's own green building rating system, through its site planning and water management section, emphasizes more on increasing the green spaces to reduce the UHIE and make cities liveable. GRIHA is a tool for measuring and rating environmental performance of the buildings in the context of India's varied climate and construction practices. It accesses the criteria, qualitatively and quantitatively, in turn measures the degree of its 'greenness'.

Community's Participation

Community participation in building healthy and liveable cities has proven to be more beneficial. For example, HealthBridge in Vietnam developed a community-engagement process to design and build parks and playgrounds, which resulted in both community fundraising and participation in building new playgrounds (World Urban Campaign). India's urban-sector initiatives measure output in terms of physical infrastructure production but fail to measure the actual progress, that is, how much progress has been made towards the actual objective of any mission. For example, the present system is unable to evaluate whether the newly laid road has increased people's access to markets, schools, and so on.

Managing financial issues is another challenge for India. It is estimated that India needs to invest $1.2 trillion just in capital expenditure in its cities over the next 20 years.[3] Therefore, cities will need partners to help them provide these building blocks for the future. The government sector cannot address these crucial needs alone; these cities have begun looking towards innovative

[3] Sankhe, S. I. Vittal and R. Dobbs. 2010. India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth, McKinsey Global Institute.

financing options and the private sector. For example, the Smart Cities Mission is operated on Centrally Sponsored Schemes (CSs) and also relies heavily on the participation of the private sector through public–private partnerships, innovative finance mechanisms, tax increment financing (TIF), and so on. Corporate social responsibility (CSR) too can help in financing projects for social, environmental, and economic sustainability. If India taps into these sources of funding that are used in major cities around the world, then its largest cities could generate as much as 80 per cent of the funding they require from internal sources.

Further, cities are stretching out to accommodate a swelling population. Slums and illegal colonies have emerged within major cities in India, which are characterized by poverty, congestion, poor health, and inadequate sanitation and water facilities. Compact cities can work as a solution to such unsustainable urban sprawl. A compact city focuses on shorter distances between houses and urban services. Mixed land use is of prime importance in such city designs where houses, schools, offices, hospitals, parks, shops, and the like are all built in confined spaces, or in the same buildings, to reduce travel time and distance. Amsterdam is an example of one such sustainable city in the world, which optimally uses space while ensuring public health and preserving natural reserves. To accomplish this, local governments should identify certain areas in the city for compact growth and connect them to the centre for smooth functioning. This will in turn lead to reducing the pressure on urban landscape while giving more affordable options to citizens based on their requirements.

Half of the world's population lives in cities and it is predicted that it will grow up to 70 per cent by 2050.

Conclusion

Cities indeed are the emerging futures. For long-term impact, initiatives in India must go beyond the programmatic approach and identify the actual targets that are tangible, concrete, and measurable. We will need to ensure that in India sustainable urban development includes aspects beyond the scope of municipal service and build cities that are environmentally sustainable, socially inclusive, and economically productive and resilient so that they can genuinely contribute to the national development, prosperity, and sustainability. The targets in SDG 11 have the potential to impact real change across many of the SDGs. ◻

FAKIR MOHAN MEDICAL COLLEGE, BALASORE, AND PANDIT RAGHUNATH MURMU MEDICAL COLLEGE, BARIPADA

It was a wonderful experience to get associated with the GRIHA team for our prestigious government medical college projects in Balasore and Baripada. It was the first time that we targeted a 4-star GRIHA rating for a design-and-build project. Absorbing the GRIHA strategies into the design and construction, and complying with the requirements of achieving GRIHA 4-star rating within a stipulated time was a challenge. With respect to the GRIHA requirements, we were able to achieve 70 per cent energy savings from the benchmark and 50 per cent reduction in potable water consumption. The GRIHA rating has truly laid a perfect path, which guided us to streamline our goals towards optimizing the resource usage and enhancing the efficiency of building operations.

Under the GRIHA rating, three mandatory site visits are prescribed which are conducted by the GRIHA Council officials. During these visits GRIHA officials essentially handhold the project team to weigh the sustainability quotient at each stage of the projects. The GRIHA team performed an important role in facilitating the integrated approach which acted as a catalyst in resolving a lot of design and construction challenges. We are very proud to say that both our projects, Fakir Mohan Medical College, Balasore, and Pandit Raghunath Murmu Medical College, Baripada, have received a 4-star GRIHA rating. ◻

Dr S Rajkumar

Implementation of Sustainable

Housing through Redevelopment

Amrita Kaur Gulati is a gold medalist and an architect and planner from the School of Planning and Architecture, Delhi. She has 10 years of expertise in research related to housing projects of varied scale and typology. Currently, she is working as an associate professor in the MBS School of Planning and Architecture, Dwarka. She can be reached at amrita.arch@gmail.com

Given the formidable list of challenges facing the housing industry today, incidentally also a multi-billion dollar industry, sustainable housing has emerged as more than a buzz word. Broadly speaking, green houses or sustainable architecture is a way of ensuring that minimum resources are spent in the building process while minimizing the toll it takes on the environment. In this article, **Amrita Kaur Gulati** discusses the ways in which a systematic and planned approach should be adopted to be mindful of the resources available and preserve the environment, to the extent possible, for the future generations.

In a rapidly changing and urbanizing world, the provision for adequate and affordable housing remains a priority for the government. However, the concept of housing requires a new understanding to effectively address the pressing issues of slum prevention, the urban divide, economic and human development, and climate change. No longer regarded simply as a roof over one's head, housing today plays a crucial role in achieving sustainable development, as envisaged by the idea of sustainable housing. Sustainable housing, however, is yet to gain its due prominence in the developing countries. Furthermore, finding an integrated housing policy that addresses social, cultural, environmental, and economic facets is a rarity. There is an implicit understanding that the housing and construction sector is important as sustainable development policies and practices can be played out for a better, greener future. Since the majority of sustainability problems concerning housing can be located in the existing deteriorating stock, this article addresses the issue of redevelopment of housing projects (RHPs).

Need for the Implementation of Sustainable Housing through Redevelopment in India

The older parts of most cities reflect the urban ideologies and standard of living that were prevalent then. These spaces embody the needs, technologies, and socioeconomic situations of the age in which they were built. With changing times and rapidly altering sensibilities, especially with regard to what comprises a 'modern' way of life, urban planning and building, too, require a redevelopment of physically, economically, and socially obsolete habitats.

Urban redevelopment, a process that began in the nineteenth century, is a programme that seeks to revive places where there is urban decay. In other words, old buildings and facilities that have outlived their usefulness are being replaced by new ones using eco-friendly technologies.

Currently, given the scarcity of resources and time constraints, urban redevelopment is being approached in a systematic and planned manner as owners/inhabitants do not have the ability or the money for reconstruction and, in order to be sustainable, the environmental pressures to meet the increased demand for resources, coupled with a rapidly changing climate, are being addressed by policymakers at various levels.

In modern times, redevelopment takes place mainly because of three reasons: first, age or the deteriorated condition of a building; second, a building's unsuitable location; and third, a change in the city's structure directly altering the area in which the building is located. Renewing, upgrading, and changing to suit the transformed city spaces is an essentially western characteristic. European cities have grown by accretion such that they have witnessed a slow process of development with the periodic addition of infrastructure, modern buildings, etc., unlike the eastern set-up where the old was discarded. The best example is that of Delhi, which has been built several times by different dynasties at different points in time. In developing countries like India, growing urbanization is threatening the very existence of cities, thus breaking down established systems and institutional capacities. This is the opportune time to look at sustainable redevelopment as an answer to all the rapid urbanization and resource efficiency-related problems.

Concept of Redevelopment

Generally, redevelopment is considered as the demolition of old buildings and the creation of new buildings on the same site. But as per the ULI Community Catalyst report on Environmentally Sustainable Affordable Housing, by practising good demolition techniques, 20 to 30 years of energy savings can be observed; however, tearing down an old building and constructing a new one leads to unsustainable development. Instead, having a clearly formulated and streamlined process of transformation is preferable. Redevelopment, for all practical purposes, should be divided into three categories, namely, clearance and rebuilding, rehabilitation, and preservation and conservation. A brief explanation for this is as follows:

The **clearance and rebuilding** approach is applicable to two kinds of areas: one, where buildings are in a seriously deteriorated condition and have no preservation value; and two, areas in which the buildings are arranged such that satisfactory living conditions cannot be provided for its occupants and in which land as a scarce resource is not fully utilized as per its holding capacity. In such cases, the demolition and reconstruction, either of entire blocks or of small sections, is often thought to be the only solution to ensure the future comfort and safety of the residents.

Rehabilitation is an operation involving considerable work on deteriorated and obsolete buildings and the surrounding spaces. Rehabilitation includes activities, such as repair, alterations, additions, modernization, demolition of a building's scattered part(s), providing more recreational and open spaces, rezoning, providing off-street parking facilities, building more schools and community facilities, etc. This process uses repair, alterations, and additions to make complete use of a property and maximizes its potential for the occupants' benefit.

Preservation and conservation means the process of applying the necessary measures to sustain the existing form, integrity, and materials of a property of historical importance. Work in this domain, including preliminary measures to protect and stabilize the property, generally focuses on the ongoing maintenance and repair of materials and features rather than extensive replacement and new construction.

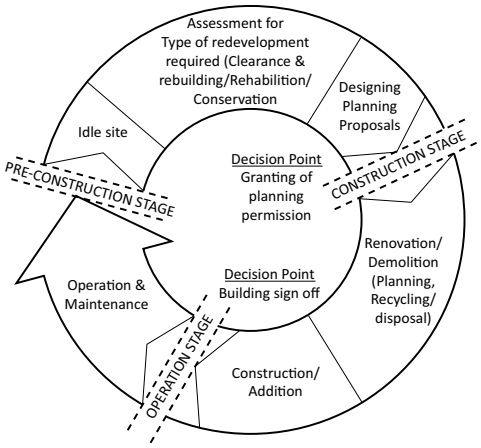
The reason for a renewed importance in redevelopment is that it offers not only the opportunity to create a more spatially integrated, mixed-use urban environment but also to introduce resource-efficient, high-quality buildings. Additionally, redevelopment offers benefits such as: better opportunities to revitalize a community, a judicious use of the existing infrastructure for projects to integrate better with the urban context, to remove blight, and so on. Redevelopment also reduces the pressure to develop greenfield sites. Therefore, for these reasons, redevelopment projects are inherently sustainable.

The Life Cycle of Sustainable Redevelopment Housing Projects

The life cycle of an RHP can broadly be split into three separate phases, namely, the preconstruction stage, the remediation and construction stage, and the operation and maintenance stage.

The preconstruction stage is the most crucial as the decisions made at this stage will affect the sustainability of a development throughout its life cycle. Although a site selected for redevelopment often goes through a period of limited economic or social activity, however, as the site is idle (Figure 1), it is not until an interest for redevelopment has been expressed through the submission of an outline planning application that an RHP can be evaluated with regard to its sustainability.

The first step in the preconstruction stage is identifying areas of blight. Blight is a generic term, never applied to a single building but to a site area where the quality of the built environment falls below substandard. The second step includes a study of the blighted site area selected for treatment in order to establish the extent of the



» **Figure 1** Life cycle of a redevelopment housing project

blight and the reasons for it. The third step is to evaluate whether the site is still suitable for housing or is it more suitable for industrial, institutional, or commercial use. After finalizing the site, it is important to determine the type of redevelopment that should be adopted, that is, should it be clearance and rebuilding or rehabilitation and preservation, followed by redevelopment plans showing the phases of redevelopment, cost analysis, and project feasibility.

It in the initial phase of the RHP, by following the process of obtaining planning permission, one identifies the scope for implementing and assessing the sustainability of the RHP. At this point, a large number of stakeholders, those who are participating in the decision-making, are identified and pre-application negotiations with the competent authority are also finalized. Furthermore, it is vital that the sustainability factors are undertaken for the planning and design phase, especially in a way that is compatible with the existing planning processes (some of which consider sustainability only implicitly). This can be done by registering the project with GRIHA and also by involving all the relevant stakeholders of the project.

The second phase in the life cycle includes the remediation and construction phase, which is necessary to set clear goals and to start thinking about sustainability as early and comprehensively as possible. Adding the green elements at a later stage has proven to be a more expensive process and such a project is less likely to achieve the desire energy efficiency and reductions in carbon emissions. Moreover, it is important to ensure that greening is not simply an upgrade that is seen as an expendable item that adds to the project cost, but rather an integral part of the design and construction. Going green incrementally is often less effective and more expensive than simply committing to green development from the start.

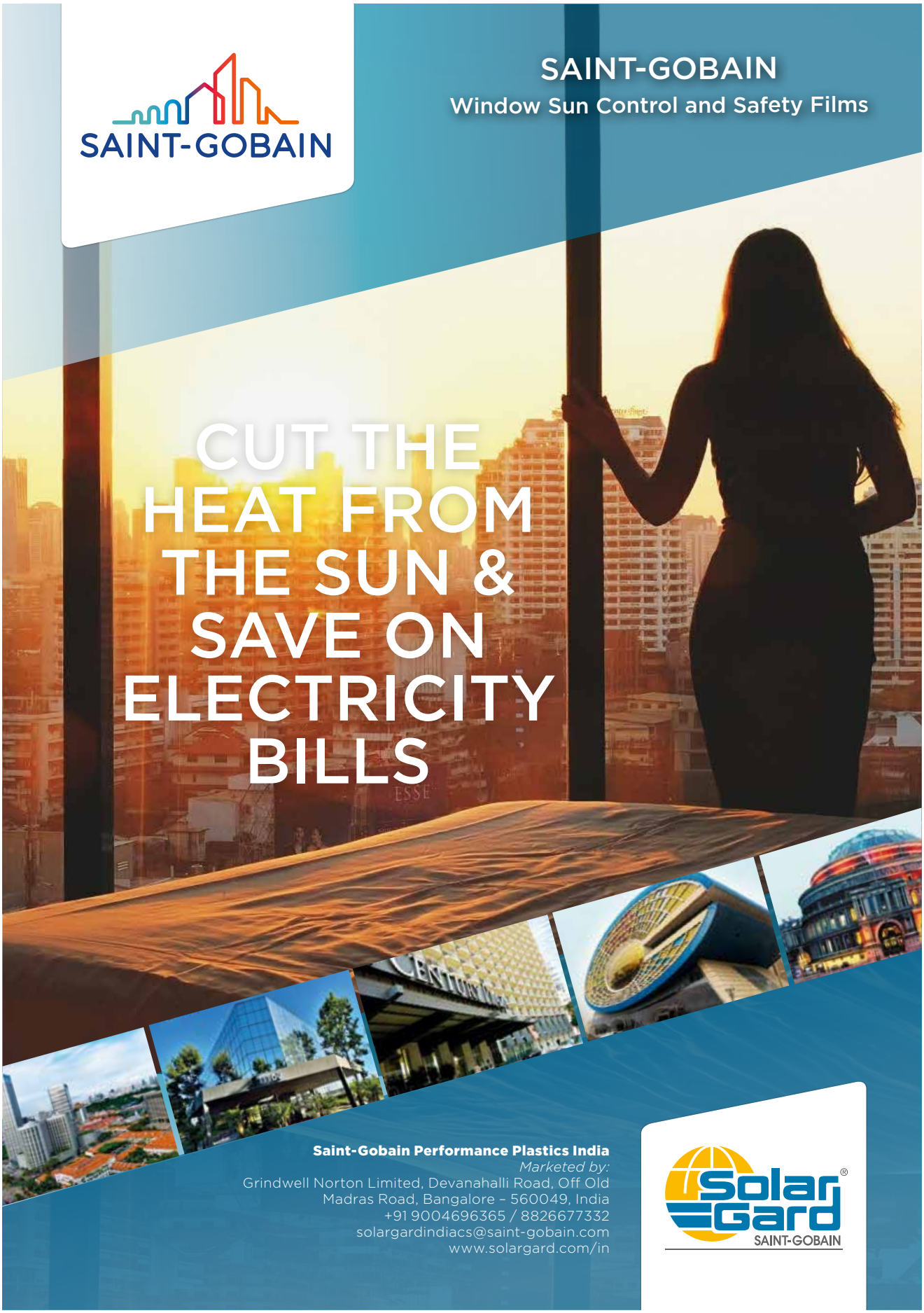
Keeping this in view, guidelines for a sustainable habitat have to be followed. The guidelines are based on different construction organizations under which the proposed plan will be implemented. Like the CPWD guidelines are intended to be used by the CPWD architect/engineers in a day-to-day decision-making process with regard to the use and evaluation of materials and technology on sustainability parameters. The guidelines have been divided into four parts:

1. Guidelines on the architectural design and layout
2. CPWD sustainability index and guidelines for materials
3. Guidelines for the selection of equipment for electrical and mechanical services for sustainable buildings
4. Guidelines on the reuse and recycling of construction and demolition waste

The third phase in the life cycle is the operation phase, which starts with the handover of the project and lies in the hands of the operation, maintenance, and management stakeholders. This phase includes considering the impacts with regard to usage, management operations, and long-term maintenance. The operations phase involves aspects typically monitored as part of environmental management systems, such as energy efficiency, waste management, and water conservation, which in turn ensure the long-term sustainability of a project. These, however, are rarely considered when dealing with redevelopment projects.

Conclusion

The life cycle designed for RHPs should be sustainable in all dimensions. Different modules have to be formulated as per the type of redevelopment required for the specific site. Just as clearance and rebuilding are not the only solutions for an aged building, an integrated planning approach must be adopted for all redevelopment projects, irrespective of their category, in order to achieve a reasonably long (residual) use period for a building in terms of maintenance and modernization costs. The existing buildings that are in continuous use, and with their ability to adapt to new requirements, reduce the consumption of natural resources, protect the environment, operate on low energy and material consumption, and judiciously use the existing infrastructure. Renovating the existing housing also helps to conserve developmental costs by removing demolition expenses from the budget. However, there may be some cases in which the different variants like conversion, expansion, partial or complete demolition, and new constructions have to undergo holistic comparison. A stocktaking exercise for a particular period will need to be done as this is the only way to determine whether a particular variant will pay off. In this case, the environmental impact of demolition, disposal, or recycling must be taken into consideration. The same applies to the demolition of buildings or parts of buildings. To recapitulate, for RHPs, there is no standard, fixed concept. Instead, every project requires a specific concept or sub-concept with different approaches, alternatives, and measures. ◻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GREENING THE IMPOSSIBLE!

This Mumbai-based Start-up Is Doing It All!

The Mission of APRO GREEN TECH

Apro Green Tech, established in the year 2012 by Abhijeet Sirkar, has been providing assistance to government bodies, corporates, and private organizations on green technology initiatives and corporate social responsibility. Additionally, it also provides help in planning rural/urban development projects and integrating green technology in the city's infrastructure.

The solar selfie tree installation at Dadar

The APRO Surya tree installation at Dadar, Mumbai, is credited to be one of their most successful projects. The solar trees have been installed in 12 locations across Mumbai. The plan for installations in 20 more locations are underway in various stages. According to Abhijeet, solar power has a huge potential to make a major impact on the electricity requirement. The tree at Dadar was one of their first solar tree installations. The solar cells or photovoltaic (PV) cells used in the Apro Surya Tree convert sunlight directly into electricity. These can be used to illuminate our surroundings, save electricity, and cause less pollution.

Apro Green Tech believes in bringing about cutting-edge environmental solutions from across the world and carry out dedicated

research for the same. A few of their known innovations include:

i. Waste to roads

Rainwater accumulated in used tyres becomes a breeding ground for mosquitos during the monsoons. An environment-friendly disposal of these used tyres and plastic waste is another problem. In an innovative solution to the issue, Abhijeet came forward to help the MCGM. 'We came up with the idea of making roads and filling up potholes with waste rubber and plastic. Around 1,000 tyres were collected and sent for recycling. The resulting rubberized asphalt mix prepared, was used to repair potholes at Padmabai Thakkar road in Dadar (W). This saved over 40 tonnes of carbon dioxide from being released into the atmosphere', he says.

ii. Waste to homes

Another idea for sustainable low-cost housing includes the use of plastic water bottles littering roads, canals, gutters, rivers, and oceans, and asking people to live inside the structures built from them.

'We came up with a sustainable solution to build houses, loos, cop cabins, benches, etc., using the waste plastic bottles and glass bottles. This provided an environmentally smart strategy of low-cost, sustainable and eco-friendly housing. It also helped us create carbon sinks,' says Abhijeet.

iii. SUSLOO

Sustainable sanitation urinals in public spaces are one of the prime areas of focus. The specialized SUSLOO toilets are one of a kind. They are constructed using APRO's patented 'Bottle Brick' innovation (plastic and glass bottles) and recycled milk and juice cartons and avoid the use of conventional building material. These e-toilets are powered by solar energy.

The following initiatives can be attributed to the organization as well:

- At the World Environment Day 2018, Apro Green Tech set up a plastic recycling kiosk at the food court in Juhu beach. The machine crushed the plastic into flakes.
- On the World Water Day 2018, Apro Green Tech installed a cold drinking water cooler, which could generate 150 L of cold drinking water per day.
- This Independence Day, Apro Green Tech installed a wind solar hybrid technology in Worli, Mumbai's sea-facing stretch.
- A small shading was installed at the Elphinstone station in Mumbai. Besides providing shading lights at night, this station also harvests rainwater during the rains.

Challenges

One of the biggest challenges for Abhijeet and his team has been underlining the importance of these environmental initiatives. 'Sustainable solutions are of long-term importance and require a certain amount of effort to carry out. Convincing people about these initiatives has been the biggest problem to overcome,' he says.

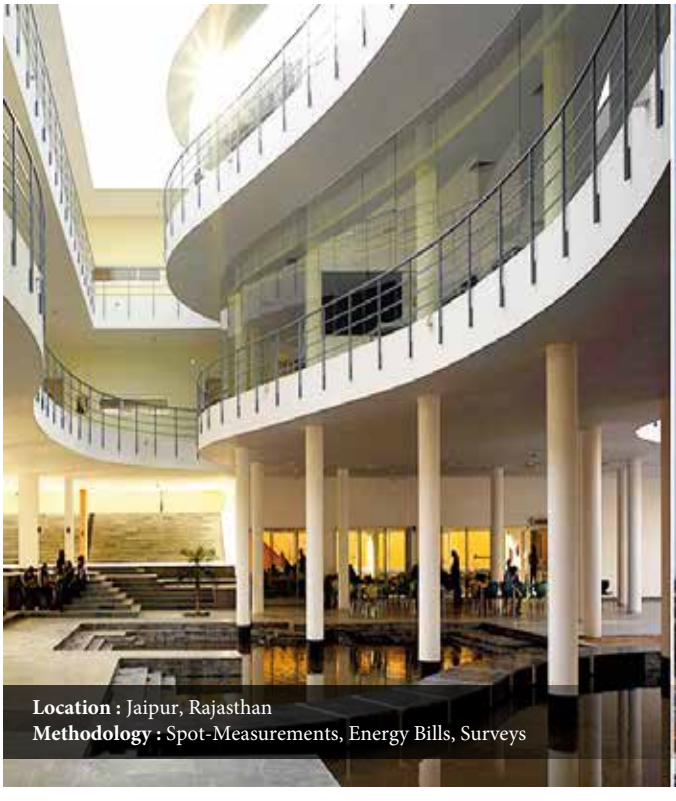
He praises the government for the support and says, 'We have often had to work in conjunction with AMCs and government officials to carry out our project and we have had support on every step of the way'.

The Road Ahead

Any entrepreneurial venture requires effort and hard work, especially in its initial stages. 'We worked hard to create, pitch, and implement these sustainable solutions, and created a network of people with a similar vision and ideas to help us out. It is this hard work that has enabled us to carry out various innovations. We persevered in the initial stages and that perseverance has paid off,' says Abhijeet. ◻

Closing the Loop

Re-Visiting Built Projects Through Post-Occupancy Analysis



Location : Jaipur, Rajasthan
Methodology : Spot-Measurements, Energy Bills, Surveys

Manit Rastogi *is founding partner in Morphogenesis, New Delhi. He co-founded the company in 1996. Known as an architect who consistently pushes the boundaries of sustainable design, Manit lectures extensively globally and has published several research papers with respect to zero-energy buildings. Besides being an educator, Manit is a founder member of the GRIHA Council.*

Post-occupancy evaluation is easily one of the most effective tools in completing the full-circle of learning from practice in architecture. The impact of the design strategies envisioned during a project can truly be understood by the experiences and satisfaction of the actual occupants of that space. In this article, **Manit Rastogi, Nitin Bansal,** and **Piya Verma** outline the results from post-occupancy evaluations of open and transitional spaces in different project typologies located in India's prevalent composite and hot-dry climate. The projects mentioned rely solely on passive design principles, and vernacular precedents, for user comfort and have been designed without the support of computer-aided simulations.

Location : Noida, Uttar Pradesh
Methodology : Spot Measurements, Energy Bills, User survey

Nitin Bansal *works as Senior Associate, Morphogenesis, New Delhi. With 12 years of experience in architecture and a specialization in sustainable environmental design from AA graduate school, Nitin has worked on a range of projects from healthcare through to large commercial buildings. He has delivered projects which are sustainable and practical with a high level of technical documentation. He can be reached at nitin.bansal@morphogenesis.org*

[1] 'Morphogenesis: The Indian Perspective'. 2016. The Global Context, Images Publishing.

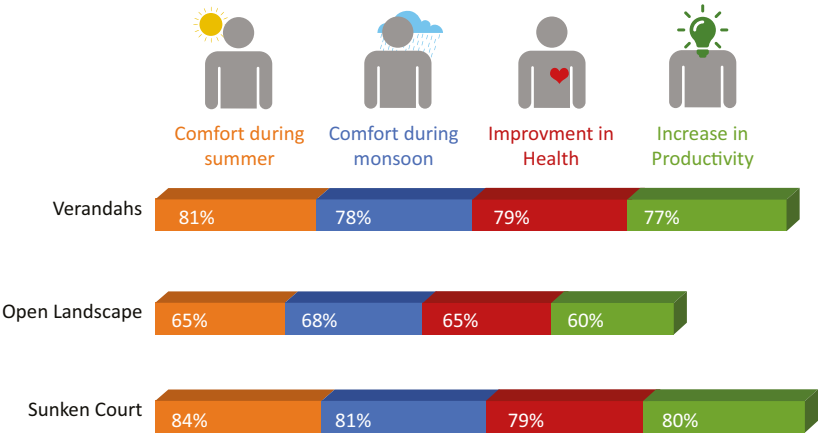
Piya Verma is Senior Architect, Morphogenesis, New Delhi. She graduated from Vastu Kala Academy of Architecture in Delhi and The Architectural Association, London. She has contributed to the practice of sustainability through built and published work at various Indian and international forums. She can be reached at piya.gupta@morphogenesis.org

Majority of commercial architecture projects today, such as offices, institutes, malls, etc., are products of the interaction between a developer and the architect, making educated evaluations of the end-user's needs. Consequently, the actual occupants of these spaces are left out of the design process altogether. This raises concerns and doubts on the 'livability' factor of the projects; how comfortable does this 'product' really make the user? Post-occupancy evaluation is easily one of the most effective tools in completing the full-circle of learning from practice in architecture.

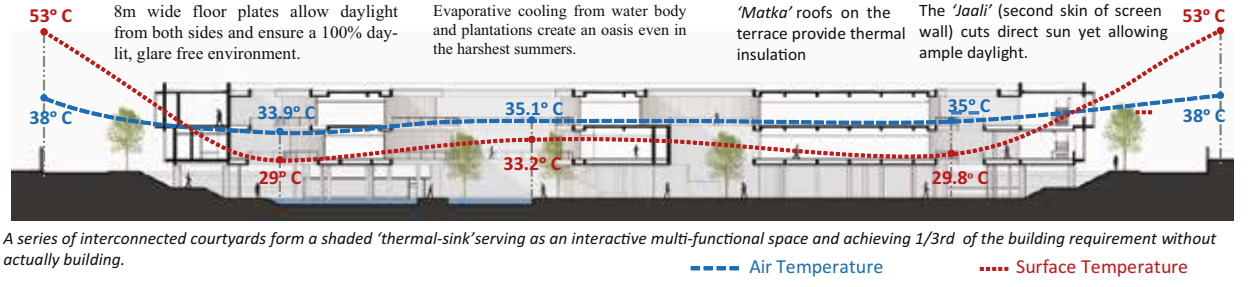
The following projects demonstrate that comfortable, open, and transitional spaces can be successfully treated as an extension to the indoors, leading to the potential elimination of built spaces for interactive functions. Again, the passive design strategies applied are in fact inspired from the rich architectural heritage of India; vernacular techniques, such as *baoli* (step-wells), *jaali* (screen walls), *haveli* (courtyard house) which exercise passive design principles, such as earth-sheltering, evaporative cooling, solar control, etc.

Institutional Building in Hot-Dry Climate

Given the nature of an educational institution, budgetary constraints on the project called for the use of cost-effective design solutions to stay within the price points set by the client while being able to achieve the desired functionality and quality. The brief called for design of a Fashion and Gemology Institute on the outskirts of Jaipur, Rajasthan, one of the hottest climatic zones in the world. Achieving energy and resource efficiency was of prime concern. Vernacular passive design strategies, such as *'baolis'*(step-wells), *'courtyards'* and *'jaalis'* (screens) form an integral part of the design and aid in reducing the dependency on conventional environmental controls (See Figure 1).

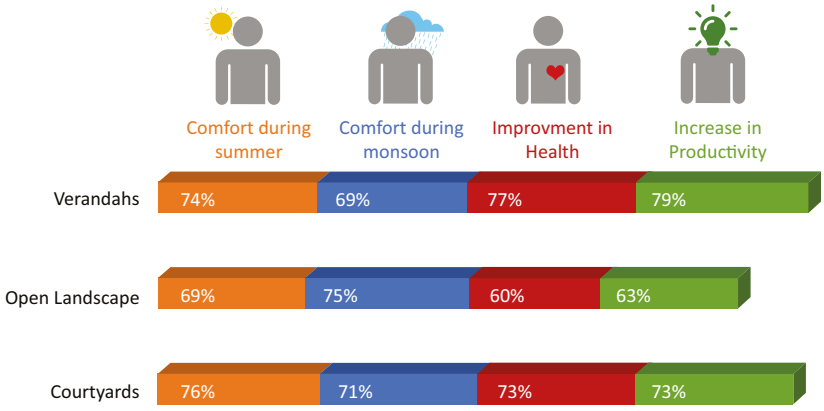


» Results from post-occupancy survey



» **Figure 1** Spot measurements of an institute in Jaipur on a peak summer day (May 20, 2011, 2 p.m.)

Post-occupancy analysis shows that students enjoyed spending time in open and transitional spaces such as the sunken court and actively use them for open-air lectures, co-curricular activities, etc. 'The air circulation, the aesthetics of the building, inner courtyard, and work spaces make it an unforgettable experience to study here!' a student stated.



» Results from post-occupancy survey of the office building

Office Building in Composite Climate

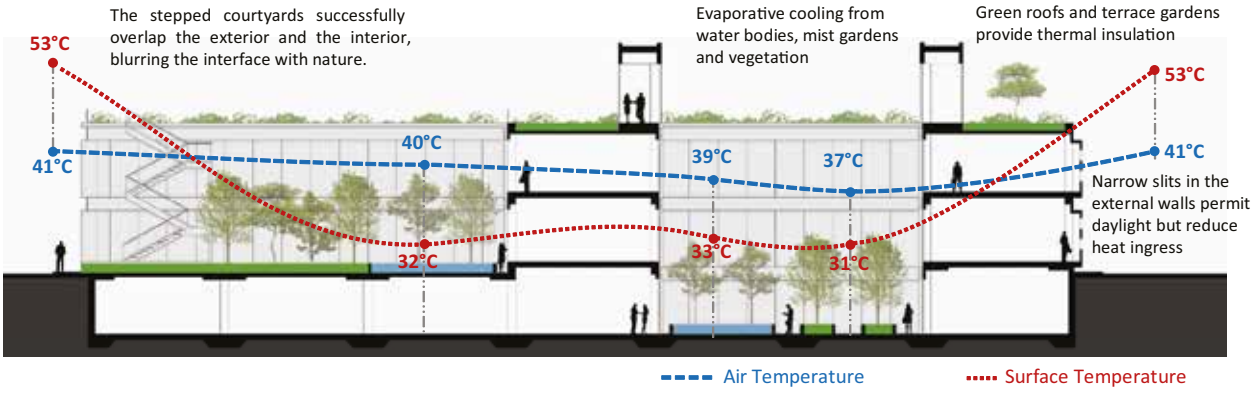
The primary concept that guided the office development was an energy-responsive design corresponding to the requirements of a modern workplace. The development of building techniques was carried out using modern materials within the Indian construction format. Inspired from the traditional *baoli* and *kund* (small tank or reservoir) concepts, microclimate tempering is achieved by the multiple shallow water bodies and mist gardens. Design and construction techniques and features, such as cavity walls, low window-to-wall ratio (WWR) on external walls, and landscaped terraces further reduce solar exposure.

Spot measurements showed a variation of 5 °C to 6 °C between internal and external air temperatures (See Figure 2). More importantly, the radiated heat dropped by 23 °C between external road and internal landscape. These variations proved to have a much deeper impact on the energy consumption of the building, which was demonstrated through the actual energy bill of 59.6 kWh/sq. m/yr. This was just 42 per cent of the recommended EPI for an air-conditioned building, that is, 140 kWh/sq. m/yr. The post-occupancy surveys highlighted that people enjoyed using the courtyards even during the peak summer months. 'We don't know how the building works, but one thing we can tell you is we don't feel tired when we go home.'

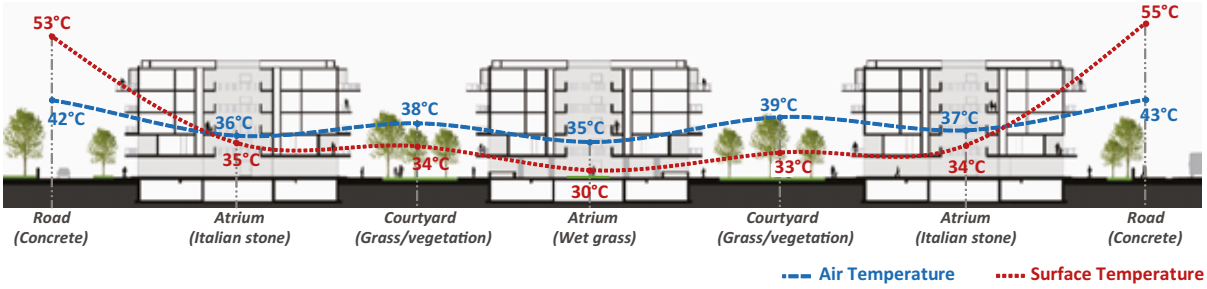
Residential Project in Composite Climate

Shifting away from the archetypal morphology of high-tech residential modules and equipment crammed into an undersized apartment, the housing complex was designed and developed to address issues of liveability, spatial configuration, and socio-environmental issues. The design intent was to rely as much as possible on nature's resources, such as day light, natural ventilation, and passive cooling techniques.

Visiting the project on a peak summer day, the outside air temperature was found to be 43 °C whereas the air temperature inside the landscaped courtyards was at 38 °C (Figure 3). Moreover, the surface temperatures dropped by 25 °C while moving from external roads to open spaces within the complex. Upto 85 per cent of the residents found the courtyards comfortable for use both in summers and monsoons while 80 per cent vouched for improvement in health due to the use of verandahs. 'I have never felt as comfortable and safe as I am feeling right here. The complex, the blocks, each individual apartment just works so well! You can ask anyone around here, it does not



» **Figure 2** Spot measurements of an office building in Delhi on May 23, 2012, 1 p.m.



» **Figure 3:** Spot measurements of a residential complex in Chandigarh (May 19, 2012, 1 p.m.)

get any better than this,' a resident expressed to the surveyor.

Conclusion

The importance of microclimate management and its impact on the resource consumption of the projects proved to be the most significant and accessible strategy applicable to all prevalent project typologies. Modern-day adaptations of vernacular precedents, such as shaded coutyards, *baolis, jaalis,* and verandahs where integrated with thermal mass, solar shading, and natural ventilation resulted in an average 75 per cent user satisfaction where most occupants across typologies preferred spending time in courtyards.

Overall, it will be fair to conclude that passively designed open spaces have the potential to practically replace most functions of the built form.

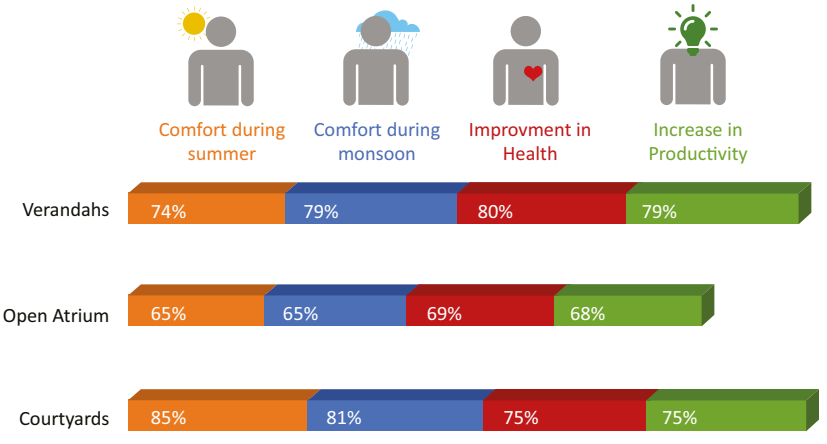
Acknowledgements

The studies would not have been possible without the cooperation of the project clients and occupants who took the time to help with interviews and surveys.

We would like to further acknowledge the following project design teams for their hard work:

- Institional Project in Jaipur: Manit Rastogi, Sonali Rastogi, John Alok De Cruz, Rachna Agarwal
- Office in NOIDA : Manit Rastogi, Sonali Rastogi, Bala Otra, Sanjay Bhardwaj, Ipsita Hadke
- Residential Complex in Chandigarh: Manit Rastogi, Sonali Rastogi, Sanjay Bhardwaj.

Note: The authors have used spot measurement Tools 905-T2, 610 by Testo India Pvt. Ltd for all the Spot Measurements in the present study. ◻



» Results from post-cccupancy survey of the residential building

Need for Sustainable Building Materials

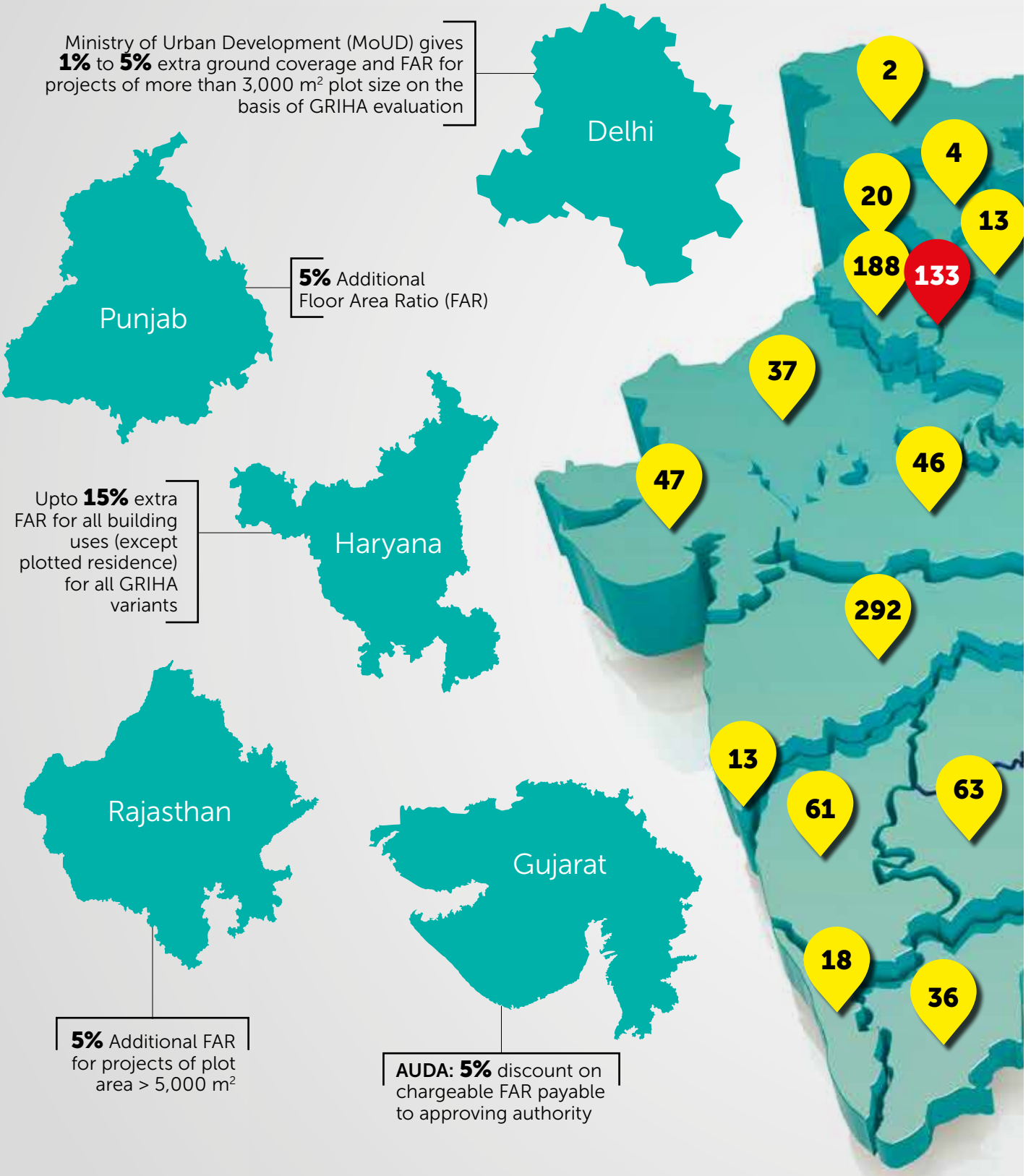
Nikita Korgaonker
Architect, MArch (Sustainable Architecture),
GRIHA CP, LEED AP, IGBC AP
Sustainability Consultant
Mobile +91-9545-447-552
Email korgaonkernikita@gmail.com

Materials are the main components in the construction industry as they account for a building's mechanical strength. The selection of building materials is usually done based on functional, technical, and financial requirements. However, in the last decade, sustainability has become a crucial issue. The building industry directly or indirectly contributes to the environment deterioration. This has given rise to the need to find more environmentally benign methods of construction and building operation. One of the solutions could be recycling and reuse, sustainable material production, or use of green resources.

The fastest way to start integrating sustainable building concepts is through careful selection of building materials. Generally, costs have been a primary consideration during material selection, but this is the manufacturing and transportation cost. It rarely reflects the social and environmental costs involved. The application of stable, cost-effective, and low-impact building materials is the key to any high-performance building. Green buildings can be beneficial to our health as well, for example, building and furnishing materials, such as paints, cleaning products, and carpets, can be dangerous for human health. The use of low volatile organic compound paints and adhesives, following proper building flush out procedures before occupancy, and using green housekeeping products post occupancy can help with the purification of the air. This creates environmentally friendly workspaces, which help employees perform better while reducing absenteeism. In Europe, the construction industry is responsible for 34.7 per cent of the continent's total waste. Green buildings minimize waste due to their lower environmental impact and use of renewable sources and materials. Recycled materials used during the construction process are contributing significantly to the reduction of waste. Moreover, sustainable construction takes into consideration a number of critical elements, such as the installation of well-insulated windows, ceilings, and walls that ensure there is no energy being wasted. Additionally, the use of solar water heaters, insulated air conditioning pipes and photovoltaic panels, and the reuse of treated water can make buildings more energy efficient and less harmful to the environment.

Sustainable building materials by definition are materials that are locally sourced and manufactured. They not only reduce transportation costs and greenhouse gas emissions but also consist of reused materials, possess a lower environmental effect, are thermally effective, need less energy than conventional materials, use renewable resources, and are economically sustainable. A sustainable building material when used properly and contextually in community development not only minimizes costs but also offers employment and skill development opportunities for community members.

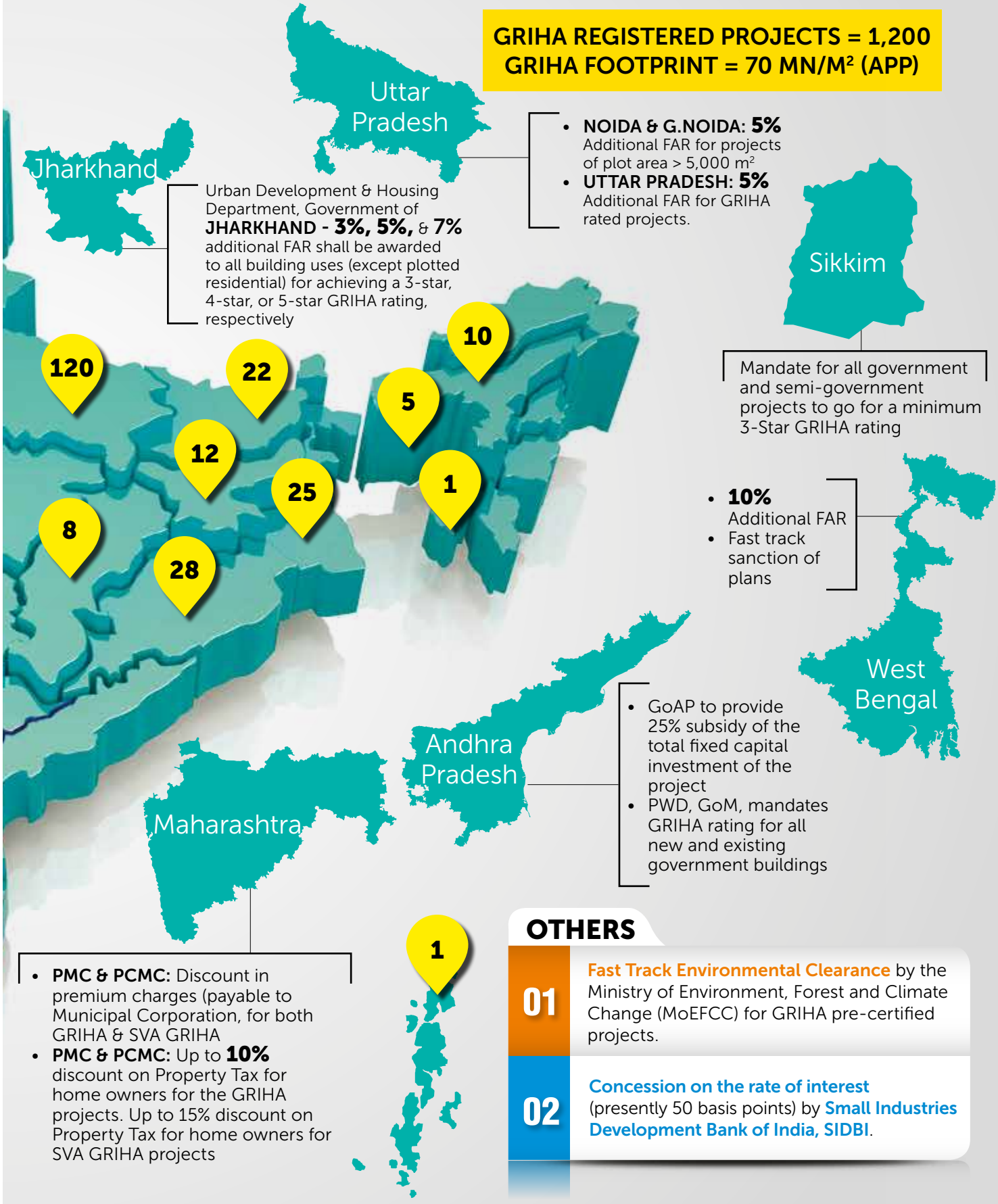
GRIHA PROJECTS' UPDA



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

TE & LINKED INCENTIVES

GRIHA REGISTERED PROJECTS = 1,200
GRIHA FOOTPRINT = 70 MN/M² (APP)



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

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

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
- PWD, GoM, mandates GRIHA rating for all new and existing government buildings

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

OTHERS

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

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

DIDI CONTRACTOR

DIDI CONTRACTOR, ***a household name in architecture, resonates with those who have a penchant for the organic, serene, vernacular, and traditional. With more than 15 buildings to her credit, she continues to be devoted to sustainable building practices and, above all, displays a close adherence to natural formations in all her designs. To this living legend, a building is an integrated part of a landscape—a natural, obvious extension of its beauty—quite unlike the ostentatious display of scale and grandeur often seen in modern architecture. In this conversation with GRIHA, Didi Contractor reflects on her extraordinary journey and reveals the architectural aesthetics that appeal to her and also infuse her teachings and practice.***

1 Can you tell us about your journey from being Delia Kinzinger to Didi Contractor?

The story of my names begins by the end of the 1920s, before my birth. In those days, when the gender of every child at birth was a surprise everywhere, two names were always kept ready. Had I emerged as a boy, I would have been named George, OK: an acceptable name, but starting life with the proposed accompanying nick name, Dodo, an extinct species, would have been enough to prompt an instant in-utero 'transition' to the other option: the serious lady like Delia after my great grandmother, with the attractive fashionable nickname, Didi.

I grew up aspiring to the ideal of becoming Delia, whom I envision as mature, confident, convincing, and competent. I have never quite achieved being Delia.

The Kinzinger was automatically dropped in 1950 at college in America when I met and married Narayan Ramji 'Contractor', a name my father-in-law had chosen according to his profession. After we moved back to India, Didi became even more appropriate. Here my quirky, trendy nickname evoked the expectation of a sympathetic, dependable, and supportive presence. I have been comfortable trying to contribute to the implied, soothing, sisterly affection.

2 Tell us about your inclination towards village architecture.

Beauty, in the diversity of nature and in the variety of the many artistic traditions, inspires me. From my earliest childhood, I was greatly exposed to the works of both by my parents, who were professional painters.

When I was about to become a teenager, my parents took me to hear Frank Lloyd's lecture. Deeply impressed, I spent many hours studying an accompanying exhibition on his work where I picked up the concept of how a three-dimensional building's photograph relates to the accompanying flat-scale drawings. Ever since I have been entertaining myself by imagining buildings and scenarios, and sketching out the plans, for the events they could house.

Arrogant buildings, which proclaim power, reinforcing the divisive force of dominance in human concerns: political power, even religious power and, most of all, financial power, repel me.

A view of a tyre berm - Old tyres, as in 'Earthship' construction are used to berm the northern walls help protect the building against the slope and provide insulation.

The local stone up to splash back height.

3 What is the essence of the word 'vernacular' from your point of view?

Look up the word 'vernacular'. There is a whole, valuable essay to be explored there. By strict definition, one could also refer to evolving slang or the even the current fashion for pink and lavender constructions that people now find attractive, which I find so offensive, so hideously inappropriate, 'vernacular'. Like 'weeds' indigenous to an area , which when transplanted to other areas, depending on the specific environmental surroundings, are either valued as desirable exotics or pest like, while the basic scientific principles of botanical understanding and observation remain the same and equally applicable everywhere. In their native habitat, the so-called weeds almost always evolved to play a role in the complex essential diversity of each specific biosphere.

Likewise, traditional domestic styles and the materials and techniques used in each area evolved out of an intricate interplay between need, cultural vision, and practicality.

A sky-lit bedroom with a cosy fire place.

Space created by light and height

Improving the concept of wood burning smokeless chulha with an innovative design on a raised counter. Also, the use of a filler slab with local earthen pots to reduce the use of imported concrete.

4 Tell us about 'Marrying the building to the earth'.

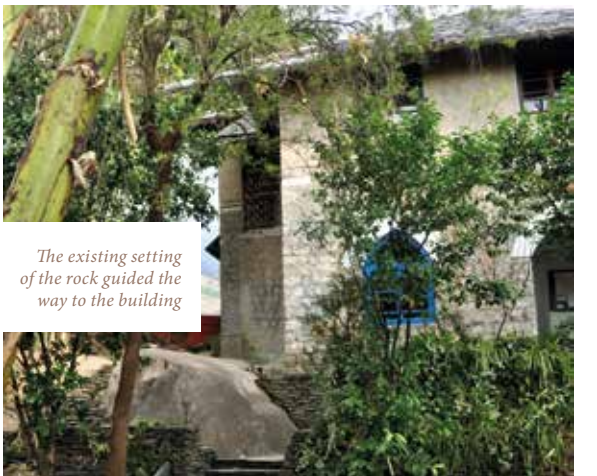
It is lovingly done—visually beautiful and very poetic. When, several years ago, my dear friend Steffi Giaracuni finally obtained the backing which enabled her to shoot this documentary based on my architectural work, I did not, during the time her gifted team could be here, have any active ongoing building projects in hand. Then, due to professional and financial constraints, it took several years to prepare the exquisitely finished film, a lovingly crafted work of art in itself, for release. Although it has been shown at festivals and has been released in Europe, it is still not readily available for screening in India.

Meanwhile, Shabnam Sukhdev, whose renowned father had been a dear and admired friend of mine, was able to persuade the films division to allow her to archive a series of lectures I had, unexpectedly, been invited to give and to assemble a film from an Indian point of view. Her vigorously paced film, Earth Crusader captures a very different moment and would also appeal to a different audience.

Between the buildings, which I hope speak for themselves, these two films and Joginder Singh's beautiful book of photographs of my work, An Adobe Revival,[1] I feel secure that most of my message will remain available for the future.

[1] For more information, please visit http://www.immaterialonline.com/.

A detail of the stairwell railing using attractive black bamboo, saves wood and labour.



The existing setting of the rock guided the way to the building

5 Who do you admire and who inspires you?

The architecture of the humble self-built dwellings moves me. I admire snails, who naturally grow themselves homes of perfect dynamic symmetrical beauty and delight in the innate creativity of nest-building birds who ingeniously use materials from their environment, like all ordinary people did everywhere in the past. Traditional domestic architecture everywhere developed from the the judicious use of materials at hand. In the past, everyone everywhere had to create within sustainable limits if they and their cultures were to survive. There are the telling examples of cultures that overstepped the bounds of environmental sustainability and did not, as a result, survive.

For a time science and industrialization have enabled our species to increase its comforts, and disregard the limits and imperatives that nature has set, thereby guiding the planet into what is now termed as 'anthropocene'. The stark reality now is that our species seems to have provoked the possibility of the unimaginable and the increasingly probable destruction of the basic conditions that sustain all life on this planet.

Light is leading the way in a staircase

Brick with the rice husk to provide better binding and insulation: an incremental improvement in the excellent heat retention in Earthen building.

6 How would you like to be remembered?

I would like to be remembered as a serious Delia. I would like to be remembered as one of the many who are currently offering numerous alternatives in each field of human endeavour to stimulate deep change. I aspire to help prompt change: change from the rule of the value of quantity and growth to that of quality and maturity; change from irresponsible consumption to wise conservation; change from seeing the past as 'his story' to 'our story'; change from behaving as a species of voracious, over-successful and exploitative predators to accepting responsibility as stewards of plant Earth.

Mark Moore, Founding Director of Dharmalaya Institute in Bir (for which Didi designed and supervised construction of the main building), praised Didi and her holistic approach, saying 'Along with her extraordinarily sensitive architecture, Didi also brought us equally thoughtful solutions for other essentials of sustainable living, such as this solar cooker built of adobe and upcycled vegetable oil tins, which allows us to cook superlatively delicious and nutritious food with zero carbon footprint and zero energy expense.'

Walls filled with plastic waste constructed with plastic bricks/ plastic bricks walls a berm filled with non-biodegradable plastic.

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Visualize difficult concepts instantly in lifelike 3D holographic projections

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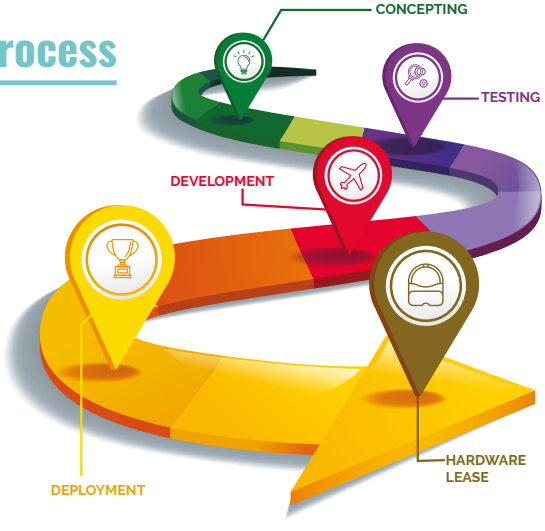
Advanced enterprise grade mobile app & web services - AI, ML, ROR, Python

Process



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Energy Efficiency in Indian Building Sector

For Driving Sustainable Development

The building and construction sector holds the key to a sustainable future for the world. Thus it is considered important for achieving Sustainable Development Goals in India as well as at a global level. In this article, **Venkatesh Dwivedi** says that India has initiated several national missions which focus on up scaling building efficiency and, with path-breaking technological innovation, comprehensive planning, and concerted efforts, India can not only ensure sustainability in its building sector but also show the way to other developing countries.

Mr Venkatesh Dwivedi is the Chief Operating Officer at Energy Efficiency Services Limited (EESL), India. He has been the first project manager of EESL's flagship scheme UJALA as well as the national project manager of the Street Lighting National Programme of India (SLNP). He has more than 25 years of executive experience, he has earlier workered worked in the oil and energy sector in India in various capacities in operations, technical services, project management, and business development. He can be reached at vdwivedi@eesl.co.in

Buildings are amongst the biggest consumers of energy globally. Despite the growing realization that the business-as-usual approach in resource utilization is not sustainable, there is still a long way to make green construction a norm rather than an exception. Accounting for 40 per cent

of the global energy use, and 30 per cent of energy-related greenhouse gas (GHG) emission, the buildings and construction sector holds the key to a sustainable future for the world.

Amongst all the regions in the world, the fastest growth in buildings energy consumption by 2040 will occur in India, as per the *International Energy Outlook 2017*. The residential and commercial structures in India consumed approximately 32 per cent of the country's total electricity in 2016, according to *Energy Statistics 2017*, published by the Ministry of Statistics and Programme Implementation.[1] The electricity consumption by the sector is expected to increase by 76 per cent by 2040.[2]

This unprecedented demand for energy can be attributed to rapid urbanization. A report by the UN Habitat titled, 'World Cities 2016, Urbanization and Development: Emerging Futures'[3] projected that India will have additional 300 million new urban residents by 2050. Moreover, commercial buildings including offices, hospitals, hotels, retail outlets, educational buildings, government offices, and so on will have significant demand for energy with each building estimated to have a minimum connected load of 100 kW or contract demand of 120 kVA. The total built-up area of commercial buildings is expected to touch 1.9 billion m^2 by 2030[4] signifying a three-times rise from 2015.

Energy efficiency, therefore, can play a catalytic role in ensuring a smooth transition to sustainable buildings while ensuring there is no additional

burden on resources. Implementing energy efficiency measures in buildings that are being constructed in the next ten years presents a singular opportunity to lock in energy and cost savings for the next several decades. A study by the International Energy Agency (IEA) shows that, if implemented globally, energy efficiency measures in the building sector could reduce CO_2 emissions up to 5.8 billion tonnes (Gt) by 2050.

Government Leadership Enables Significant Progress

India has initiated several national missions, such as the National Mission on the Sustainable Habitat and the National Mission on Enhanced Energy Efficiency, which focus on scaling building energy efficiency. In 2007, the Bureau of Energy Efficiency (BEE) launched the Energy Conservation Building Code (ECBC) that establishes the minimum requirements for an energy efficient design and construction for buildings with a connected load of 100 kW/120 kVA or more, and provides guidelines for the building design, including the envelope, lighting, heating, air-conditioning, and electrical systems. In addition to the code, the presence of independent rating standards is important.

A revised version of the ECBC was released in 2017 prescribing energy performance standards for new commercial buildings to reduce consumption and promote low-carbon growth. It sets parameters for builders, designers, and architects to integrate renewable energy sources in the building design, with the goal of achieving a 50 per cent reduction in energy use by 2030. While the ECBC has been developed by the BEE, its implementation and enforcement lies with state governments and urban local bodies. Presently, the code is in the voluntary phase of the implementation with about 22 states being at various stages of mandating it.

Also, the BEE has introduced the star Labelling programme for the existing commercial buildings, which provides a label to the buildings based on their actual energy performance, making the adoption of energy efficiency appealing. Further, the United Nations Development Programme (UNDP), in association with the BEE, is executing 'Energy Efficiency Improvements in Commercial Buildings' which aims to address barriers such as informational, capacity, institutional, and financial. The Department of Expenditure, Ministry of Finance, has issued instructions to all the government departments for mandatory installation of LED-based lighting and energy-efficient equipment (fans and ACs). EESL, as of now, has completed such installation in 8,000 buildings.

1 Energy Statistics 2017; http://www.mospi.nic.in/sites/default/files/publication_reports/Energy_Statistics_2017r.pdf.pdf ; last accessed on October 8, 2018.

2 CSE, 2014

3 World Cities 2016 - Urbanisation and Development: Emerging Futures; https://unhabitat.org/wp-content/uploads/2014/03/WCR-%20Full-Report-2016.pdf; last accessed on October 8, 2018.

4 Retrieved from http://www.in.undp.org/content/dam/india/docs/pub-EnE/Rolling%20out%20ECBC%20Codes.pdf; last accessed on October 10, 2018.

Bringing Affordable Energy Savings to India's Buildings

While there is a clear need for bringing the benefits of energy efficiency to the buildings sector and reduce its financial and carbon costs, this goal faces both technical and financial barriers. In response, EESL's Buildings Energy Efficiency Programme (BEEP) offers a uniquely designed solution for buildings of the government, industry, and institutions to implement and retrofit energy-efficient appliances and systems at affordable prices. EESL has applied its proven model of demand aggregation as a means of ensuring affordability for the energy-efficient appliances, implementation, and systems maintenance offered to the buildings sector.

Building Efficiency: A Vital Piece of the HCFC Phase-Out Management Plan

Space cooling of the built environment makes up a major share of the electricity consumption. The refrigeration and air-conditioning (RAC) systems in buildings account for a significant amount of hydrochlorofluorocarbon (HCFC) consumption and also energy use in buildings. The building sector RAC systems accounted for 43 per cent of the HCFC consumption in India in 2015, as per the data available with the Ozone Cell under the Ministry of Environment, Forest and Climate Change (MoEF&CC), Government of India. In addition to RAC systems, HCFCs are used as foam the blowing agents for insulation of buildings and also in firefighting equipment.

Since the construction activity is going to increase further in India, the demand for ACs is expected to grow from 3.8 million a year to 6.2 million in 2020/21 (increase of 63 per cent cumulative annual growth rate, according to the Ozone Cell, resulting in higher level of GHG emissions). While India's building sector is one of the largest contributors of GHG emissions, it also offers the biggest and most cost-effective opportunities for energy efficiency and phasing out of ozone depleting substances (ODS).

With reduced expenditure on space cooling and lighting requirements, sustainably designed buildings have a smaller carbon footprint and lesser HCFC emissions. Therefore, building efficiency offers the twin advantages of energy savings while supporting the reduction and eventual phase out of ODS such as HCFCs.

India is currently implementing the HCFCs Phase Out Management Plan (HPMP) as part of its commitment to the Montreal Protocol's global goal of phasing out ODS. Implementing the building-sector interventions under the HPMP, the Ozone Cell, along with UN Environment, have collaborated with EESL. Various initiatives have been taken towards phasing out ODS and promoting refrigerant alternatives with low global warming potential (GWP), under the three-pronged approach:

- Reduce demand for refrigerants through energy-efficient equipment and buildings.
- Replace HCFCs with zero ODP and low GWP alternatives
- Use not-in-kind alternative technologies that do not rely on the use of fluorocarbon refrigerants

Phase II of HPMP marks India's commitment to completely phase out harmful ODS. Sensitizing the building sector stakeholders will be crucial for the successful implementation of this stage, which seeks to achieve the phase out of 804.10 tonnes of ODP material. This can be achieved by identifying priority targets for energy-efficiency programmes and policy amendments, identifying gaps between the existing initiatives and best practices, and selecting the appropriate alternatives.

Therefore, capacity-building efforts, training programmes, and financial incentives, along with knowledge exchange, will be vital towards implementing the HCFC phase-out strategies.

Harnessing the Potential of Trigeneration Technology

Considering that India will need to build 700–900 million sq. m of commercial and residential space until 2030,[5] and that energy demand is expected to increase by at least four times by 2032, it is time to identify large-scale energy solutions. To both decarbonize and find affordable fuel options, India must find a sustainable way of meeting the energy needs of residential and commercial establishments, two of India's large consumers of energy. Their energy needs arise due to heating, cooling, and water-heating needs.

The personal and macro cost of these needs can be met through one technology: tri- generation. Using gas as fuel to generate electricity, trigeneration uses the high temperature emissions to provide cooling by heat transfer. Simultaneously, low-temperature heat can be used for heating water. One fuel and three applications—a truly versatile solution. In terms of the overall efficiency, using gas for applications such as generation of electricity, heating, and cooling is around twice as more efficient than conventional systems.

The capacity-generation potential of the trigeneration technology for India's industrial sector has been estimated at 7,600 MW, with an additional 10,072 tonne of refrigeration (TR), translating to approximately 6,000 MW, estimated which is supplement the heating, ventilation, and air-conditioning capabilities in the country's retail residential and commercial infrastructure sectors, including airports, hospitals, office spaces, and hotels.[6] Industries and commercial buildings that require 24x7 supply of electricity, heating, and cooling, can expect to derive major benefits from trigeneration.

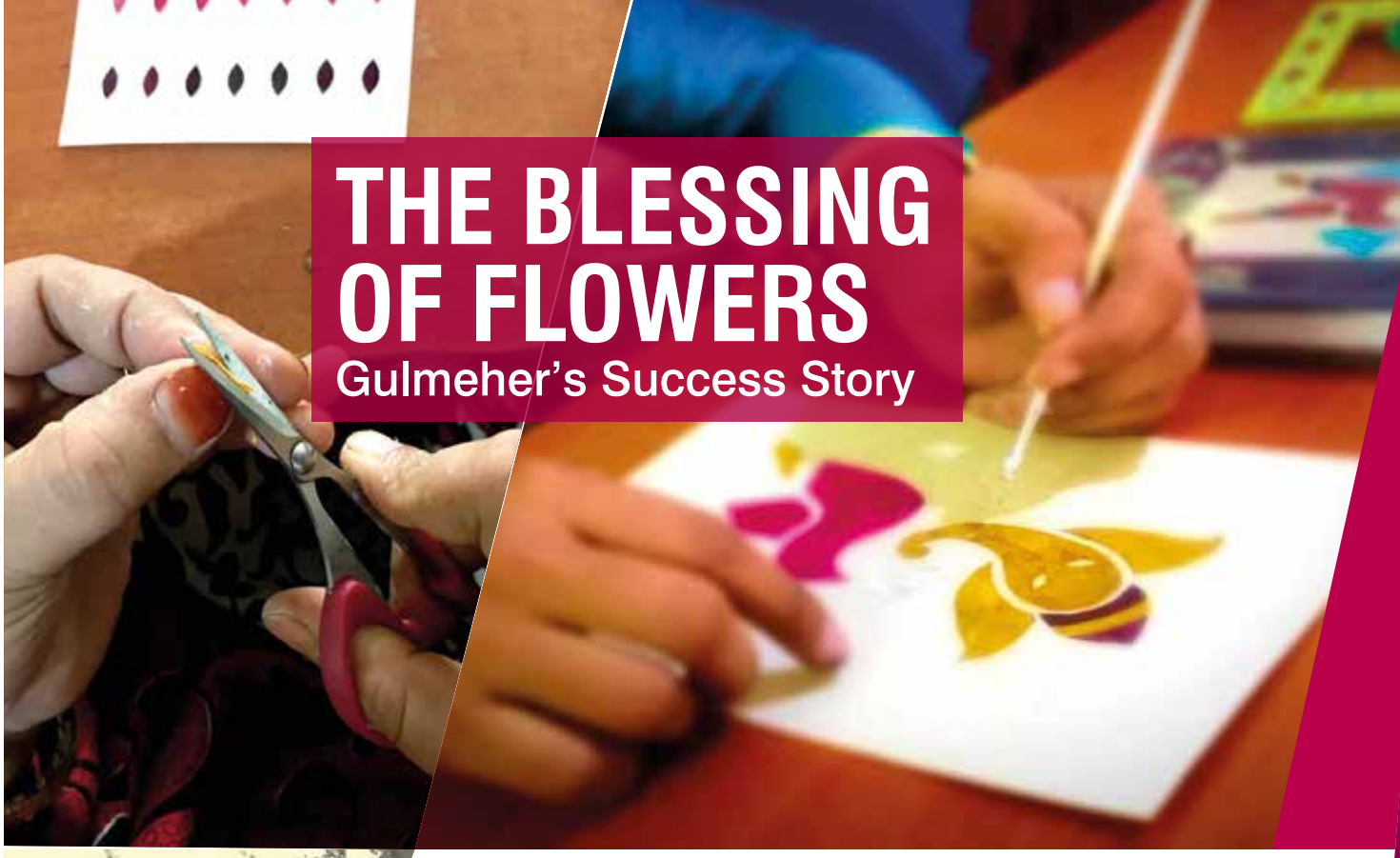
That the pressure on global resources will continue to grow with the rise in population is a well-known fact; however, we need to adapt to this phenomenon by equipping ourselves with sustainable practices. With path-breaking technological innovation, comprehensive planning, and concerted efforts, India can not only ensure sustainability in its building sector but also show the way to other developing countries which are still in the middle of charting out a growth trajectory. After all, the journey towards sustainable development begins with embracing resource efficiency. ◻

[5] Retrieved from https://www.mckinsey.com/global-themes/urbanization/urban-awakening-in-india; last accessed on October 10, 2018.

[6] The stated market potential reflects 2010 estimates. The market potential of trigeneration in India is expected to have increased in this interim due to greater supply of natural gas since the assessment period.

THE BLESSING OF FLOWERS

Gulmeher's Success Story



Gulmeher is a social entrepreneurship initiative to create alternative income-generation activities for women waste pickers in the vicinity of one of Delhi's largest landfills at Ghazipur. Gulmeher provides skills training and creates market linkages for the products made by erstwhile waste pickers turned artisans. The project is operational since 2013. The aim has been to create a self-sustaining entity with diverse livelihood streams, such as handicrafts, stationary, and embroidery.

The innovative model of Gulmeher not only focuses on the livelihood generation aspect for erstwhile waste pickers, it also combines social initiatives to meet the needs of the waste picker community, such as financial inclusion, crèche for young children, after-school programmes for students, health services through a mobile medical unit, and a toilet block for sanitary needs. A programme on financial inclusion was implemented: till date 2,800 zero-balance accounts have been opened and remittances have greatly benefitted the migrant population of Ghazipur. School dropout rates are high for the youth, and girls usually drop out to tend to household chores and become caretakers for young siblings. The community is vulnerable to the negative influence of criminal activities, drug and alcohol abuse. To address this, the Panchi education programme was established to provide more than 200 enrolled children educational support. In addition, the iDream programme in Kalyanpuri helps underprivileged girls to complete high school and become socially responsible, independent, and mature adults. This programme provides academic and life skills support for girls with the goal to improve school attendance and reduce incidences of early marriages.

Gulmeher organizes periodic health check-ups for the women and their children, along with health-awareness workshops for the whole community. A recent addition to the social programmes has been the waste collection, segregation and composting project, which Gulmeher is piloting in the DDA residential colony of approximately 1,000 households.

Over time, the intention is to increase the breadth and depth of the initiatives so as to impact a larger proportion of the community and ensure the sustainability of the Gulmeher programme by adding different streams of revenue generation. The plan is to have multiple Gulmeher centres across the city and eventually across the country, thus ensuring that waste pickers, too, get a respectable means of livelihood. ◻

Paryavaran

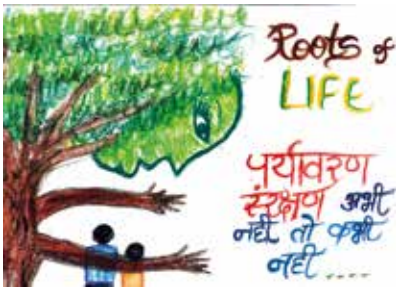
Earth को अनर्थ से बचाएँ

Certificate of appriciation presented to the President, RWA, Pocket D-2, Vasant Kunj

Residents enthusiastically playing 'Power Wars', a game to learn energy and its management

Daily Dump demonstarting working of Khamba for the management of organic waste

Group photograph of the participants and the GRIHA Team



Rakshak

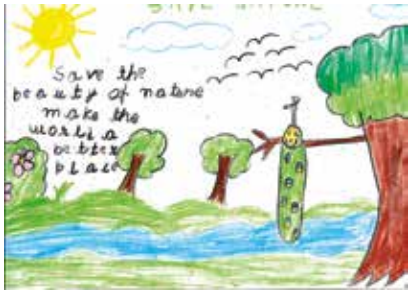
This is a two-hour programme conducted by the GRIHA Council where people are made aware about environmental issues through several activities designed in the form of games, such as waste segregation, tambola with sustainability words, drawing competition for children, energy consumption calculation for 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.

Team GRIHA with the T-shirts for Paryavan Rakshak Program

Residents deeply involved in playing 'Power Wars', a game to learn energy and its management

Tree paltation at the ATS Village, Noida

Residents all geared up for the waste segregation game at Pocket D2, Vasant Kunj



There were two programme held in the year 2018, August 19 at the ATS Village, Noida, and October 21 at Pocket D2, Vasant Kunj, New Delhi. More than 100 residents, including the elderly, were sensitized.

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Putting People First

The Social Sustainability Facet of the Green Building Industry

The basic working and living conditions of construction workers have been long ignored. It is high time we realize that the people constructing our remarkable cities spend most of their lives in terrible, slum-like situations and the most basic human needs are callously infringed. In this article, **Ar. Ashu Dehadani** says that GRIHA has been working diligently towards changing the consciousness level of the people involved in construction, as it emphasizes the importance of the labours' health, safety, and sanitation by enforcing them through a mandatory criterion. The most significant change can be seen in the consciousness level of the employers and the awareness level of the employees.

Ms. Ashu Dehadani *is Manager (Technical and Publications) at the GRIHA Council. She has been working at the GRIHA Council for more than 3 years. Ashu is an architect with a master's in sustainable architecture. She has 12 years of experience in the field of sustainable architecture, green buildings, and design. She has organized more than 60 exhibitions on environmental awareness in 15 states between 1994 and 2008. As a member of the State Level Scrutiny Committee for the Prime Minister Skill Development Scheme, she contributed to selecting deserving institutions to implement the scheme.*

The construction industry in India is a behemoth growing at a fast pace. With large- and small-scale constructions dotting the cities, it has more than 16 per cent of the Indian population working on construction sites. According to the 2011 census, the available workforce in the country is about 482 million of which about 94 per cent of the labour is employed in unorganized sectors and the remaining percentage is employed in the various organized sectors. The success of a construction project is dependent on a timely, economical, and systematic construction, to which the safety of the structure and the personnel contribute to a large extent, and this in turn is dependent on proper coordination amongst contractors, the workforce, and clients.

Their work is of a temporary nature and so is the relationship between the employer and the employee; also, the working hours are uncertain. The basic amenities and welfare facilities provided to these workers are inadequate. The construction workers lead transient lives, moving from site to site. Their usual stay at a particular site is around 3–4 years, which becomes their home during that time. Usually, these labour accommodations are makeshift arrangements, with poor sanitation, open defecation, erratic water supply, and no access to good lighting or ventilation. Mostly, the labour hutments are made of metal sheets, resulting in sweltering interiors. Global warming and climate

change have caused frequent and severe heatwaves which leave the marginalized population such as construction workers vulnerable. There have been many high-impact events due to global warming, resulting in more than 258,000 weather-related fatalities, for example, the 2015 heatwaves in Pakistan and India led to approximately 4100 mortalities.[1] Exposure to intense or prolonged heat and humidity can reduce the workers' enthusiasm and concentration, increase their irritability, and lead to heat-related illnesses.[2] It is imperative that we realize that the very people who construct our magnificent cities deserve a better treatment, and, additionally, they complete the triangle of sustainability. Being part of the unorganized sector, they have to fight for minimum wages, do not have an insurance cover, and lack access to medical facilities. In most cases, the service staff of a building, such as cleaners, sweepers, maintenance staff, drivers, and often does not have access to the basic facilities, such as dedicated toilets, or to the common toilets of the building and restroom for breaks or lunch.

The International Labour Organization aims to create worldwide awareness of the dimensions and consequences of work-related accidents, injuries, and diseases, and to place the health and safety of all workers on the international agenda to stimulate and support practical action at all levels. Furthermore, a code of practice on the safety and health in construction provided practical recommendations, guidance for safety, and health in construction.[3] The Directive Principles of the Constitution of India lay down provisions for the health and strength of the employees, and also mentions that 'just' and humane conditions of work and maternity relief must be provided. In India, departments under the Ministry of Labour and Employment deal with occupational safety and health issues in the construction sector under the head of

1 World Meteorological Organization. The Global Climate 2011–2015: Heat Records and High Impact Weather. Available online: https://public.wmo.int/en/media/press-release/global-climate-2011-2015-hot-and-wild; last accessed on October 1, 2018.

2 Hancher D. E. and Abd-Elkhalek H. A. 1998. 'The effect of hot weather on construction labor productivity and costs'. Cost Eng 40: 32–36.

3 Safety and Health in Construction, International Labour Office Geneva, 1992, Switzerland.

the Chief Labour Commission. Based on this, the National Policy on Safety, Health and Environment at Workplace has been developed, which establishes preventive safety and health culture in the country through the elimination of work-related injuries, diseases, fatalities, and disasters, to enhance the well-being of employees in all sectors of economic activity in the country. Although most firms and companies have safety protocols, guidelines, and policy in line with various Acts, the safety and sanitory conditions of this particular group are deeply concerning as it is often overlooked. Employers often view occupational health and safety as a cost to be avoided if possible, though the costs of occupational accidents and disease to employers include property damage, lost production time, lost skills as well as the cost of recruiting and retraining replacements. As a result, these indirect and direct costs are incurred by employees due to occupational injuries and diseases. The absence of adequate training of workers is another hindrance in the execution of safety norms on site. The workers are exposed to life-threatening conditions and diseases due to the absence of personal protective equipment (PPE) and clear instructions to operate on active sites. This results in accidents, delays in the construction process, and legal hassles at times. The number of fatal accidents on sites is quite alarming with falling from heights being a major cause.[4] The Indian construction labour force is 7.5 per cent of the total world labour force, and it contributes to 16.4 per cent of the fatal global occupational accidents.[5]

Since the last few years, the focus has shifted to making the construction industry sustainable with broadly three facets: economic, environmental, and social. Currently, the economic and environmental parts are being given immense attention as the world faces the constant threat of climate change, greenhouse gas emissions, and energy crisis. The green building design focuses on the climate response design, sustainable materials, reduction in energy and water consumption, better occupant comfort, and waste management. However, providing better working conditions to the labour force is an additional facet of the design. Construction workers are exposed to more health and sanitation risks than many other industries. The variety of H&S hazards that construction workers are exposed to include noise, irritant or sensitizing materials, dust, fumes, gases, and other hazardous materials which result in health risks.[6]

The Green Rating for Integrated Habitat Assessment (GRIHA), India's own green building rating system, emphasizes the importance of the labour health, safety, and sanitation, by enforcing them through a mandatory criterion. Being a national rating system developed for the country's diverse climatic conditions and construction techniques, GRIHA strives to bridge the gaps. Mandatory clauses have been integrated into the rating to ensure compliance with the most important facets of sustainability. Criterion 24 of the GRIHA Version 2015 rating mandates compliance with the NBC, 2005, safety norms for providing the necessary safety equipment and measures for construction workers; PPE, such as, harness, goggles, hard hats, jackets, and so on is mandatory. Additionally, it mandates the provision of drinking water, hygienic working and living conditions, and sanitation facilities on site as well as in labour accommodation. These parameters are explained to the project team during the orientation workshop organized upon the registration of the project. The contractor, client, and green building consultant are taken through the rating system to ensure that the entire team is aware of the requirements. Furthermore, two due-diligence site visits during the construction by the GRIHA Council officials ensure that all the safety and sanitation requirements are followed on site. The site visits are carried out when the project is at the plinth level and then at the completion of structural work. A compliance report from the project team is expected to ensure that the concerns raised during the site visit have been addressed on site.

» **Figure 1** Labour accommodation and safe sites from GRIHA registered projects

The children of the workers often wander around the construction site, which is dangerous and can cause them injuries. GRIHA encourages the provision of creche for the children of construction workers by rewarding it with a point. Safe and clean environment, as well as healthy working conditions, are necessary for achieving social justice and economic growth and are fundamental human rights ensured by the criterion. Other than the aforementioned direct benefits, the criterion inadvertently encourages good practices on site, such as the constitution of safety committees on site, regular medical

[4] Shirur S. and Torgal S. 2014. 'Enhancing safety and health management techniques in Indian construction industry'. *International Journal of Engineering and Technical Research*, 2 (4): 52–56.

[5] Kulkarni G. K. 2007. 'Construction industry: more needs to be done'. *Indian Journal of Occupational and Environmental Medicine* 11(1):1–2.

[6] Danso H. 2012. 'Construction Workers Satisfaction with Work Provision Requirement Dimensions in Ghana's Construction Industry'. *International Journal of Engineering and Technology 2* (9): 1–2.

» **Figure 2** Workers with PPE and restroom for service staff during operational phase in GRIHA registered projects

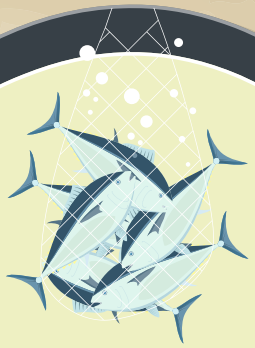
visits, and welfare facilities, to name a few. The most significant change is realized at the level of consciousness of the employers and the level of awareness of the employees. Furthermore, female workers are even more vulnerable to the adverse site conditions, such as lack of safe and clean toilets and bathing areas. The issues are get compounded in case of pregnant and childbearing women. The criterion positively influences the provision of segregated facilities for the women workers, thus encouraging equal opportunities.

GRIHA also has a criterion which caters to the provision of dedicated facilities for the service staff. With two points, Criterion 26 incentivizes provision of restrooms and toilets for the service staff of the building, thus taking care of their basic needs.

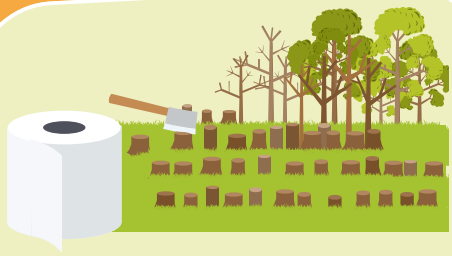
Until we understand that the people constructing our dazzling cities spend most of their lives in horrendous slum-like conditions and that their most basic human needs are callously infringed, change cannot happen. GRIHA has been working diligently towards changing the consciousness of the people involved in the construction industry in order to create a ripple effect, and each version of the rating strives to raise the bar further so as to manage the social angle of sustainability. ◻

INFO-BYTES

Recycling one aluminum can save enough energy to run a TV for three hours.



78 per cent of marine mammals are threatened by accidental deaths such as getting caught in fishing nets.



Around 25,000 trees are cut down each day just to produce toilet paper.

A glass bottle can take 4,000 years to decompose.

A hot water faucet that leaks one drop per second can add up to 625 litres a month. That's more than one person uses in two weeks!

Sumaira **Abdulali**

Unchecked and unparalled, urban growth has come to a point where the ever-increasing demands barely find sufficient sources of supply. In this lopsided equation, nature along with those at the fringes of economic development is at the receiving end. Responding to such urgencies, ***Sumaira Abdulali,*** *fearless, determined, and focused, is an environmental activist who works in the areas of noise pollution and sand mining—both lesser-known but equally formidable environmental foes. In a forthright, honest, and inspiring conversation with GRIHA, this environmental crusader shared a detailed account of her journey and discussed the way forward.*

What motivated you to work towards environmental issues such as noise pollution and illegal sand mining?

I was approached for help by fishermen whose livelihood was affected by the blocking of a road leading to the beach at Kihim, my ancestral home. Although I did not know how I might be able to help, I succeeded after a struggle to restore access to the road. This was the first time I realized it was possible to take up issues in the public interest in this manner. I had young children at the time and wanted to work in Mumbai so that I would not have to travel too much. I volunteered to help my uncle Saad Ali who was working on a primarily urban issue, noise pollution policy, in 2002, and filed public interest litigation, started to collect ground-level data, and invite public complaints. Soon afterwards, I noticed illegal sand mining at Kihim beach. In spite of my determination to work only on urban issues, I could not bear to see my ancestral area being devastated and started work on illegal sand mining. A physical attack on me by the sand mafia in 2004 made me realize the seriousness of the issue and strengthened my resolve to continue my work in this field.

What was the biggest challenge that you had to face and how did you overcome it?

My biggest challenges have been the initial lack of awareness about the issues I have taken up. Both noise pollution and sand mining were unrecognized environmental hazards and people reacted with surprise and sometimes ridicule that I chose to work on them. Gradually, an active opposition, often political, became apparent. It is now well understood that public events, where noise levels are highest, are organized for political mileage and commercial gain. Sand mining businesses tend to be risky as the stakeholders often block reform in these sectors.

What would be some of the measures you would like the government as well as individuals to implement to curb noise pollution?

I would like to see the government undertake further detailed studies on the health effects of noise and place more stringent restrictions on noise emitted from various noise sources, including recreational, traffic, railway, construction, etc. The EU[1] has recently published the most comprehensive report of this kind which makes it clear that noise is a serious health hazard. India is amongst the noisiest countries in the world and requires urgent intervention to curtail noise from all the existing sources. I would also like to see the government integrate noise as a part of urban planning and development control regulations so that all future projects take measures to restrict their own noise emissions. Recognizing that noise is a health hazard, which cuts across religion, community, economic divide, etc., individuals should limit their own noise exposure and restrict their own noisy activities.

Besides noise pollution, what are the other pressing issues you would like to work on keeping in mind the sustainable development goals?

Besides noise pollution, I have worked on illegal sand mining and have advocated the use of recycled aggregate, including debris, plastic, and industrial waste to replace unsustainably mined sand and stone. I would like the construction industry, which is currently founded on cement/concrete, to follow the change from traditional energy sources towards renewable energy in the energy sector. I would like to see the government prioritizing recycling of waste materials mainstreamed as commercially viable for construction activities through policy measures. I have also begun work on light pollution, an unrecognized health hazard.

To arrive at a solution to the various environmental issues that we are facing today in our cities, how important do you think partnerships are?

I believe that partnerships are crucial for success and have made every effort to partner with a wide variety of organizations, including other NGOs, government, lawyers, advertising professionals, educational institutions, scientists, engineers, and so on. Every different expertise or skill contributes to and enhances the overall success of mainstreaming difficult, unrecognized issues. Involvement of the public makes such campaigns a public movement which are difficult to ignore.

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

I specially admire the work of unrecognized lone crusaders in my fields of work who soldier on for years without adequate recognition. The list includes Chetan Upadhyaya who works against noise pollution in Benares and Brijmohan Yadav and

Aakash Chauhan who are fighting lonely battles against impossible odds against the violent sand mafia in UP.[2]

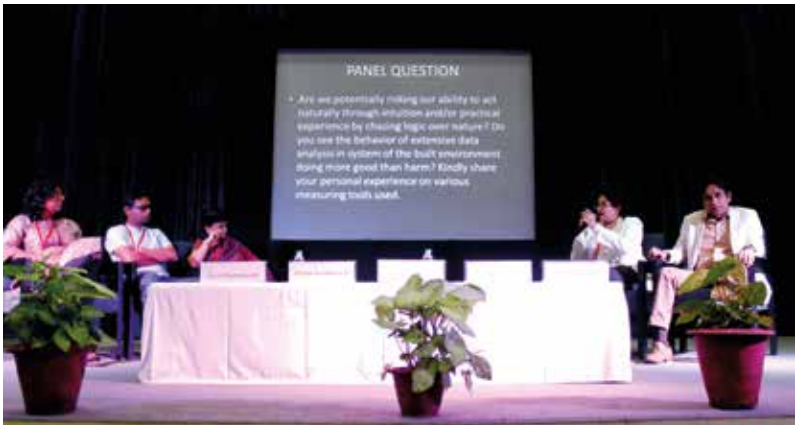
What according to you is the future of sustainability?

I feel as if the world's natural resources are depleting due to over exploitation; it is imperative to find new sustainable ways to proceed with our ambitious growth agenda, especially in developing countries like India. Fortunately, India is blessed with excellent resource persons, including brilliant scientists, engineers, etc., who are competent to address the world's most pressing problems and to provide inspiration and leadership in executing the growth agenda in a sustainable manner. We need political will to take on this ambitious and worthwhile project, which has the potential to make India a world leader in sustainability.

How do you feel AWAZ contributes to curb noise pollution?

AWAZ has worked to curb noise from all sources through ground-level data collection, awareness, policy, and implementation. AWAZ contributes by bringing about awareness amongst people, conducting studies which generate data and also facilitates appropriate policy change and better implementation through public interest litigation and advocacy with the government. Police and municipal helplines have been set up and a noise mapping study by NEERI[3] is underway. AWAZ, in collaboration with the MPCB,[4] conducts noise testing on firecrackers every year and, as a result, the decibel levels of the commonly available firecrackers have reduced. AWAZ has partnered with various NGOs, government, and other agencies, to conduct awareness campaigns against traffic, construction, railway, and aircraft noise. AWAZ has facilitated the use of noise barriers in Mumbai and advocated noise mapping to be integrated into the development control plan. At the same time, we have interacted directly with citizens and coordinated their efforts to reduce noise from the various sources in their neighbourhoods.

1 European Union.
2 Uttar Pradesh
3 National Environmental Engineering Research Institute
4 Maharashtra Pollution Control Board



Panel discussion during the session 'Tools to foster Integrated Design Approach'

(L to R: Ms Swati Puchalapalli - Director, TerraViridis Environmental Design Consultancy; Mr Sriram Kuchimanchi - Founder & CEO, Smarter Dharma; Ms. Leena Kumar - Principal Architect, Kumar Consultants; Ms Deepa Vedavyas - Principal Architect, Ecopod Architects; Mr Anil Bhaskaran - Managing Director, IDEA Centre Architects Pvt. Ltd.)

Unveiling of GRIHA EB Detailed Manual

(L to R: Ms Shabnam Bassi - Secy, GRIHA Council; Mr. Sanjay Seth - CEO, GRIHA Council; Ms K N Savithri - Chief Architect, PWD Karnataka; Mr Narasimha Raji - TERI SRC; Ms Samhita Madagobalane - MD, Ela Green Building & Infrastructure Consultants Pvt. Ltd.)

Ms Anu Tandon - Founder, The Retyrement Plan during the session 'SMEs in Green Construction'

Mr Sanjay Seth delivering the Vote of Thanks

Mr Jeremie Gaudin, Partner, Made in Earth presenting during the session 'Innovative Construction Materials'

GRIHA Southern Regional Summit 2018

Sustainable Architecture to Urban Fabric

Panel discussion during the session 'Sustainability in Existing Buildings' (L to R: Mr Sanjay Seth - CEO, GRIHA Council; Mr Avinash G - Design Consultant & EPD Coordinator, Saint Gobain; Mr Praveen Gupta - COO, Better Power; Mr Swapnil Joshi - Regional Manager - Infrastructure & Green Initiatives, Infosys; Mr Rohan M Parikh - Director, McD BERL)

> **"The best way to predict the future is to design it."**
>
> **—Buckminster Fuller,**
> American designer and futurist

The GRIHA Regional Summit 2018, Bengaluru, was held on October 4–5, 2018. Its theme was **'Sustainable Alternatives to Urban Fabric'.** Over the last decade, practices such as haphazard and poorly planned development, design and use of materials that are not environmentally responsible, and mismanagement of resources during construction have damaged the environment. There is, therefore, a need for change in the ways we build and operate buildings.

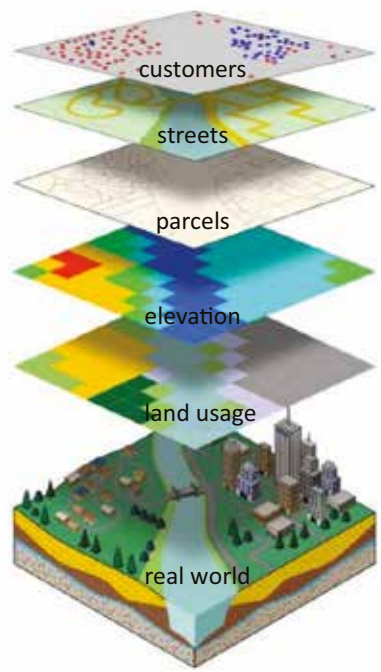
Evolution from Intelligent to Smart Transport Systems

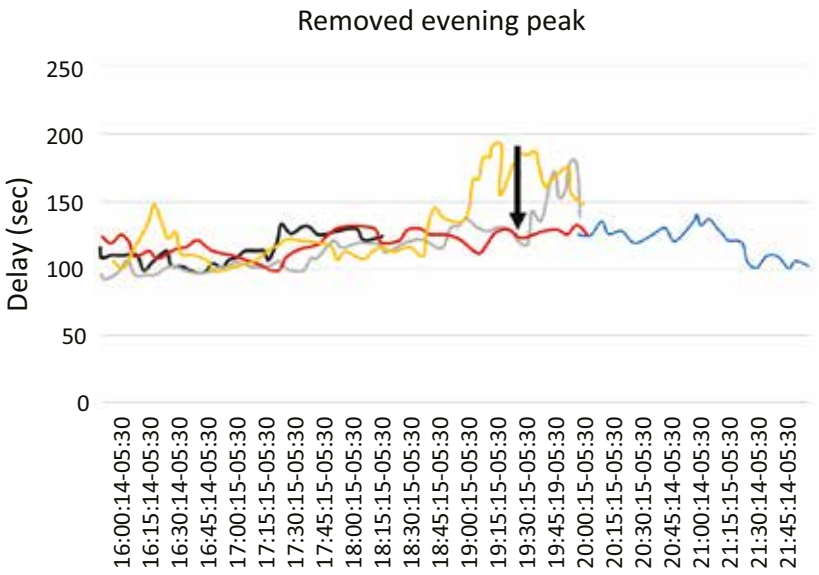
In this age of mobility-as-a-service (MaaS), reshaping the way people view travel can orient them towards using smart mobility solutions. To achieve this end, understanding the customers' mobility needs is imperative so that the infrastructure could be tailored to deliver efficient mobility services. **Vinayak Dixit** dwells on the role of ubiquitous data and connectivity in planning for the future. He argues that the convergence of connectivity, data, and models is now making it affordable to build and operate a smart and sustainable transport system.

Ar./Professor Vinayak Dixit is Director, Research Centre for Integrated Transport Innovation (rCITI); Director, Travel Choice Simulation Laboratory (TRACSLab), University of New South Wales, Sydney, Australia; and Academic Director, Insurance Australia Group (IAG). His research focuses on studying risk in the transportation infrastructure system as it relates to automated vehicles, highway safety, travel-time uncertainty, as well as natural and human-made disasters. He can be reached at v.dixit@unsw.edu.au

The dawn of the millennium was the age of intelligent transport systems, which was driven by new sensor technologies that analysed and measured the performance of transportation systems. Over the next decade, the intelligent systems evolved to smart transport systems; this involves taking appropriate proactive measures to safely and efficiently manage transport with an integrated view. If the drivers for intelligent transport systems were sensing technologies, smart transport systems have been fuelled by ubiquitous

connectivity, data, and reliable models. Ubiquitous connectivity—the provision of connectivity to everyone and everything, everywhere, every time—has enabled individuals to affordably access mobility with ease. This has created the age of mobility-as-a-service (MaaS). MaaS is a concept of considering mobility as a single need of an individual, as opposed to needs that are mapped to the different modes of transport in a disconnected manner. This has shown up as the integration of payment systems as well as last-mile connectivity. The Research Centre for Integrated Transportation Innovation (rCITI) at the University of New South Wales (UNSW) has been involved in trials in New South Wales, Australia, with partners like GoGet (the company operating the car-sharing service) and Keolis-Downer (the company operating the multimodal bus and tram services). Early results have been promising and indicate that it is imperative to understand and incorporate the mobility needs of the customer. This understanding informs how to tailor the infrastructure to deliver efficient mobility services. In fact, autonomous systems play an important role to predict service needs to plan and manage MaaS systems in real time.





Ubiquitous data has enabled affordable autonomous systems. Though the term 'autonomous systems' immediately draw images of autonomous vehicles there are several low-hanging fruits such as signal systems where significant improvements in efficiency, safety, and comfort of travel can be realized. rCITI, in collaboration with the Thane Municipal Corporation and Medulla-Soft Technologies, demonstrated significant benefits of autonomous systems that have been honed by reliable scientific models but driven by real-time traffic data for adaptive traffic signals. Queue lengths were reduced by almost 30–35 per cent, and, furthermore, evening peaks were removed in certain sections of the networks. This has been trialled in other cities and has shown significant promise.

Ubiquitous connectivity and data can be overwhelming for planning. Reliance on reliable scientific models is of paramount importance to inform directions for future planning. rCITI has been developing affordable integrated transportation models that carefully account for the convergence of electricity, communication, and economic networks. Such integrated models account for the real complexities associated with cascading impacts and feedback loops across these networks. This provides a consistent platform to evaluate transportation projects in a comprehensive manner while accounting for the complexity. rCITI has deployed and used these models to inform decisions in Asia, Australia, and the US. Furthermore, rCITI is home to one of the world's largest interactive multimodal driving simulator virtual reality laboratories that allows planners and engineers to understand the behavioural impacts of their interventions. This provides planners an affordable tool for rapid prototyping.

These trends have significantly reduced the costs associated with transportation and mobility tools. This has resulted in a more accessible and affordable transport system. While congestion and safety-management technologies have become affordable for engineers, models and tools for rapid prototyping and planning for smart cities have become affordable for planners. Overall, the convergence of connectivity, data, and models is now making it affordable to build and operate a smart and sustainable transport system. □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Planning Smart, Healthy, and Accessible Cities

Aligned with the theme of the GRIHA 2018 Summit, **Professor Chris Pettit** and **Dr Simone Z Leao** propose fostering a global partnership amongst international leading organizations in Australia, the UK, USA, and India to better understand and manage sustainable and healthy urban transport/mobility. Along with a better, more holistic understanding of smart, healthy, and accessible cities, they urge asking the right questions to gauge the impact of a global partnership.

Professor Chris Pettit is the Inaugural Chair of Urban Science, Faculty of Built Environment, University of New South Wales (UNSW). Professor Pettit's expertise is in the convergence of the fields of city planning and digital technologies including Geographical Information Sciences. He can be reached at copettit@unsw.edu.au

Dr Simone Z Leao is a senior lecturer in City Analytics at UNSW. Her research explores forms of using data and applying analytics in the domain of smart cities to promote sustainable and equitable development and improve quality of urban life. She can be reached at s.zarpelonleao@unsw.edu.au

Project Vision

Congestion, air pollution, and sedentary behaviour are some of the adverse effects of current transport and mobility patterns in cities worldwide, mostly related to the predominance of private cars with combustion engines. Improvements have been made in the past few decades in the engineering of cars are fuels; in the provision of public transport; and in the contemporary renascence of walking and cycling as healthy modes of transport, but they have largely been offset by the increasing access to cars by a growing population concentrated in urban areas.

Current technological advances in ICT are significantly changing the way several urban infrastructures operate, are provided to, and used by the population. In the transport and mobility domain, examples include electric cars, autonomous vehicles, car rides as a service, dock and dock-less bike share services, and a myriad of apps that aim to facilitate citizens to find their way in an optimized way though those diverse and interconnected systems. The future of mobility appears to be heading to a significantly different pattern in the so-called smart cities, which combines large inherited transport infrastructures (roads, trains, bus freight, etc.), with new systems. Therefore, at the same time as we are trying to solve the problems of the current transport systems, researchers, urban planners, and citizens are also faced with uncertainties of what would be the good and adverse effects of the new systems and use patterns. One advantage of the present context is that these transitions and associated uncertainties are happening in a moment when goals for sustainable, healthy, safe, equitable, and resilient future in cities are in the global agenda, and, therefore, these principles should guide the design, implementation, and monitoring of transport and mobility systems.

In this context, modelling and simulation become an essential approach for researchers and a tool for planners as it is the only way of testing possible scenarios of the configuration, patterns of use, and social and environmental outcomes of new mobility systems. Getting insights of what the consequences of the use patterns of transport and mobility systems in the future will bring to society is essential to guide decisions at the present and near future. Examples of relevant questions include: How the wider adoption of electric cars will affect air pollution? How autonomous vehicles will impact the travel mode choices and, consequently, the travel mode share? How 'mobility as a service' will affect the repurposing of redundant infrastructure, such as on-street parking, which can potentially be replaced by improving the infrastructure for walking and cycling? How future mobility will balance the will for more walking and cycling with reduction of people's exposure to air pollution on streets? How will this increase in 'active travel' contribute to the increased well-being of urban citizens?

Models, however, are only as good as the data that go into them. Cities and regions that are 'data-rich' in particular topical areas (e.g., transportation, air quality, or health) develop complex models that take advantage of the information available, but robust modelling tools are lacking for 'data-poor' cities, regions, and topical areas.

Project Aim

This project aims to develop a critical integrative approach required to underpin the next generation of data-driven modelling and decision-support focused on transport and mobility, which can be applied to realize smart, sustainable, healthy, and resilient cities. The proposed project will connect transport and mobility research, which, generally, are developed exclusively. The full functionalities of the proposed approach will be demonstrated in this project through case studies exploring different urban processes and patterns associated directly or indirectly to transport and mobility. They include Sydney, London, Phoenix (the PLuS Alliance university members), and Pune (part of the 100 Smart Cities Mission in India). These case studies bring the required variety of urban contexts in terms of transport systems, air quality, and resilience, for a global impact. The case studies will explore the use of such smart city metrics for measuring the performance of cities.

This project will begin to test the robustness of simple modelling tools for data-poor environments. We ask which data are needed in order to understand and benchmark/evaluate progress in our cities. To accomplish this, 'gold standard' indicators will be developed for city health and accessibility based on information available in the relatively data-rich environments of the PLuS Alliance cities. These indicators will be then stripped down into versions based on much more limited datasets from those same cities. Tests of the spatial and temporal robustness of the results against the gold standard indicators will provide a measurement of the efficiency of such simplification. This is particularly relevant to benchmark integrated analysis on mobility, air quality, urban health,

» **Figure 1** UNSW big data analytics, the 30-minute city dashboard for Sydney
Source https://cityfutures.be.unsw.edu.au/cityviz/30-min-city; last accessed on November 15, 2018

» **Figure 2** Work on air pollution modelling by King's College London
Source http://www.londonair.org.uk/LondonAir/Default.aspx; last accessed on November 15, 2018

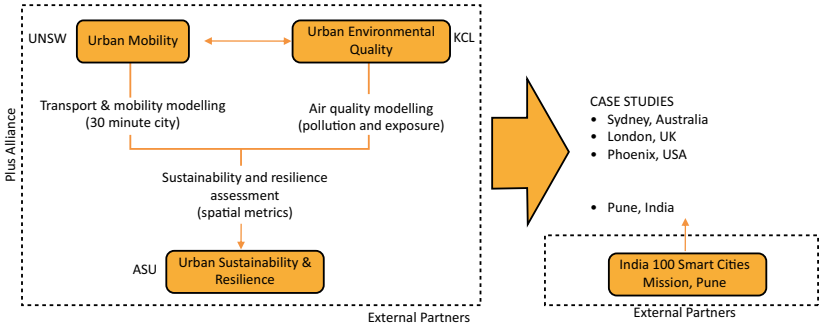
and resilience that work on limited data contexts, and, therefore, are more globally applicable.

Fostering a Global Partnership

The PLuS Alliance initiative brings internationally renowned expertise in the fields required to develop and deliver this project proposal. The University of New South Wales research team will be responsible for developing the transport and mobility modelling approaches to evaluate how the case studies perform in terms of the '30-minute city' goal (see Figure 1), and also to assess potential outcomes from different scenarios. The King's College London research team will be responsible for the air quality modelling associated to transport infrastructure and behaviour, and the assessment of human exposure to air pollution based at a personal exposure level (see Figure 2). Arizona State University will contribute with the development and assessment of metrics for urban sustainability and resilience associated to the intersection of urban mobility and air quality. The three universities will work closely in order to promote an integrative approach, in which data and models are compatible and interoperable. Sydney, Phoenix, and London will provide the background for the exploration of how varied contexts of urban form, transport infrastructure provision, and mobility patterns affect the sustainability and resilience of cities. For making the comparative analysis, more meaningful in a global level, the city of Pune in India will be also added in this project as case study. Pune is part of the India's '100 Smart Cities Mission'. Figure 3 illustrates the project framework for research partnership.

Moreover, in the pursuit to facilitate the global partnership, the project team has created an open-city data platform, known as PluS Data (see Figure 4) which will support FAIR data (findable, accessible, interoperable, reusable). The Geonode open-source geospatial content management system was chosen as the data publishing platform for the PLuS Data, the primary location where data for the project will be published. This platform provides an intuitive user interface for uploading and documenting data, for data discovery, and download, and it automatically provides standard web service Application Programming Interfaces on the published data.

» **Figure 4** PluSData store, an open data platform for publishing city data
Source http://data.plusalliance.org/; last accessed on November 15, 2018



» **Figure 3** Framework for research partnership

Concluding Remarks: This is Just the First Step

A workshop is being held during the GRIHA 2018 Summit in Delhi with key and leading Australian and Indian stakeholders associated to urban planning, transport and mobility management, healthy cities, smart cities, and sustainability. This is the first step of a global partnership to design the programme and plan the analytical and comparative case studies across the four continents. Although results are yet unavailable, this article aims to showcase the inception of a robust global project with envisioned high-impact outcomes. ◻

JOINING THE CLOTH PAD REVOLUTION WITH ECOFEMME

EcoFemme is a women-led, social enterprise dedicated to being a scalable project with a demonstrable impact that can be an example of how business and social responsibility really can go hand in hand. Founded in Auroville in 2010, the goal is to create

environmental and social change through revitalizing menstrual practices that are healthy, environmentally sustainable, culturally responsive, and empowering for women around the world.

EcoFemme seeks to create a truly holistic approach to menstruation through integrating ethical business practices, production processes that engage rural women as cloth pad producers and culturally sensitive, life-affirming education about the menstrual experience.

The organization produces and promotes cloth-based, washable menstrual pads, an alternative menstrual product, which lasts for approximately 75 washes. Cloth menstrual pads are rapidly gaining acceptance around the world for their health, environmental, and cost-saving benefits. A woman who switches from using disposable to reusable menstrual pads can prevent an average 600 disposable pads from being thrown away during a 5-year period. A single disposable sanitary napkin takes an estimated 500 to 800 years to decompose. In a country like India with undeveloped waste disposal mechanisms and a vast population; using cloth pads can have a dramatic impact on waste reduction.

EcoFemme pads are made of organic cotton flannel which is not only reusable but, when cared for properly, can reduce the risk of infections and irritation. The pads are produced in five units, namely, AVAG (an Auroville-related NGO), Cocoon (an Auroville-related women's production unit), Blossoms (an Auroville unit), Ektha (Bangalore, women's producer company), and Clothing Crafts. All these units take on other stitching works as well and are not directly employed by EcoFemme. All five units ensure fair wages and safe working environments to the women employed there. EcoFemme supports the idea of women generating their own income and considers it to be a crucial step towards bringing empowerment to underserved communities. Additionally, for every EcoFemme washable cloth pad sold outside India, a pad is donated to a girl in rural India as part of the Pad for Pad programme. Four donations are clubbed together to form one kit that consists of four pads, a travel pouch, an educational booklet, and care instructions. Pads are offered as a free choice to girls, ages 10–19, who come from economically disadvantaged backgrounds. The Pad for Pad sessions are designed to give girls the skills to manage their periods hygienically and with dignity, and the chance to relate to menstruation as a normal, healthy experience.

EcoFemme is currently reaching an average of 280 girls per month and partners with organizations across India to widen its reach. The programme is also regularly evaluated to receive the girls' feedback and assess the usage and acceptance of the programme. In October 2013, the organization launched its Pads for Sisters programme to make the products accessible to economically disadvantaged women (above age 19) at a subsidized price and through organizations working with women. This programme had significantly grown in the past year.

In 2016/17, 14,500 subsidized pads were sold directly and through partners in India. The target for 2017/18 is 24,000 pads.

In addition to the Pad for Pad and Pads for Sisters programmes, EcoFemme is also developing educational workshops and training for menstrual health educators and have so far conducted two such sessions for some of the ambassadors and peers in the field.

Scaling up

EcoFemme through its products, programmes, and training aims to generate critical reflection and greater awareness in the media around menstruation. Responding to the urgency to retell stories surrounding menstruation, women's bodies, and the ways in which we live with ourselves and the environment, the organization prioritizes awareness as much as its outreach. The organization believes the current work on menstrual hygiene in India and around the world has opened a potent space for reflection on the very nature of development work and what it means to be a sustainable business. EcoFemme hopes to fill this space by being a locally inspired and guided initiative that allows women and girls to live healthily and with dignity, armed with information about their bodies, and in tune with their own inner wisdom and power. ◻

Role of Façades in Energy Conservation and Operational Cost Reduction

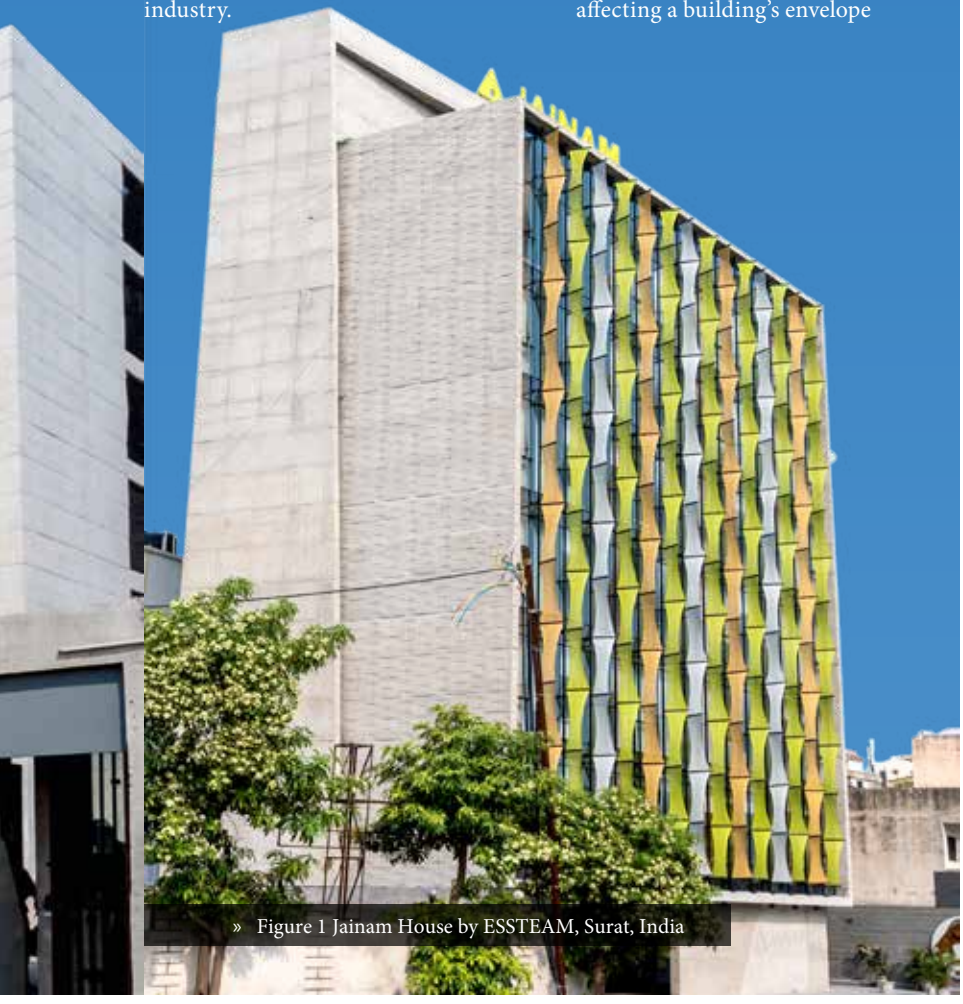
The construction sector is touted to be one of the fastest-growing sectors and the largest consumer of energy. In this article, **Hardik Gupta** draws our attention to the importance of a façade—usually the front of a building—and the ways in which it can contribute in reducing costs, saving energy, and in being mindful of occupants' comfort and well-being.

» KGK Diamond Factory by ESSTEAM, Surat, India

Hardik Gupta *is an energy and sustainability consultant with more than three years of experience. He is been accredited by the GRIHA, USGBC LEED and IGBC for his expertise in green building. His areas of expertise include green building certification energy and daylight simulation, HVAC commissioning, testing adjusting and balancing. He can be reached at guptahardik22@gmail.com*

Buildings are the largest energy consumers in the context of the prevalent construction industry practices, which enable a unique, boundless opportunity to protect the environment and conserve energy in a sustainable way. The combined crises of energy source depletion and significant climate change are generating a sense of urgency and fundamental changes in many industries, including the construction industry.

Heating, air conditioning, and lighting loads can be reduced in many ways; notable amongst them are the proper design and selection of building envelope components. The façade is one of the most important contributors to the energy expenses and comfort parameters of any building. It is also an essential consideration in a building's design, engineering, and operation. The parameters affecting a building's envelope energy performances may be designed variables (e.g., configuration of the exterior wall) or design inputs imposed by the context of a project (e.g., the site's outdoor temperature).

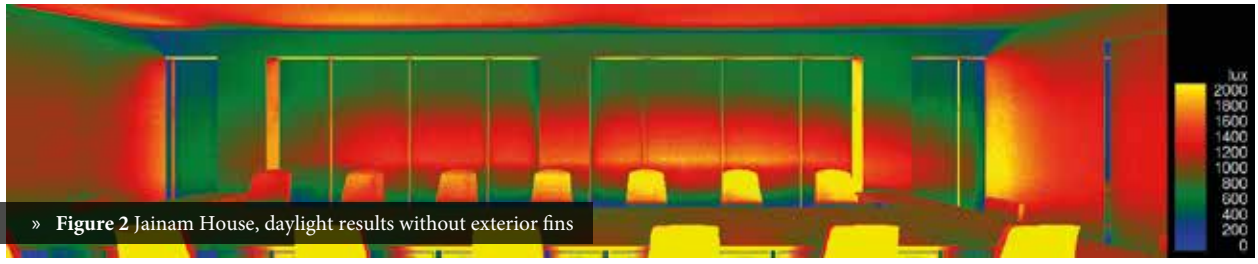


» Figure 1 Jainam House by ESSTEAM, Surat, India

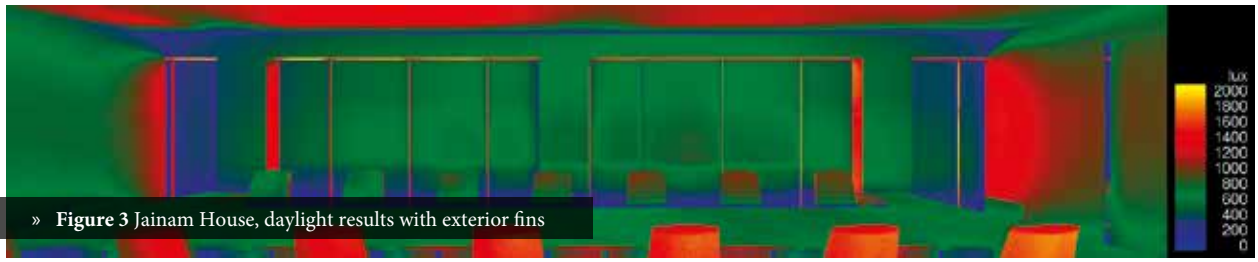
Building envelopes differentiate a building's inner environment from the outer environment. Additionally, building envelopes have a dominant impact on a building's energy balance and can, therefore, play a big role in making the change towards sustainable, energy-neutral buildings. Façades not only shape the appearance of a building, they also have the potential to redirect and filter daylight, provide natural ventilation, manage heat transfer, enhance occupants' productivity, create visual and physical connections between the inside and outside and, most importantly, reduce a building's operating costs.

Solar radiation is the main source of heat gain in a building. According to research, the importance of a façade can be seen in the way it prevents solar radiation from entering a building's interiors. These studies show that the application of overhangs reduce the electricity consumption by up to 5 per cent on a high-level floor since the lower floors would be in the shadows of the surrounding buildings. The thermal insulating the envelope and the partitions would be effective in reducing the yearly space cooling load by up to 38 per cent.

The façade designing for Jainam House has been done using computer technology. From a solar illuminance study, the façade was analysed under various true conditions as per its geological location and climatic



» **Figure 2** Jainam House, daylight results without exterior fins



» **Figure 3** Jainam House, daylight results with exterior fins

conditions. The optimum variant is implemented in the project (see Figure 1). The illuminance results have been shown in Figure 2 and Figure 3, which proves to be lower down the surplus solar light ingress, thus resulting in largely lowering the heat gain and making it aesthetically unique and appealing too.

There are several studies that have investigated a building's skin, envelope, and façades whereby different terms have been used to label a building's exterior elements. Powler and Kelbaugh (1990)[1] defined a building envelope as any surface that separates a building's thermally-conditioned interiors from its environment. According to this definition, a building envelope includes roofs, exterior walls, floors, ceiling slabs, and foundation walls and each plays an immense role in building sustainability and determines how buildings respond to different requirements. Exterior walls and roofs consist of four elements, namely, structural elements, exterior finish, exterior colour, and exterior or interior insulation. A high-performance window system with good thermal and optical properties is important in determining thermal comfort and illumination levels. In recent years, significant advances have been made in glazing materials, including low-emissivity (low-e) coatings, insulating glass units, aerogels cavity fills, and thermally break frames. Thermal properties can be measured by U-value, K-value, and solar heat gain coefficient, and optical properties can be evaluated by visual transmittance. The primary objective of a façade designing should be to minimize the energy use while simultaneously enhancing the comfort and well-being of a building's occupants, and, secondly, to identify some of the practical considerations related to the successful design and implementation of advanced façade solutions. Installing high-quality fenestration and shading features, such as landscaping (trees and hedgerows), overhangs or fins, light shelves, and blinds, can save excess energy which otherwise would have been used for heating and cooling purposes as well as, if designed properly, can save on electrical lighting. Shading features should be installed atleast on the east, west, and south-facing façades. The facade design decisions can be achieved through the process of understanding the problem, identifying the potential design measures, setting up models, running an annual cooling load analysis, and making design decisions.

The amount of energy lost through the envelope is influenced by both design and materials. Design considerations affect the placement of windows and doors, the size and location of which can be optimized to reduce energy usage. Decisions regarding the appropriate material also play a vital role in determining the energy performance. Therefore, energy-efficient building envelope design measures can be generally separated into two groups, namely, architectural design measures and material design measures.

Architectural design measures

- Optimize the building form to minimize heat gains through surface.
- Orient building towards north–south exposures to take advantage of north–south daylighting.
- Turn long façades towards the prevailing winds to enhance natural ventilation.
- Employ solar shading devices to block direct solar radiation.
- Use innovative wall type, for example, double-skin wall.
- Proper design of the window area and size (window-to-wall ratio).
- Install light shelves to penetrate daylight deep into the building.

Material design measures

- Insulate the exterior wall and roof.
- Use high-performance concrete for its thermal mass.
- Use reflective exterior wall/roof finishes to reduce solar heat gain.
- Incorporate windows with low-e or reflective coating.
- Incorporate windows with tinted or multiple layers of glazing.
- Incorporate windows with thermally improved frame.

To maintain a comfortable indoor climate, fixed and operable shading systems are used in northern Europe to limit solar heat gain, and operable windows are implemented to allow natural ventilation. European buildings, typically, have a narrow floor plate which enhances the effectiveness of natural ventilation and daylighting and reduces the need for cooling and electrical lighting.

[1] Powler and Kelbaugh. 1990.

» **Figure 4** Hills Nursery School by ESSTEAM, Surat, India

The prevalence of narrow floor plates amongst European office buildings can be explained by a combination of factors: working condition standards, economics, and cultural expectations in terms of access to daylight and operable windows. Natural ventilation enables the elimination of expensive ventilation and cooling systems. In fact, air conditioning is used very selectively—typical office spaces in northern Europe are not air conditioned, with the exception of conference and other meeting rooms, which are often subject to higher internal loads, and are thus more likely to need mechanical cooling. In contrast, typical US office buildings, especially those constructed in the last three decades of the twentieth century, have sealed envelopes and rely on mechanical heating and cooling to maintain uniform interior temperature conditions.

The Energy Conservation Building Code of India, Bureau of Energy Efficiency, American Society of Heating, Refrigerating and Air-Conditioning Engineers, and the Department of Energy have begun programmes that seek to incrementally reduce building energy use to net zero over the next 15 to 20 years.

Effective façade strategies can range from simple passive solutions with low or moderate window-to-wall ratio and fixed exterior shading to highly complex design solutions with automated shading and ventilation elements, which can further improve performance but require additional operation and maintenance. The incorporation of these strategies provides the opportunity to minimize the need for electric lighting, cooling, and heating energy and enhance occupant well-being and productivity.

Simple design strategies (proper building massing and orientation, moderate window-to-wall ratio, high-performance glazing, fixed exterior shading, etc.) are relatively healthy design solutions and have a predictable impact on energy use. These, therefore, should be pursued whenever possible.

The most intelligent façade is as passive as possible.

Integration of facade systems with the building systems provides an opportunity to maximize performance benefits and cost savings. For example, a high-performance façade can allow for a reduction in peak cooling loads, and thus provide the opportunity to implement a smaller HVAC system and/or a low-energy alternative, which can translate into increased energy savings, reduced initial costs, and HVAC system operation and maintenance savings.

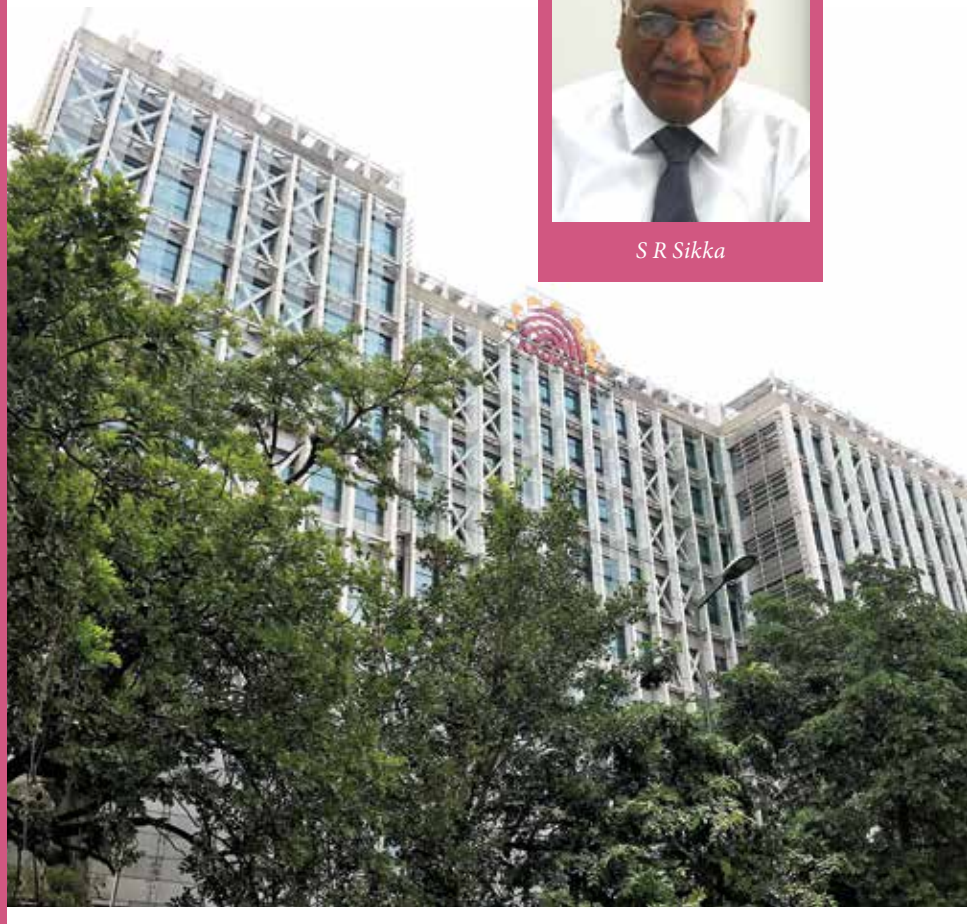
The next generation of façades consists of multifunctional and highly adaptive systems, where the façade, between the interior and exterior environment, is able to change its functions, features, or behaviour in response to the transient performance requirements and boundary conditions, with the aim of improving the overall building performance. ◻

THE UNIQUE IDENTIFICATION AUTHORITY OF INDIA— HEADQUARTERS AT NEW DELHI

S R Sikka

The Unique Identification Authority of India (UIDAI) had a vision to have its headquarter building—an example of marvellous structural architecture, an energy-efficient and sustainable building and landmark—in New Delhi. To achieve this endeavour of acquiring an environment-friendly building, UIDAI has been closely associated with GRIHA Council along with a team of highly skilled architects, project managers, contractors, and other building service consultants. GRIHA Council helped UIDAI to learn and implement various sustainable and climate-responsive strategies during and post-construction of the UIDAI Headquarters building.

The journey to attain a GRIHA 5-star rating for UIDAI Headquarters was not an easy task and has faced many challenges. Located on Bangla Sahib road, near Gole Market, Central Delhi, and with a 1.099-acres (approx.) site area, the location had many constraints, including limited ground coverage, height restriction, building orientation, parking space availability, existing tree location, and so on. However, the GRIHA team was very supportive and advised the project team from time to time in meeting the requisite criteria requirements and provided the best possible solutions to build an energy-efficient building through their site visits and review reports. Initially, the building aimed for a 4-star rating; however, with the knowledge shared by the GRIHA team and with a few innovative solutions implemented by the project team, UIDAI was able to achieve GRIHA's coveted 5-star rating.



The UIDAI Headquarters building showcases the implementation of state-of-the-art technologies such as robotic shuttle parking (resulting in lower carbon emissions) and green walls along the site periphery. This green wall, apart from the aesthetics and shade, also helps in lowering the ambient temperature during the hot Delhi-summers, thereby, providing comfort to the building occupants.

The prompt review and timely delivery of due diligence reports prepared by the GRIHA team for the various criteria under the rating, further accelerated the process and enabled UIDAI to achieve the desired result on time.

Apart from handholding and educating the project team to achieve their sustainability goals during the planning, designing, construction and operation stages of UIDAI Headquarters, GRIHA team also enlightened the project team in the ways in which labour safety and sanitation can be improved during construction. Overall, working with GRIHA Council and their interaction with our project team was a very enriching experience.

Building India's Urban Cities

A Step towards Achieving UN SDGs

In this article, **Sangeeta Prasad** says that by 2030, cities are likely to house 40 per cent of India's population. Building cities is capital-intensive and requires long-term planning. Nevertheless, how we build our cities will define how India can achieve its sustainable development goals. It must incorporate resilience to mitigate climate risk and productivity loss, ensure inclusivity, and be biodiverse and socially vibrant.

Sangeeta Prasad is the CEO of Mahindra Lifespace Developers Ltd. She is also a member of the Group Executive Board, Mahindra Group, and Co-chairperson, Group Diversity Council, Mahindra Group. Sangeeta is a frequent speaker at prestigious industry and international events, including the 2015 United Nations Climate Change Conference, or 'COP 21', in Paris and the eighth Clean Energy Ministerial (CEM 8) held in Beijing in 2017. Achevening scholar, she has to her credit a General Management Programme at INSEAD, Fontainebleau, and has also attended programmes at Harvard University. She can be reached at sangeeta.prasad@mahindralifespaces.com

In 2015, the 193 UN member states adopted the new Sustainable Development Goals (SDGs) comprising 17 goals, 169 targets, and 100 global indicators.

Earlier, between the years 2000 and 2015, the Millennium Development Goals (MDGs) provided an important development framework and achieved success in areas such as poverty reduction, health, and education in developing countries. The key difference is that the SDGs amount to an inclusive framework for broader adoption built on the success of the MDGs. They span the emerging focus areas relevant to a new world order—new areas of climate change and disaster risk, economic inequality, peace and justice, and sustainable consumption and innovation.

It is a framework for all: the corporate sector, governments and individuals all have a role to play. Also, it does not differentiate between developed and developing nations. The SDGs help define the 'sustainability context' of all our anthropogenic activities, identify risks and opportunities, and define a roadmap for action towards a sustainable world for all. The framework covers climate change action and enables a circular economy: the two biggest opportunities of current times.

The SDGs succeed the MDGs in providing a global framework leading to a sustainable world by 2030.

The Case for a Sustainable Built Environment

By 2030, cities are likely to house 40 per cent of India's population.[1] Building cities is capital-intensive and requires long-term planning. However, how we build our cities is what will define how India can achieve its SDGs. The 'how' must incorporate resilience to mitigate climate risk and productivity loss, ensure inclusivity, and be biodiverse and socially vibrant. This is the vision for India.

Buildings in India account for 40 per cent energy use, 30 per cent raw material use, 20 per cent water use, and 20 per cent land use; they also generate 30 per cent and 20 per cent of solid waste and water effluents, respectively. The real-estate sector is responsible for 24 per cent of India's annual CO_2 emissions,[2] contributing to global warming and poor air quality. Is India ready to mitigate the environmental fallout of its real-estate sector?

The good news is that we have a massive opportunity for change that can result in long-lasting, positive shifts. Urban India will need approximately another 2.4 million homes to be built by 2020; moreover, a significant portion of India's built infrastructure lies in the future. Therein lies our opportunity to ensure that our built infrastructure is responsive; resilient; and able to transform how we live, work, and play.

The private sector can play a key role in accelerating this transformation and helping India leapfrog into a future wherein the building sector's contribution to greenhouse gas (GHG) emissions is curtailed as per the expectations of the 1.5-degree pathway.[3]

Impacts of Construction-Sector Value Chain on SDGs

1 Retrieved from https://www.mckinsey.com/featured-insights/urbanization/urban-awakening-in-india; last accessed on November 1, 2018.

2 Retrieved from https://www.mahindralifespaces.com/media/3749/the-sustainable-housing-leadership-consortium-launches-greenhomes-campaign-for-20-of-india-s-new-homes-to-become-green-by-2022.pdf; last accessed on November 1, 2018.

3 Retrieved from https://climateanalytics.org/briefings/1-5c-key-facts/; last accessed on November 1, 2018.

» **Figure 1** SDGs on which the sustainable built environment (SBE) has the greatest impact

» Figure 2 SDGs which are potential opportunities for the SBE

A sustainable built environment involves ethical land acquisition; siting as per climate, water risk, and seismic risk; the incorporation of passive and active strategies in building design; integrated planning of mobility with last-mile connectivity; ethical and conscious procurement; and the mitigation of construction-phase impacts via low-carbon green homes.

There are two aspects of mapping business activities with the global goals.

1. Impact of corporate activities on SDGs' - performance (Figure 1)
2. SDGs which could lead to green growth opportunities (Figure 2)

It is important that we map the value-chain impacts of the sector to identify the negative impact and accentuate the positive impact (Figure 3).

The built environment consists of the system of roads, housing, bridges, and so on which is human-made. In contrast, the natural environment comprises flora/fauna and natural physical features such as mountains, rivers and lakes. The built environment is the hub of all economic activities as it provides shelter, work spaces, and cultural hubs; is interconnected, and exists in the natural environment. It draws from the environmental resources for building, water, and energy; it also affects nature via the waste generated and emissions (air pollutants and GHGs) and impacts biodiversity. As humans interact with each other in the built environment, they develop spaces where cultural activities thrive amidst strong communities. Table 1 highlights our understanding of whether an SDG is a risk or an opportunity for the construction sector.

Table 1 SDG risk and opportunity mapping for construction sector

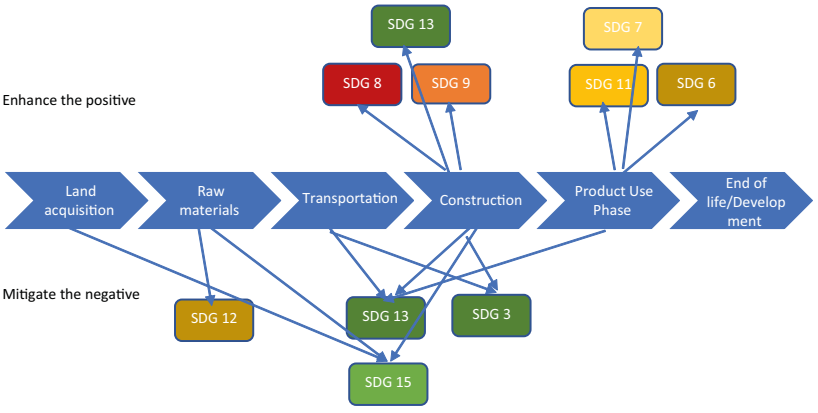
SDG	Value chain stage	Risk	Opportunity
SDG 12: Responsible consumption and production	Raw materials, construction	Negative impacts can be reduced by responsible sourcing material, waste mitigation	Low embodied carbon materials, eco alternatives for the built environment
SDG 8: Decent work and economic growth	Transportation and construction		To create opportunities for employment
SDG 13: Climate action	Transportation and construction, product-use phase	Emissions generated during various life-cycle stages	Net zero, low-carbon green homes
SDG 7: Clean energy for all	Use phase		Renewable energy grid connectivity, on-site solar
SDG 15: Life on land	Construction, land acquisition, raw materials	Biodiversity impacts	Opportunity to integrate natural environment and built environment in design
SDG 11: Creating sustainable cities and communities	Use phase		Building integrated sustainable resilient cities
SDG 3: Good health	Construction and use phase	Occupation safety during construction phase, Use phase indoor-air quality, glare, comfort	
SDG 8: Decent work and economic growth	Construction		Opportunity to add to economic growth and decent employment opportunity
SDG 6: Clean water and sanitation	Construction		Opportunity to create facilities for STP and sanitation
SDG 9: Industry innovation	Construction		Opportunity for research on new materials with low embodied carbon, circularity

Our Role in Delivering India's SDGs

As mentioned earlier, the private sector is expected to witness numerous opportunities to help India meet its SDGs by 2030. Of the 60 major opportunities to deliver on the UN SDGs, six are within the purview of the construction sector: affordable housing, energy-efficient buildings, resilient cities, durable and modular buildings, smart metering, and water and sanitation infrastructure. Global goals offer an economic opportunity of at least $12 trillion and over 50 per cent of this opportunity lies in the developing world.

Sustainable urbanization remains at the core of everything we do at Mahindra Lifespaces. It influences our choice to be present across three distinct lines of business across the built environment—Premium Residential, Integrated Cities (Mahindra World City) and Industrial Clusters (ORIGINS by Mahindra World City), and Affordable Housing (under the Happinest brand). We are driven by our mission of 'transforming urban landscapes by creating sustainable communities', which in turn ensures the triple bottom-line performance of our organization. We are not only focused on low-carbon-emitting buildings, but also ensure zero discharge (water and waste), which mitigates indirect emissions. Our activities relate to SDGs 3, 6, 8, 11, 13, and 15.

Mahindra Lifespaces is a founding member of the voluntary, private sector-led initiative Sustainable Housing Leadership Consortium (SHLC) convened by the IFC, which is working towards mainstreaming green homes in India. The aim is for at least 20 per cent of India's new housing developments to be green by 2022 (this impacts SDG 11). This platform will help in identifying scalable and efficient technology that reduces the cost of going green, thereby impacting SDG 9. This dovetails into our research efforts where we have partnered with The Energy



» **Figure 3** SBE value-chain mapping to SDGs

and Resources Institute (TERI) to establish the Mahindra TERI Centre of Excellence (CoE) for Sustainable Habitats. Its vision is to build a greener urban future by developing innovative science-based, open-source, and energy-efficient solutions tailored to Indian climates.

We espouse urban development that is sensitive to the needs of the environment. In doing so, not only can we address the contemporary urban issues, but will also be able to secure a prosperous and harmonious future for generations to come. Mahindra World City (MWC) embodies our approach to urbanization—via the development of pioneering integrated cities built on the ethos of 'Livelihood, Living and Life', and world-class industrial clusters (ORIGINS by Mahindra World City). MWC, Jaipur, is the first project in Asia and the world's largest to receive Climate Positive Development Stage 2 Certification from the C40 Cities Climate Leadership Group (C40), a global network of large cities taking action to address climate change. These relate to SDGs 13 and 11.

SDGs as a Business Opportunity

The Mahindra Group *is a* $20.7 billion[4] federation of companies that enables people to rise through innovative mobility solutions, driving rural prosperity, enhancing urban living, nurturing new businesses, and fostering communities. Sustainability is aligned to our philosophy: rise for Good by enabling stakeholders to rise, rejuvenate the environment, and build enduring business. Mahindra & Mahindra Ltd is committed to EP 100 (doubling energy productivity by 2030),[5] is the first Indian company to announce an internal carbon price, and is committed to becoming carbon neutral by 2040.[6] It is focused on becoming water positive and zero waste to landfill, and promoting biodiversity.

SDGs are a framework for value creation that help in realizing our philosophy 'Rise for good' by providing a contextual understanding of impacts and opportunities in our aspiration of improving our world. It helps us lay out a plan to get there. Our businesses contribute to the SDGs in numerous ways. As the Mahindra Group chairman Anand Mahindra affirms, 'SDGs are the single-biggest business opportunity for the next couple of decades.' Most business impacts relevant to the business activities relate to SDGs 3, 6, 7, 12, 13, and 15. We believe in mitigating negative impacts through conscious action and enhancing the positive impacts through green business growth. Most new businesses in Mahindra are in sectors aligned with the SDGs for green growth. These include smart mobility and electric vehicles (SDGs 9 and 12), solar energy (SDGs 7 and 13), affordable housing, integrated cities and industrial clusters (SDGs 13, 15 and 11); and water management (SDG 6), amongst others. Climate science and growing awareness of the impacts of environmental pollution are fuelling sustainability globally. Businesses cannot survive in an unsustainable world. Businesses are nurtured by social contract and ecosystem services provided by nature. 'Incremental sustainability' does not work anymore. In all our endeavours we strive to accentuate positive impacts and mitigate negative impacts. We believe businesses are part of a larger social ecosystem, and it is their responsibility to give back to society a sustainable world. We at Mahindra Lifespaces believe now is the time to '#RiseForGood', to drive positive change in the lives of all our stakeholders to make this world a better place. □

[4] Retrieved from http://www.mahindra.com/resources/investor-reports/FY19/Announcements/PressReleases01062018.pdf; last accessed on November 1, 2018.

[5] Retrieved from https://www.theclimategroup.org/what-we-do/news-and-blogs/new-global-ep100-initiative-to-increase-energy-productivity-welcomes-mahindra-as-first-indian-company; last accessed on November 1, 2018.

[6] Retrieved from https://www.globalclimateactionsummit.org/mahindra-mahindra-to-go-carbon-neutral-by-2040/; last accessed on November 1, 2018.

Corporate Sustainability

Practices on Green Work-Life Balance

In this article, **Ankush Gupta** and **Soumya M** discuss the concept of a green work-life balance to facilitate environment-friendly behaviour in both life domains, that is, professional life and personal life. The purpose of their research is to frame a conceptual work-life balance framework for the employees working in the IT industries. This framework will help organizations to identify the problems being faced by the employees and how they can implement Green HRM practices so that the employees will not be under any kind of stress and pressure. Such practices will help employees to keep a balance between their personal and professional life.

Ankush Gupta is Assistant Manager – HR. He has been working with TCS for more than 4 years now and is currently with Talent Engagement group (HR) since the last 1.5 years. His interests include writing research papers, watching sports, CSR activities, quizzing, etc. He can be reached at ankush.gupta3@tcs.com

Soumya M is Assistant General Manager – HR. She has been working with TCS for more than 12 years, and is currently working as the HR Head for a Business Group. Her interests include sketching and cycling. She can be reached at soumya.m@tcs.com

The meaning of Green Work-Life Balance concept is to facilitate environment-friendly behaviour in both life domains, that is, professional life and personal life. The main objective of the Green Work-Life balance is to have balance in personal and professional life of the employees using Green HRM practices. For any organization, an employee is the real asset and human resource executives play a very crucial role in handling those resources. In today's scenario, especially in IT companies, the stress level amongst the employees has increased to a greater extent. The reason for the same is that they are unable to keep a balance between their personal life and work due to strict project deadlines, increase in expectations, work pressure, etc. In our research, we have studied about Green Work-Life balance and some of the Green HRM practices, which can help employees to keep a balance between their personal and professional life. These practices can help employees to reduce their stress levels and they can work with a more calm and composed mind. Finally, we have tried to devise a Conceptual Work-Life Balance Framework for employees of IT companies for their effectiveness and efficiency.

Objectives of the Research

- To study about the concept Green Work-Life Balance
- To study some of the Green HRM Practices adopted in most of the IT industries today and their benefits
- To frame a Conceptual Work-Life Balance Framework for employees of IT companies for their effectiveness and efficiency.

Research Methodology

This research is purely based on secondary data. Data were collected through extensive review of literature, such as previous journals, articles, various organization websites, magazines, newspapers, research papers, periodicals, etc.

Discussion

Objective 1: Green Work-Life Balance

According to Viola Muster and Ulf Schrader (2011) Green Work-Life Balance is the settlement or the balance between private life and work life with regard to environmental values, behaviour, and attitude. So, it helps the employees to reduce imbalance between their work and private life. The Green Work-Life practices include supple work timings, car sharing, wellness programmes, telecommunicating, etc.

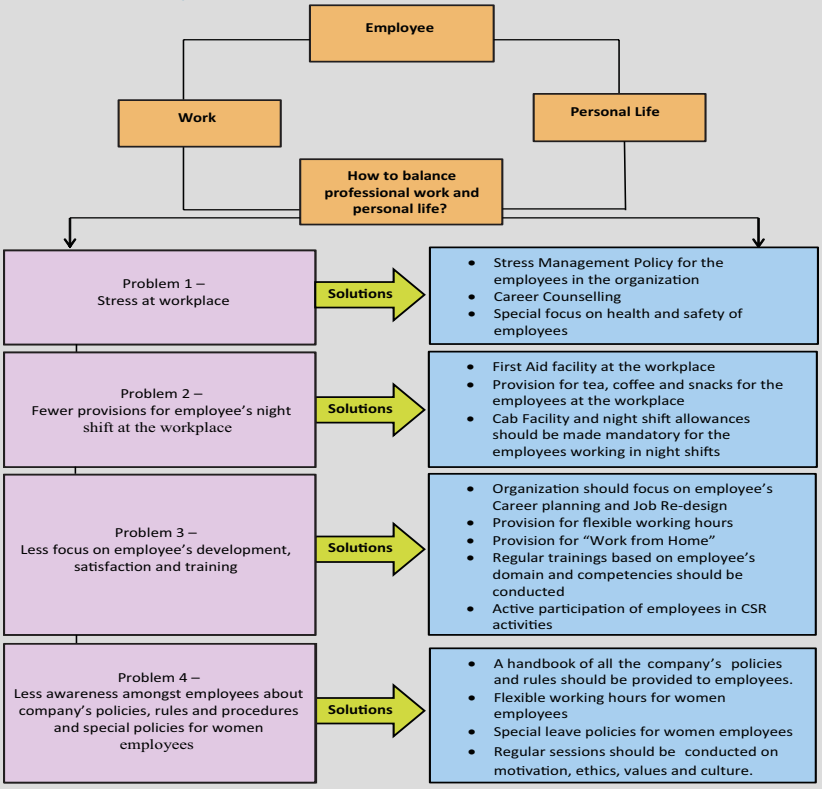
Objective 2: Some of the Green HRM practices adopted in most of the IT industries today and their benefits

Green HRM Practices for maintaining Green Work-Life Balance	Description/Benefits
Reduce Workplace Pressure	Strict work deadlines sometimes create a lot of stress amongst the employees. This will create an imbalance amongst their personal life and work. Deadlines should be flexible so that employees can deliver on time without any stress or pressure. Agile workplace will all help the associates to collaborate and work towards achieving their targets.
Job Sharing Idea	Two persons can share one task in an organization. This will reduce their workload and thus they can give proper time to their families also.
Wellness Programmes	Wellness programmes, such as team outing, sports camp, yoga, etc., should be organized on a regular basis for employees to keep them mentally fit and free from any kind of stress.
Green Learning and Training Programmes	In today's scenario, most of the employees working in IT industries are in favour of web-based training because they can access the same from their homes also. Organizations can save cost and resources using green learning techniques.
Green Targets in Performance Appraisal	The main objective of green target is to contribute towards the environment apart from the yearly project targets. Merging green targets with the normal work targets will make employees responsible towards the work and the environment will become happy, healthy, and free from stress.
Green Rewards	Organizations can present rewards to employees in the form of plants, bio-friendly cups, bags, e-certificates, e-coupons, etc., to employees at their workplace. This will help organizations to induce green objectives amongst the employees and such rewards will make employees stress-free and green citizens. According to a survey, green citizens are happy, calm, and they have a stable work and personal life.
Telecommuting	Work from home facility will help employees to work with less pressure and thus they can deliver the best.
Teleconferencing	It will help organizations and employees to cut travel cost and also reduce lot of pressure.
Family Get Together	Organizations must organize special functions for employees and for their families at the workplace. Such get together functions will help employees and organization to strengthen their bond.
Employee Assistance Programme	Regular assistance and counselling should be provided to employees so that they can concentrate more on the work and remain free from any tension.
CSR Activities	Active participation of employees in CSR activities will make them responsible towards the environment, society, and organization.

(Cont...)

Green HRM Practices for maintaining Green Work-Life Balance	Description/Benefits
Time-out Zone	Organizations should allot time-out zones spanning for about 40–50 minutes for the employees so as to enable them to pursue activities of their choice while at work. This would create a happy mood amongst the employees.
Transport Facility for Employees	Organization's transport facility will help employees to conserve their energy, save time, which would ultimately lead to lesser family tensions.
Nature of Work and Job Location of Employees According to Family Conditions	Organizations can sometimes give easy task and home locations to those employees whose family conditions are not strong. Such steps will make employees loyal towards their organization.
Use of Eco-friendly Coffee Cups	Employees can make use of bio-friendly coffee cups in the workplace instead of plastic cups. This will make them responsible towards the environment and organization. Responsible citizen is an important asset for the organization and for their respective family.
Sessions on Global Warming and Environment Protection	Organization must organize sessions for their employees based on global warming and environment protection. This will make employees responsible towards the environment and their work.
Give something to the society policy for the employees	Organizations should make a policy for the employees that they have to give at least 5 hours per week to the society in the form of participating in tree plantation drives, organizing blood donation camps, etc. Such policies will make employees happy, responsible, and free from stress.

Objective 3: A Conceptual Work-Life Balance Framework for employees of IT companies for their effectiveness and efficiency



The only way to restore the problem of environmental degradation is to revive the ecosystem which once supported it.

Conclusions

- Green Work-Life balance/HRM practices will help organizations to strengthen their bond of trust between them and employees.
- This research can help employees especially of IT companies to balance their personal and professional life.
- This conceptual framework will help those IT organizations who are not aware of the problems being faced by their employees.
- These Green Work-Life balance/ HRM practices will make employees responsible and loyal towards their organization, society, and environment.
- Such practices will save our environment and ecology. □

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Green Alchemists in India

The collection, transport, treatment, and disposal of waste is known as waste management. A health and environment hazard, waste needs to be effectively managed, else it turns toxic and causes air, water, and ground pollution. **Ar. Taru Rawat** in this article draws our attention to the importance of waste collection and mentions a few initiatives that have been undertaken to combat this problem.

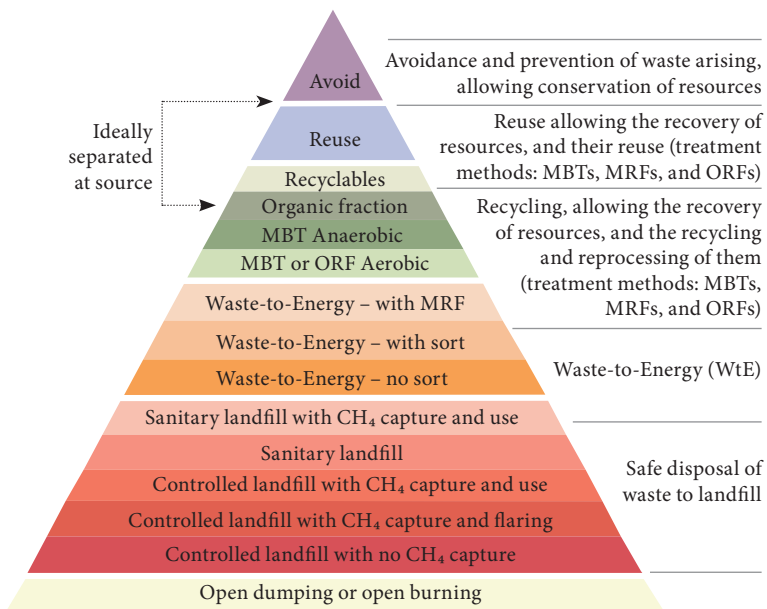
Ar. Taru Rawat, *a GRIHA Certified Professional, is working with M Moser Associates in design and sustainability projects in Corporate Interiors. She has more than six years of work experience, including a four-year stint with a French design studio. She can be reached at tarurawat@outlook.com*

Background

Waste management has always been a concern considering the stories we read every day wherein marine life is endangered and the landfills are a menace. We have a large knowledge network equipped with software, theories, and researches catering to waste management but it is not sufficient to actually deal with the problems in real life. Approximately 65 million tonnes of garbage is created every year and not more than 30 per cent is recycled; shockingly, at least 75 per cent can be easily achievable. The main awareness and understanding required here is the type of waste generated and the level to which it can be recycled.

The concentration of urban population in a few large cities has led to a tremendous pressure on civic infrastructure systems, such as water supply, sewerage and drainage, solid waste management, parks and open spaces, transport, and so on. These have resulted in the city environment deteriorating considerably and in

several cities problems, such as traffic congestion, pollution, poverty, slums, crime and social unrest have risen at an alarming rate.[1] The quest to build sustainable cities, and the importance for global development, is also putting mayors and local government leaders at the forefront of international politics. Copenhagen, for example, has gained considerable attention and investment by aiming to be the first capital city in the world to be carbon neutral.[2]



» **Figure 1** Waste pyramid chart

A formation of an entity or a partnership at a vertical and horizontal level amongst the local bodies and local government or the local government with the central government has become an urgent call. Apart from the statutory awareness and need, certain incentives or tax redemptions from the government have motivated companies and individuals with 'waste to wealth' start-ups.

National Mission on Sustainable Habitat

'Development without destruction' is the path India needs and frameworks laid down by National Environmental Policy and National Action Plan on Climate Change (NAPCC) provides a sharper focus towards waste management. The eight missions as summarized in Figure 2 focusses on a sustainable habitat and green India, which can be achieved with the most basic measures for reducing landfills. Landfills by themselves are a major aspect wherein most of the waste gets accumulated, thus creating health issues.

The government has invested significantly in solid waste management projects over the years and has provided `25 billion ($ 397 million) as grant in aid to states and urban local bodies specifically for SWM through public–private partnerships.[3]

Recycling and urban waste management is a major component

» **Figure 2:** The NAPCC's 8 missions; the 9th mission, which is a national bioenergy mission, has been added recently

of ecologically-sustainable economic development. India has a higher rate of recycling waste as compared to other countries. This national mission includes major R&D programmes, focusing on biochemical conversion, wastewater use, sewage utilization, and, wherever possible, recycling options.[4] This mission also seeks to promote and achieve sustainability of habitats through improvements in the following aspects:

- Energy efficiency in buildings
- Urban planning
- Improved management of solid/ liquid waste, including recycling and power generation
- Modal shift towards public transport and conservation

The first step towards the successful implementation is the development of sustainable habitat standards, which aim at increasing the above-mentioned aspects in accordance with the Energy Conservation Building Code, National Building Code, and Environmental Impact Assessment norms. The adoption of these standards would be incentivized through existing schemes like the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and other schemes of the Government of India and shall avoid unsound

[1] Retried from https://smartnet.niua.org/sites/default/files/resources/National20Mission%20on%20Sustainable%20Habitat.pdf; last accessed on November 6, 2018.

[2] Retried from http://unsdsn.org/wp-content/uploads/2016/07/9.1.8.-Cities-SDG-Guide.pdf; last accessed on November 6, 2018.

[3] Retried from http://www.moef.gov.in/sites/default/files/INDIA%20INDC%20TO%20UNFCCC.pdf; last accessed on November 6, 2018.

[4] Retried from http://www.moef.nic.in/downloads/home/Pg01-52.pdf; last accessed on November 6, 2018.

regulatory practices or unreasonable costs for any sector.[5]

Initiatives

The Ministry of New and Renewable Energy website has a SPIN application (an online application for solar photovoltaic [PV] installation) wherein one can apply for a solar PV installation; furthermore, the Ministry of Power, too, has a website which sells energy-efficient appliances under the Unnat Jeevan by Affordable LEDs and Appliances for All (better known as UJALA) scheme. In the list of initiatives, one must not forget the Green Earth Movement (popularly known as GEM), a market place by the Government of India, for promoting local and sustainable products. While schemes such as the JNNURM, National Mission on Sustainable Agriculture (NMSA), and National Clean India Fund (NCEF) are initiatives from the government, there have been private set-ups as well; a few of these have been summarized below:

- **Kyaari:** The Jaipur-based 21fools have created a venture called beej kapas, that is, recycled paper (made with pre-consumed cotton waste) with embedded seeds which grow into plants after its use is over. Calendars embedded with seeds of tulsi, neem, and various flower categories can be potted once it, too, has been used. To know more, visit www.21fools.com.
- **Eco-friendly idols:** From immersing Ganesha idols on Ganesh Chaturthi to replacing the existing idols with new ones on every Diwali, the cycle continues. Fortunately, some start-ups such as Ecoganpathi, Tree Ganesha, and Green Practices are selling eco-friendly idols, which can be sown and grown into a plant, rather than plastic idols which typically end up near auspicious trees, thus adding to the existing waste in that area.
- **Daily Dump:** This website can make every home a start-up with self-set-up composters that help manage and convert household waste into something useful. From selling khambas to 'sorting stations' and zero-waste products, they also have special containers to segregate used batteries, lights, etc., so that they do not poison the land or water with their leakages. Explore their website www.dailydump.org.
- **Code:** In an interview with The *Better India,* Dr Vishal Rao from the HCG Cancer Centre said, 'Cigarette waste is a huge environmental hazard today. Most of the cigarette filters are carcinogenic and can contaminate drinking water, too, if disposed of in our water bodies'.[6]
  Code, a start-up from Noida, came up with the idea of recycling cigarette butts. They not only make sure that every part of the butt is recycled but also pays people for these leftover butts from 700/kg to 80/100gms.
- **Electronic recycling:** There is always a way to recycle waste food, water, etc., but if one wonders what an old phone, tablet, or laptop can fetch, one may simply reach out to Karma Recycling. This is a licensed collector and segregator by the Government of India and helps to recycle old gadgets. Most of their refurbished products are sold on ebay. Another such brand is Cerebra IT Solutions that helps in the recycling of old gadgets.
- **Waste Roots**: This social enterprise gives the option to exchange old newspapers/papers in return for plants. The waste thus collected goes to a registered recycler and not landfills. Currently, they are catering to Noida and the nearby areas but plan to expand.
- **Edible Cutlery:** With plastic flooding in and out of our wallets, kitchens, cars, phones, and given its durability and weightlessness, it seems to have taken over our lives. India is one of the top 10 plastic-polluting nations. Initiatives like Bakeys create edible cutlery made of sorghum and various other edible flour, which is a little on the expensive side but has a zero carcinogen count.
- **I am not PLASTIC:** Envigreen and BioGreen are one of the initiatives which ban the use of plastic and substitute it with eco-friendly biodegradable bags. These bags are made from natural starch and vegetable oil derivatives. Apart from the fact that they are non-toxic as well as biodegradable, BioGreen plastic bags decompose in approximately 160 days and can be used as manure for improving the quality of agricultural lands. Using these can result in lowering the use of chemical fertilizers, which are toxic. Moreover, since BioGreen plastic bags are made of organic waste, they help in getting rid of thousands of tonnes of municipal waste which usually end up in landfills. The entire product range is quite affordable and can, therefore, be a sustainable alternative to plastics.[7]
- **Help Us Green**: This is an initiative by a Kanpur-based company which collects flower waste from places of worship and even the Ganga River and repurposes it as vermicomposting, bathing bars, and incense sticks.

Conclusion

The aim is to achieve sustainability and if there is a process for peer-to-peer learning, or where businesses learn from the experience of other businesses, it enables a smoother sustainability journey. Mandatory implementation of certain codes will help reduce the consumption. The presence of stakeholders, NGOs, chambers of commerce, and associations in the business industry will boost the sustainability sector. It is necessary we take stock of the situation and rise to the challenge of forging a green future, else there will be little to pass on to the future generations. The main approach should be to measure and manage because now we know 'what gets measured gets managed'. □

[5] National Mission on Sustainable Habitat.

[6] Retried from https://yourstory.com/2017/01/code-noida/; last accessed on November 6, 2018.

[7] Retried from http://greenubuntu.com/biogreen-bags-indias-perfect-sustainable-alternative-to-toxic-plastics/; last accessed on November 6, 2018.

Dilip Jose

GRIHA, LOOKING BEYOND NUMBERS TO PROVIDE THE BEST HEALTHCARE POSSIBLE

For patients and their families, the hospital experience is often a central point in their lives—it's a place where their child was born; where they received life-saving treatment; rejuvenating therapy; or where their beloved died.

While designing such crucial buildings it is imperative that we go beyond the traditional cases for designing green buildings (i.e., financial savings through energy and water) and focus on sustainability issues that also add value to patients' healthcare.

GRIHA has helped us achieve the goal of making a 'green hospital' by providing a framework for arriving at a sustainable design solution that balances the requirements of patient care philosophy with principles of economic and ecological sustainability whilst allowing future flexibility. GRIHA has helped us in creating an efficient design, and, most importantly, has introduced a mindset to think green in the long term and not just at the design and construction stages.

Swati Puchalapalli

OUR EXPERIENCE **WITH GRIHA**

GRIHA is by far the best certification tool for India. The requirements of GRIHA are sufficiently flexible to accommodate various local practices and construction materials whilst being simultaneously stringent to ensure proper implementation.

Is has managed very well to strike a balance between the established practices and emerging concepts, both nationally and internationally. It is also flexible and logical with its approach while looking at non-standard applications of its requirements, constantly going back to its fundamentals to understand the holistic impact on the overall sustainability of the project. As the rating is continually revised every few years to take into account the latest technological developments as well as performance metrics, it has always been up to date.

MANIPAL HOSPITAL WHITE FIELD, BANGALORE

While the GRIHA certification process is definitely more difficult comparatively, the rigour has consistently proven to be effective in the long run. The GRIHA team has always been available to answer any questions we had at any stage of the project. Their initial kick off meeting with the client,contractors and all other stakeholders of the project helps in setting the tone for the team and their regular visits during the construction phase ensure the momentum is maintained throughout the project.

The comparison of energy and water use against nationally acceptable benchmarks helps in continually monitoring the performance of the buildings constantly. As clients can see the improvement in the actual performance of buildings against other similar buildings, they have been inspired to improve every new building they construct even further. All our clients are competitive and want the best for their organizations and for the environment. The learnings they take from each GRIHA-rated project only makes them want to beat the sustainability standards set in their previous building. This increased competitiveness and drive towards net-zero buildings is a great start.

Buildings under PAT Regime

While there are several carbon mitigation schemes targeting the industrial sector in India, very few such schemes are available for the country's building sector. The Perform, Achieve and Trade (PAT) scheme—which is the Bureau of Energy Efficiency's flagship programme for Indian industries—is now seriously considering including buildings, especially commercial establishments, in the PAT scheme. **Abdullah Nisar Siddiqui** and **S. Vikash Ranjan** weigh in on the merits and challenges of including hotels in PAT, since they are among the most energy-intensive buildings.

Abdullah Nisar Siddiqui *is associated with the Indo-German Energy Programme (IGEN), GIZ Building Project, as Technical Expert. Prior to this, he has worked with the United Nations Development Programme and the Bureau of Energy Efficiency (BEE) for promoting energy efficiency in buildings and the implementation of the Energy Conservation Building Code. He can be reached at Ar.nisar@outlook.com*

The building and industrial sectors in India account for approximately 70 per cent of the total energy consumption in the country. It is interesting to note that several mandates and programmes are run by agencies to bolster the carbon mitigation scheme in industries. However, there are very few such schemes in the building sector, and even those are implemented in a discreet manner. The Bureau of Energy Efficiency has launched a flagship programme for Indian industries, called the Perform, Achieve and Trade (PAT) scheme, which seeks 70 per cent coverage of the total 36 per cent of energy consumption by the industrial sector. After the successful implementation of PAT (Cycle I) for industries and a successive rolling cycle thereafter, it is now high time to seriously consider including buildings in the PAT scheme.

The initial plan is to cover the commercial establishment in the very first phase under the PAT regime of the

S. Vikash Ranjan *is Programme Manager in IGEN, GIZ Building Project, and supports the BEE, Ministry of Power, in policymaking, climate change, carbon budgeting, and energy efficiency. He can be reached out at vikash.ranjan@giz.de*

building sector as a whole. Although the residential sector's energy consumption accounts for almost 24 per cent of the building sector's total energy usage (35 per cent), the mandate in the Energy Conservation Act, 2001, proposes for the inclusion of the commercial establishment under PAT due to the following reasons:

- Ease of establishment of specific energy consumption
- Data streamlined for energy consumption and efficiency
- Documents and data availability
- Data accessibility
- Regular energy audit
- Awareness of energy efficiency and conservation

Under the commercial building category, there is further classification of different non-residential building typologies—Hospitality, Educational, Healthcare, Shopping Complex, Business, and Assembly—that are broadly based on the National Building Code of India. Energy efficiency depends on many variable parameters in different building typologies, including energy use with technologies and building material. Thus, the potential of energy efficiency under PAT totally depends on the technologies used in the installed equipment, appliances, and efficient use of power sources. It hardly fetches any savings in the building envelope apart from some innovated shading system, glazing, or insulation. However, energy conservation and efficiency do have a bigger role in the overall reduction in specific energy consumption (SEC) of the total building concept under PAT.

When the zero down began to determine which commercial establishments should be included under PAT, the following sub-sectors were considered for data audit in terms of energy consumption to find out the threshold limit:

1. Hotels
2. Data centres
3. Shopping malls
4. Airport terminals

Hotels under PAT

Hotels play a very important role in India's prosperous tourism industry and will continue to grow rapidly during the next decade. When compared to residential or office buildings, hotels usually constitute a relatively small proportion of the building stock in an economy. Nevertheless, both local studies and research conducted in other countries reveal that hotels are among the most energy-intensive of all building categories. Consequently, their energy use and environmental impact can be quite large.

Electricity is the primary energy source, which is used to power HVAC, lighting, vertical transportation, and almost all equipment. Though gas is mainly used for cooking and boilers, due to its greater availability for commercial use, it is commonly used for power generation as well. In hotels where only electricity and gas are consumed, the average proportions of both the fuels are 91 per cent and 9 per cent, respectively. Some hotels also use diesel for standby electricity generation and hot water for steam generation. The former incurs less consumption, as diesel is consumed in regular test-runs of emergency generators to ensure that they work when in need as well as during load-shedding.

The survey of energy usage in hotels estimated the energy-savings potential which could be achieved by the application of practical retrofitting techniques, materials, or energy-efficient systems. Hence, due to the hotel industry's overall structure and ease of data information, this sub-sector was considered to be a fit case for inclusion in PAT in 2018.

Challenges

Yet there are several challenges to estimating the SEC and targets for the hotel industry. The first challenge was the adoption of a unit of comparison between hotels because of wide acceptance of the EPI methodology in terms of kWh/m2/year, while for gate-to-gate approach in PAT, it was necessary to adopt a terminology which should be accepted for different sources of energy like power, oil, and gas in the boundary. Hence, a widely accepted terminology in PAT, such as SEC w.r.t. built-up area in thousand square metre, has been developed and this is called the toe/'000m2/year terminology for specific energy comparison.

SEC—one of the energy-performance indicators of a process—is defined as the net energy consumed in tonne of oil equivalent (toe) per thousand square built-up area after deducting the basement parking area in m2.

However, several factors should be considered to make a meaningful and logical comparison. Occupancy rate in hotel rooms; footfalls in recreational areas like gyms, spas, and the like; meeting-hall capacity utilization; power-mix change; laundry services; ETP installation; and gas consumption in the dining area are some of the factors that can make this comparison difficult. Depending on how these factors change over the assessment period, the hotel's designated consumers (DCs) may sometimes get undue advantage or even get penalized for no fault of theirs. Therefore, a way to overcome the aforementioned problem is 'normalization', which can be defined as a process of rationalization of an establishment's energy usage to take into account the changes in quantifiable terms that impact energy performance under equivalent conditions over the assessment period.

A building's energy performance is dependent on quantifiable variables, which should be normalized so that the actual energy performance could be quantified/compared. Hence, normalization is the biggest challenge while calculating the SEC under GtG methodology and shall be handled very carefully in the pro forma itself. □

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For Addressing Urban Heat Island Effect

An urban heat island (UHI) is an urban or metropolitan area that is considerably warmer than its surrounding rural areas due to human activities. In this article, **Ar. Ketaki Karmarkar** discusses the causes of the urban heat island effect (UHIE) along with its effects on the environment. She feels that it is necessary to address the UHIE and suggest mitigation measures to provide human comfort, improve air quality, reduce pressure on thermal power plants, and thus reduce air pollution while designing and developing theurban scape.

Ar. Ketaki Karmarkar, Manager (PCMC), GRIHA Council, is involved in the rating of training and outreach for the purposes of wider dissemination. She also handholds various municipal corporations to release incentives for the GRIHA-rated projects located in the Pune region. An architect with a master's degree in sustainable architecture, she has earlier worked with a green building consultancy firm based in Pune. She can be reached at ketaki.karmarkar@grihaindia.org.

According to researchers, rapid urbanization combined with changes in the land-use pattern between 2000 and 2014 have led to about 1.8 °C warming of Bhubaneswar in Odisha as compared to the surrounding non-urban areas. This effect is known as the UHIE. As the name suggests, it is a modulation in air temperature observed due to the accumulation of excess heat in the atmosphere, associated with urban areas. Mostly, we experience warmer atmospheric temperatures in urban areas as compared to rural areas due to human-made developments; this difference in temperature constitutes the UHI. The temperature difference is usually is greater at night than

during the day, and is most intense when winds are weak. One can literally experience the UHI effect during summers and winters in cities. The annual mean air temperature of a city with a population of one million or more can be 1.8–5.4 °F (1–3 °C) warmer than its surroundings, and on a clear, calm night, this temperature difference can be as much as 22 °F (12 °C).

There are two types of UHIE: surface UHI and atmospheric UHI. The surface UHI present throughout the day gets more intense during day and in summers. The atmospheric UHI is small or non-existent during the day, but gets intense at night and in winters. Figure 1 showcases variation in the surface and atmospheric air temperature during day and night as per the development.

Causes of UHIE

The UHIE builds up due to the use of impervious surfaces, which absorb direct solar radiation, due to exposure to direct sunlight. The majority of urban areas comprise roads, paving, and higher built mass predominantly made up of concrete and asphalt as compared to undeveloped towns. These materials have high thermal heat conductivity and low heat reflectivity due to darker colour. Hence, such impervious surfaces absorb solar heat during daytime and release it back into the environment during evening or night-time, when the atmospheric temperature becomes comparatively cooler, following the rule of heat flow. As a result, the atmospheric air temperature increases and the surroundings become warmer during the evening and night-time.

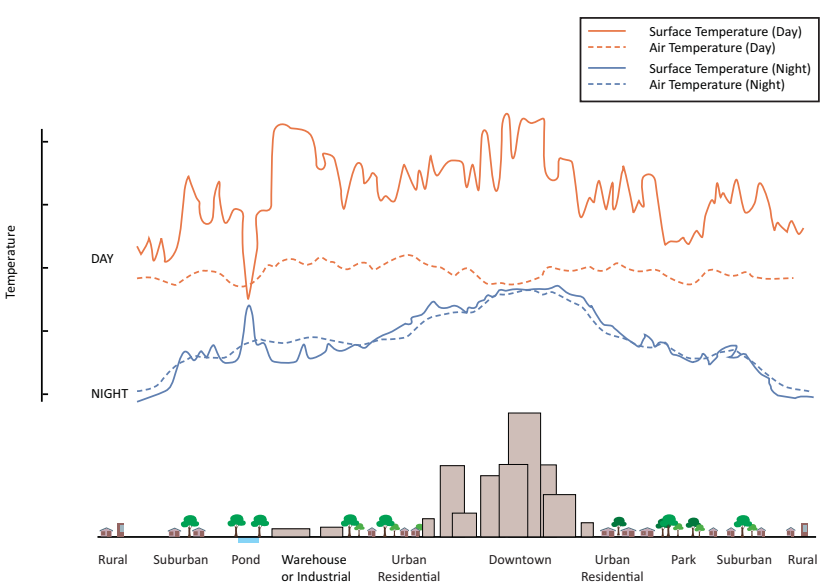
Another important reason that causes the UHIE is the lack of tree cover in urban areas. Often trees are cut due to urbanization, despite the fact that they serve a dual purpose in the UHIE reduction. Firstly, trees obstruct direct solar radiations and provide shade due to which the air temperature reduces. Another role of trees is in evapotranspiration, which is a sum of evaporation and respiration. This property of trees helps in adding moisture into the environment, further reducing the atmospheric air temperature. Tree cover also helps in reducing the carbon dioxide concentrations in the air, thus reducing air pollution in urban areas. Urban trees also have other advantages, such as improving people's mental and physical health. 'Trees in urban areas help ward off pollution, providing a long list of benefits for people and the planet,' says Rolf Skar, forest campaign director for Greenpeace, USA.

The majority of urban development comprises high-rise buildings, which have multiple surfaces getting exposed to solar radiation, absorption, and reflection. This also adds excess heat into an environment. Building geometry also contributes to increase in the UHIE. Additionally, if materials used for such surfaces are of high thermal conductivity, such as glazing, aluminium, and concrete, then the, surface temperature increases further during daytime. Waste heat from automobiles, air conditioning, industries, and other sources also contributes to the UHIE.

Effect of UHIE on Environment

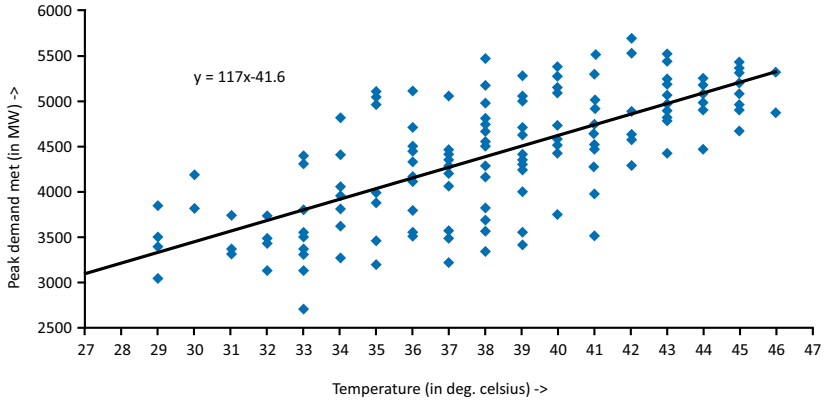
The UHI affects the environment in many ways. It demands more energy for cooling, which adds more pressure on the electricity grid during the peak period, that is, during summer afternoons. Analysis for the peak demand met in Delhi during the summer season (April–June in 2014/15) has been published by Power System Operation Corporation Limited, New Delhi. It is found that with a rise of in 1 °C in the temperature the demand of Delhi increases by approximately 120 MW owing to the increase in domestic and commercial air-conditioning load. Figure 2 showcases the slope of the best-fit linear regression for summers.

Increased use of electricity further increases air pollution, due to the emission of greenhouse gases (GHGs) such as sulphur dioxide, nitrogen oxides, particulate matter, carbon monoxide, and mercury. These pollutants are harmful to human health and adversely impact air quality, for example, acid rain. Further, thermal power plants also emit GHGs, which contribute to global



» **Figure 1** Variations of surface and atmospheric temperatures.

Source https://www.epa.gov/sites/production/files/2014-06/documents/basicscompendium.pdf; last accessed on November *3, 2018.*



» **Figure 2** Change in peak demand met in Delhi with maximum temperature in summer season (April–June)

Source https://www.epa.gov/sites/production/files/2014-06/documents/basicscompendium.pdf; last accessed on November *3, 2018.*

climate change. Increased daytime surface temperatures due to the UHI reduce night-time cooling, and higher air-pollution levels can affect human health by contributing to general discomfort, respiratory difficulties, heat cramps and exhaustion, non-fatal heat stroke, and heat-related mortality. Various satellite-measured mapping tools were used to measure the UHIE for urban areas.

Other than increased air temperature, the UHI can affect microclimate of urban areas, including change in wind-flow patterns, development of clouds, change in humidity levels, and precipitation rates. The UHI also affects the quality of water. Warmer pavement and rooftop surfaces (with higher surface temperature) transfer their heat to stormwater, which drains into storm sewers and raises water temperatures as it is released into streams, rivers, ponds, and lakes. As a result, it affects the biodiversity in water.

Mitigating UHIE

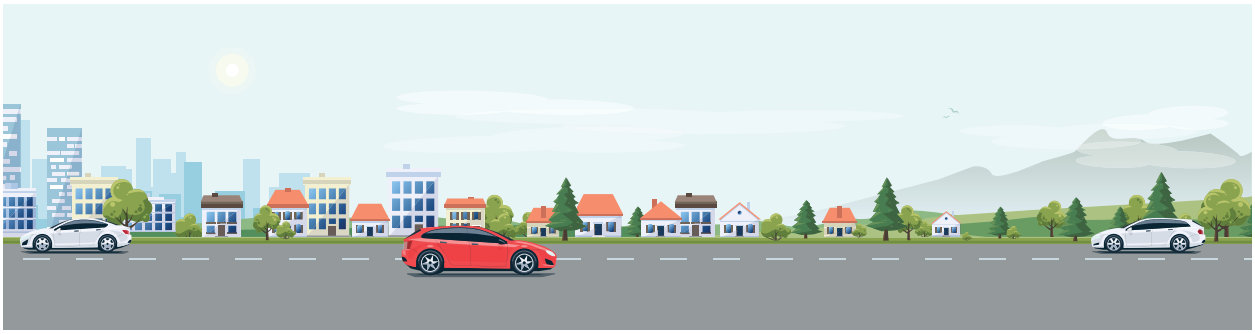
It is imperative to address the UHIE and offer mitigation measures to provide human comfort, improve air quality, reduce pressure on thermal power plants, and thus reduce air pollution while designing and developing urban areas. With proper planning we can minimize the impacts. So urban dwellers may not suffer from excessive changes to heat and rainfall patterns.

The solution to address UHIE lies in consciously designing urban scape (layout of urban areas) which includes the use of alternative methods while developing land in urban areas. Land alteration is part and parcel of urban development, which is unavoidable. The design and material used for roads, pavements, parking spaces, built mass, and so on can be environment-friendly, which will reduce adverse impacts on the environment. Some of the methods to reduce the UHIE are: providing tree cover, limiting impervious surfaces, use of high albedo materials which will have high solar reflectivity, and use of low thermal conductivity materials for built mass, and so on.

Tree plantation around the building, especially on east- and west- facing walls and along the road, paving, and parking areas, such that it provides shade to reduce the surface temperature and air pollution is also a good method to reduce the UHIE. Use of vegetation over the top roof of built mass by creating a roof garden or 'green roof' can effectively control solar heat entering the roof since the majority of it is used for evapotranspiration. Green roof temperatures can be 30–40 °F lower than those of conventional roofs and can reduce city-wide ambient temperatures by up to 5 °F.[1,2] In addition, green roofs can reduce building energy use by 0.7 per cent

[1] General Services Administration. 2011. 'The Benefits and Challenges of Green Roofs on Public and Commercial Buildings'. Available online at: https://www.gsa.gov/cdnstatic/The_Benefits_and_Challenges_of_Green_Roofs_on_Public_and_Commercial_Buildings.pdf; last accessed on October 23, 2018.

[2] Santamouris, M. 2014. 'Cooling the Cities: A Review of Reflective and Green Roof Mitigation Technologies to Fight Heat Island and Improve Comfort in Urban Environments', in *Solar Energy* **103**: 682–703.



compared to conventional roofs, reducing the peak electricity demand and leading to an annual savings of $0.23 per square foot of the roof's surface.[3] Morning and evening shade due to medium-sized tree (up to 40 ft tall) can provide thermal reduction up to 7.6 °C.[4]

Limiting the amount of impervious surface use in case of site development is directly related to the UHIE reduction. The lesser the impervious surface, lesser the build-up of higher surface temperature in the overall urban area.

The UHIE can be counteracted slightly by using white or reflective materials to build houses, roofs, pavements, and roads, thus increasing the overall albedo of the city.[5] Light-coloured concrete reflects up to 50 per cent more light than asphalt and thus reduces the ambient temperature.[6]

Similarly, these solar reflective materials can be used for rooftop surfaces to ensure cooler surface temperature, which is called cool roof. A cool roof made from vinyl reflects at least 75 per cent solar rays and emit at least 70 per cent of the solar radiation absorbed by the building envelope, as compared to asphalt built-up roofs (BUR), which reflect 6 per cent to 26 per cent of the solar radiation.[7]

Conclusion

Various studies and research papers were published to elaborate on issues related to the UHIE and mitigation strategies have also been suggested, as discussed earlier. The urbanscape can be environment-friendly only if these findings and conclusions percolate into guidelines and development rules that are followed for the design and development of urban areas. Hence, we can actually experience shady roads, pathways, roof gardens, cool roofs, and parks in neighbourhoods, in our future cities. □

[3] Sailor, D. J., T. B. Elley, and M. Gibson. 2011. 'Exploring the Building Energy Impacts of Green Roof Design Decisions: A Modeling Study of Buildings in Four Distinct Climates', in *Journal of Building Physics* **35**(4): 372–91.

[4] Rashid, Z. A. and Syed Al Junid. 2014. '"Trees" Cooling Effect on Surrounding Air Temperature Monitoring System: Implementation and Observation'. 15. 70-77. 10.5013/IJSSST.a.15.02.10.

[5] Albers, R. A. W., P. R. Bosch, B. Blocken, A. A. J. F. Van Den Dobbelsteen, L. W. A. Van Hove, T. J. M. Spit, and V. Rovers. 2015. 'Overview of Challenges and Achievements in the Climate Adaptation of Cities and in the Climate Proof Cities Program', in *Building and* C **83**: 1–10.

[6] 'Cool Pavement Report'. Environmental Protection Agency June 2005, p. 14. Available online at: http://citeseerx.ist.psu. edu/viewdoc/download?doi= 10.1.1.648.3147&rep=rep1&type=pdf; last accessed on October 23, 2018.

[7] 'Comprehensive Cool Roof Guide from the Vinyl Roofing Division of the Chemical Fabrics and Film Association'. Archived from the original on September 9, 2013.

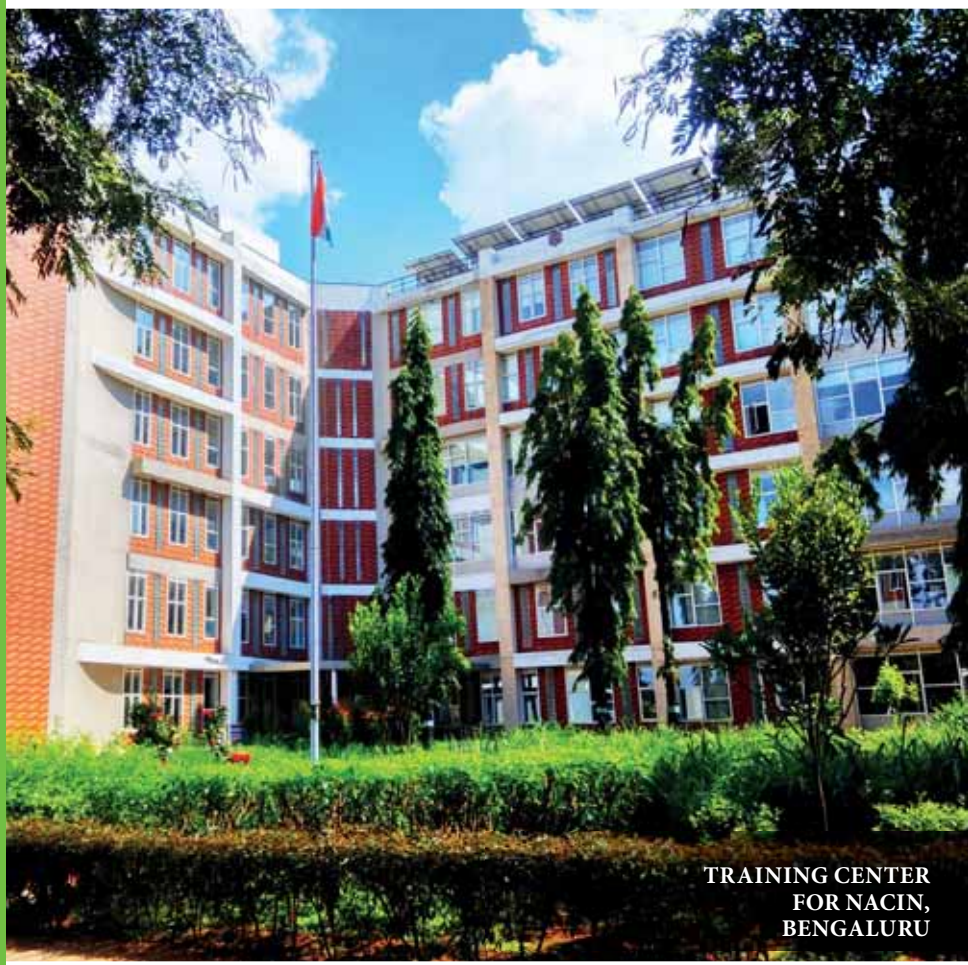
A GREEN CAMPUS FOR NATIONAL ACADEMY OF CUSTOMS, INDIRECT TAXES, AND NARCOTICS, BENGALURU

New complex of the NACIN, Bengaluru, is constructed on a land measuring 3.12 acres as per the GRIHA norms and we are gunning for a 5-star GRIHA rating for the same. We have taken care of each and every aspect as per the GRIHAfor making it a green building and we can proudly suggest that it is a GRIHA-compliant building and will be a role model for many projects under the aegis of the Central Board of Indirect Taxes and Customs.

We believe that GRIHA norms can be achieved with some innovative thinking and planning right from the initial stages of the project itself and we can achieve the green building target within the budget allocation by the Government of India for the new construction.

The GRIHA framework and guidance during the pre-construction, planning and construction, and building operation and maintenance stages has had a tremendous impact in optimizing the use of energy and resources by recommendations, such as recycling the waste generated as manure, use of recycled rain- and sewage water for in-house requirements, generation of electricity through solar panels, thereby reducing the quantum of dependency on external electricity source, and so on. The building is made of an efficient envelope which complies with the ECBC requirements to reduce heat gain and also energy consumption improve daylight utilization effectively.

Ajay Dixit



TRAINING CENTER FOR NACIN, BENGALURU

The campus is reusing grey water and black water by treating the same in a sewage treatment plant for gardening and cleaning purposes, thus making it self-reliant in terms of its water requirements. Also, the landscape and kitchen waste is being converted to manure for the plants in the campus. These innovations have greatly facilitated our endeavour of making the campus a 'zero-garbage zone'. The campus also boasts of a unique herbal garden with medicinal and aromatic plants, including some endangered varieties. Apart from the above mentioned strategies minute attention was given by the GRIHA officials to micro components such as the use of low flow rate water fixtures, optimized irrigation fixtures, use of green chemicals for cleaning purposes, thus making this project a garbage-free, eco-friendly, and an energy-efficient facility.

IDEAS for Sustainable Stormwater Management in Indian Cities

The management of urban stormwater in Indian cities has been of great concern in recent times. The main issues are the frequent urban floods and inadequate stormwater percolation, resulting in depletion of groundwater sources. It is felt that multiple interventions are urgently required to manage stormwater sustainably in Indian cities. In this article, **Chitra Chidambaram** presents few common problems of stormwater management in urban colonies and puts forth a conceptual approach with five generic strategies (acronymed as IDEAS) for sustainable stormwater management in Indian cities.

***Chitra Chidambaram** is an architect planner with a master's degree in Infrastructure Planning from the University of Stuttgart, Germany. She has over 30 years of professional experience and has been a GRIHA evaluator, trainer, and researcher on sustainable buildings since 2011. She currently teaches at the School of Architecture and Planning, Sharda University, Delhi. She can be reached at chitra.chidambaram@sharda.ac.in.*

Introduction

Rainfall occurs at all places, albeit in varying amounts and temporal patterns. While part of this water percolates, part evaporates, and part of it flows down as surface runoff to reach the nearby streams and rivers. Drainage of such storm water has been of concern ever since the start of urban civilization. A well-managed drainage system has always marked the progress of civilizations and Mesopotamia, Indus Valley, and Roman civilizations stand testimony to this. The early history of Indian cities indicates a well-planned network of integrated channels, tanks and wells, built to manage the stormwater effectively. But in more recent times, the changing climate, uncontrolled urbanization, and improper urban drainage planning and management are leading to frequent floods, thereby causing inconvenience and loss of property, particularly of vulnerable groups. Further, an alarming depletion of groundwaters and pollution of the receiving water bodies in many big Indian cities is necessitating an urgent search for new ideas for urban stormwater management.

The problem of urban stormwater

The problem of stormwater is primarily traced to rampant and unplanned urbanization, which results in an increase in impermeable land cover and reduced water percolation into the ground. Also, as the volume of surface runoff increases and the time of concentration decreases, frequent peak flows commonly emerge. The increased flows erodes surface, inundates property-causing floods, and pollutes the receiving waters with the transported sediment, rubbish, and sewage it collects alongside. The problem is far more serious in developing countries where urbanization is more rampant, and the resources more limited for effective regulation. The existing drainage system in most cities has a limited coverage which is often dilapidated and needs urgent replacement either in parts or whole.

The situation in Indian cities is not very different from those in other developing countries. Metropolitan cities have built area coverage of over 70 per cent of urban land. Leave alone the flooding plains, even the stormwater carriageways are encroached illegally. Such encroachments are not serviced and all the liquid and solid wastes are disposed of conveniently into drains. Many unplanned and unauthorized colonies and urban villages also connect to such drains as they are not serviced by the city sewerage network. Further, poor solid waste management results in rubbish being disposed of into open drains, which in turn block and choke the drains. The flows then stagnate allowing mosquitoes to breed and the stink and unsightly filth ruin the quality and health of the urban environment.

Sustainable Approach to Management of Urban Stormwater

The conventional concept of management of stormwater was through a drainage system designed to rapidly dispose of stormwater away from habitation areas to prevent water logging and inundation. This approach of quick removal of stormwater not only resulted in floods and polluted waters downstream but also depleted groundwaters upstream, and hence was not sustainable.

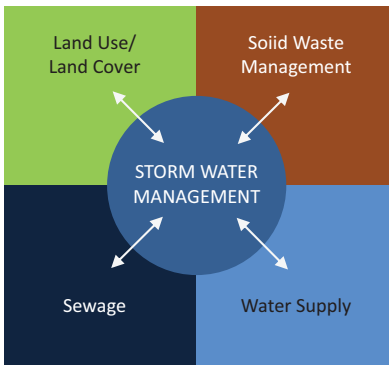
Since the last few decades, the approach has been modified globally. The objective is not to drain away stormwater quickly but instead to let it slowly soak and then store it locally. For this purpose, open spaces and soft grounds permitting percolation are promoted in built up areas. Semi-pervious pavements and parking lots also seem to work. The surface flows are partly channelled to prevent inconvenience and partly allowed to flood the adjoining open areas. Natural open drains are developed as green corridors and recreational amenities to encourage the public use of such spaces. This approach with reduced volume and speed of surface runoffs and enhanced percolation is seen to be more sustainable in creating healthy urban environments. The Indian urban context requires substantial interventions for such approaches to be adopted. Towards this end, the present article proposes five main strategies that are discussed below.

Proposed IDEAS for Sustainable Stormwater Management in Indian Cities

The following are the ideas and measures that have been set in motion to manage stormwater in Indian cities.

1. Integrated intervention
2. Decentralized planning
3. Efficient resource management
4. Appropriate system design
5. Scalable implementation

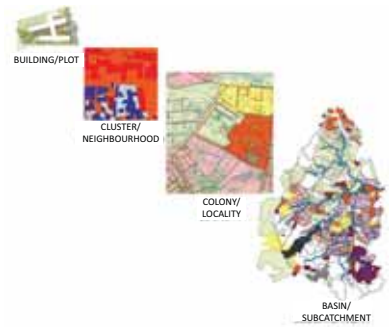
Integrated interventions: Stormwater management requires coordinated interventions in land cover, water supply, sewage, and solid waste management. Permeable land cover can percolate water and reduce the outflow. Separation of stormwater from sewage and solid waste will reduce the pollution of receiving waters and improve urban quality. Supplementing water supply using stormwater is the way forward towards sustainability.



» **Figure 1** Integrated interventions

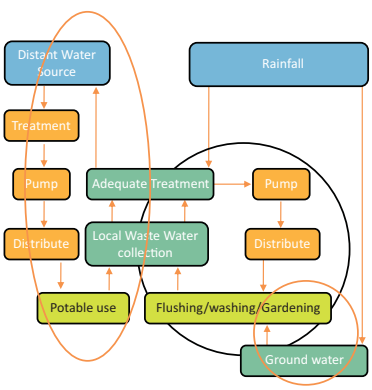
Decentralized planning: Stormwater system planning has to be decentralized and managed closest to the source, within plots, clusters, colonies, and finally natural flood basins. What can be managed at a plot or building level should be managed there itself. Rainwater harvesting at sites should be enforced. Pervious paving can hold back waters at a cluster or block level, while detention and retention ponds can manage the surplus at a colony level. Only the excess should flow out through the natural open drains to reach the surface waters nearby.

Efficient resource management: Efficiency is the key for sustainability. Stormwater and even wastewater



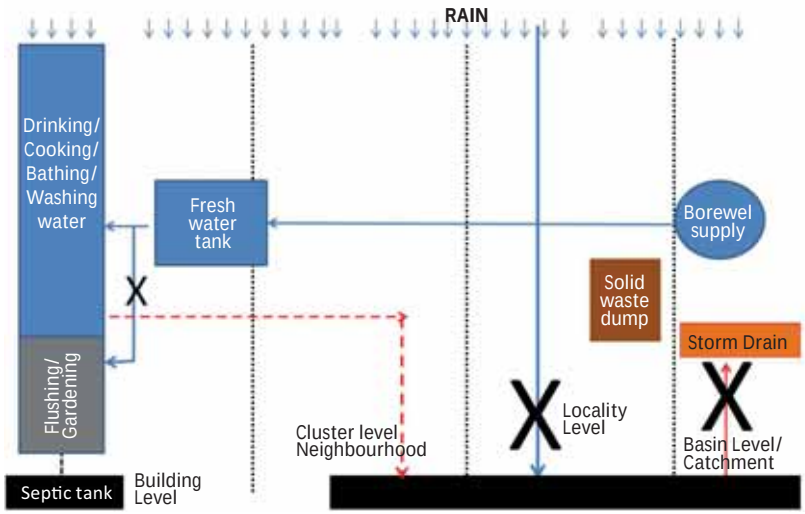
» **Figure 2** Decentralized planning

require to be treated as local resources and should be collected and treated locally and reused. Such a management would also reduce the outflows and the consequent burden on centralized treatment facilities. Further, the level of treatment should also be just adequate for the intended use. Flushing or gardening water does not require water of potable quality, and hence water supplied for such uses should only be treated adequately for the intended use.

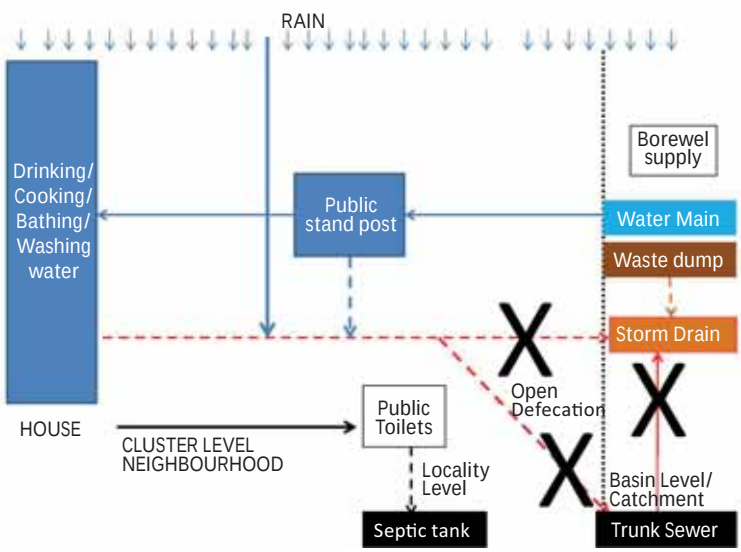


» **Figure 3** Efficient resource management

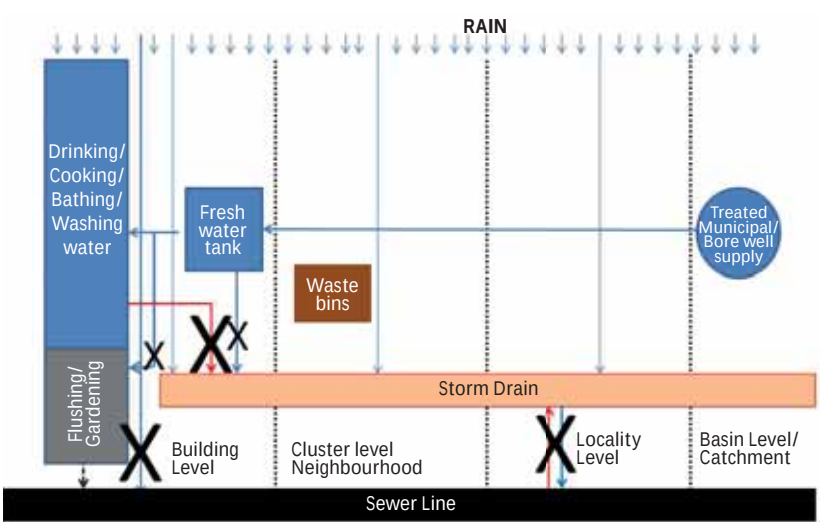
Appropriate system design: The drainage system should be context appropriate. Urban colonies are highly heterogeneous, that is, from the illegal unplanned colonies through unplanned urban villages to the well-planned colonies. The different types of colonies have significant differences in



» **Figure 4b** Unplanned and inadequately serviced colonies



» **Figure 4c** Unauthorized and unserviced localities



» **Figure 4a** Schematic representation of planned and serviced layouts of colonies

the available level of service. Planning and management of stormwater has to take this into consideration. Mobile transport of sludge from septic tanks may also be appropriate in a dense squatter settlement while dual plumbing could be easily adopted in well-planned high-rise housing blocks.

Scalable implementation: Stormwater systems should be scalable in scope over time. An overhaul or adoption of completely new systems is never feasible. The systems should be incremental in nature that permits implementation in phases, such as short term (1 to 3 years), medium term (3 to 8 years), and long term (beyond 8 years).

Conceptual model

The five generic IDEAS proposed are jointly depicted as a model in a conceptual framework. The IDEAS combine the interventions and are presented as a fully evolved long-term picture of stormwater management valid for all types of colonies. The model handles stormwater with water supply, sanitation, solid waste, and land cover in an integrated fashion, albeit at different spatial levels, starting from plots, clusters, and colonies to natural flood basins, in different typologies of urban settlements, which range from slums and unplanned urban villages to planned colonies, thus improving efficiency in resource supply, distribution, and utilization over short, medium, and long time frames.

Concluding Remarks

It is felt that there is an urgent need for interventions for sustainable stormwater management in Indian cities. IDEAS bring out the key strategies for such interventions and the proposed model is a graphical representation of combining the different strategies together effectively. While the proposed strategies and framework are very promising, they require more research on specific projects to study the technical feasibility, financial implications, and institutional arrangements. The proposed IDEAS are definitely worth further exploration. □

1

GRIHA Council was recognised for its contribution to promote the Green Building Movement in India during the Green Excellence Award 2018

2

GRIHA Evaluator and Certified Professional programme, Guwahati, 20th to 22nd June, 2018

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3

1 Day Training Programme on GRIHA EB_30th May, 2018 Chennai

2 Day GRIHA V 2015 Training Programme for PWD Officials at Pune on 27th-28th August, 2018

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GRIHA Evaluator and Certified Professional programme, Jaipur, 29th to 31st August 2018

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GRIHA Evaluator and Certified Professional programme, Delhi, 11th to 13th April, 2018

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GRIHA Evaluator and Certified Professional programme, Noida, 11th to 13th July, 2018

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AWARDS & TRAINING PROGRAMMES

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3 Day Training Programme - Bangalore - 26th to 28th September, 2018

Listening to one's conscience and treading the road less travelled seem to shape the profile of this young environmentalist. Determined to resuscitate Lake Kilkattalai, Arun Krishnamurthy founded Environmentalist Foundation of India (EFI) in 2011, after walking away from a promising career in IT. Resonating with various NGOs and initiatives, EFI in the recent years has gained momentum and received praise for its efforts in preserving the various water bodies in India. In an open and frank conversation with GRIHA, the young environmentalist discusses the importance of understanding the limitations of technology in saving the day and urges people to take accountability for their actions.

ARUN KRISHNAMURTHY

What inspired you to quit a handsome career at such a young age and choose the path of sustainability?

Right from my school days I have been involved in environment learning and volunteering. This helped me understand the intricate set-up that this planet is. My deep interest has always been towards the environment. It may sound cliché, but we understand we cannot exist without the environment. Technology will not magically solve our problems and given enough time and support, nature will fix our mess; we need to take the onus on ourselves to ensure that we allow Mother Nature to do her thing.

You are fondly known as 'the rock star activist for environmental conservation'. How does it feel?

People have been kind in encouraging our volunteering efforts at EFI. It feels positive knowing there are several like-minded individuals who care for the planet. While I am humbled by the praise that people have, there is a lot more that needs to be done if we hope to improve the planet. It is the success of our carefully selected team at EFI that has really facilitated the positive impact we've had on improving the environment.

Considering the sheer number of lakes that you and your team have restored over time, what do you think comes next?

There are several more lakes which we at EFI plan to restore in the years ahead. We are expanding our operations to new locations and are also focusing on empowering several nature leaders who can extend the work and multiply the impact. The younger leaders should be able to take forward the message of the environment's scientific conservation. Doing so will help achieve sustained results. We are thus focusing largely on grooming future eco leaders. This includes training them on all fronts needed to tackle the current environmental threats.

What has been your biggest challenge since the beginning of your journey?

Changing public perception positively towards environment conservation has been the toughest task at hand. We all care but we fail to understand our responsibilities towards the planet and what needs to be done to fulfill our duty to the other creatures that inhabit it along with us. We need to put behind emotional thoughts triggered by religion, nationality, etc., and focus on real-time result-oriented conservation. Getting this message across to the masses through engaging platforms is an interesting challenge.

How has your association/partnerships with the volunteers helped EFI to flourish?

Volunteers are an important asset for any not-for-profit organization. EFI has been fortunate to work with several such nation builders who bring their expertise and commitment to the task at hand. This has strengthened the efforts on field and helps us achieve results. We don't treat our volunteers as outsiders. All of us share responsibilities while working in the field. We ensure that EFI is a platform for innovation and equal opportunities for all those who care about the environment.

According to you, besides lake restoration, what is the key solution to India's water scarcity?

Water literacy and awareness are critical for successful water-management efforts. In modern India, there are bore wells all across the country, which are majorly depleting irreplaceable groundwater reserves. Urban and rural sewage directly flows into our freshwater bodies, thereby contaminating the elixir of life. By dumping solid waste into our lakes and ponds, we are denying the future generations clean drinkable water.

What would you like to be remembered for?

I would be liked to remembered as someone who understood India and volunteered for the environment.

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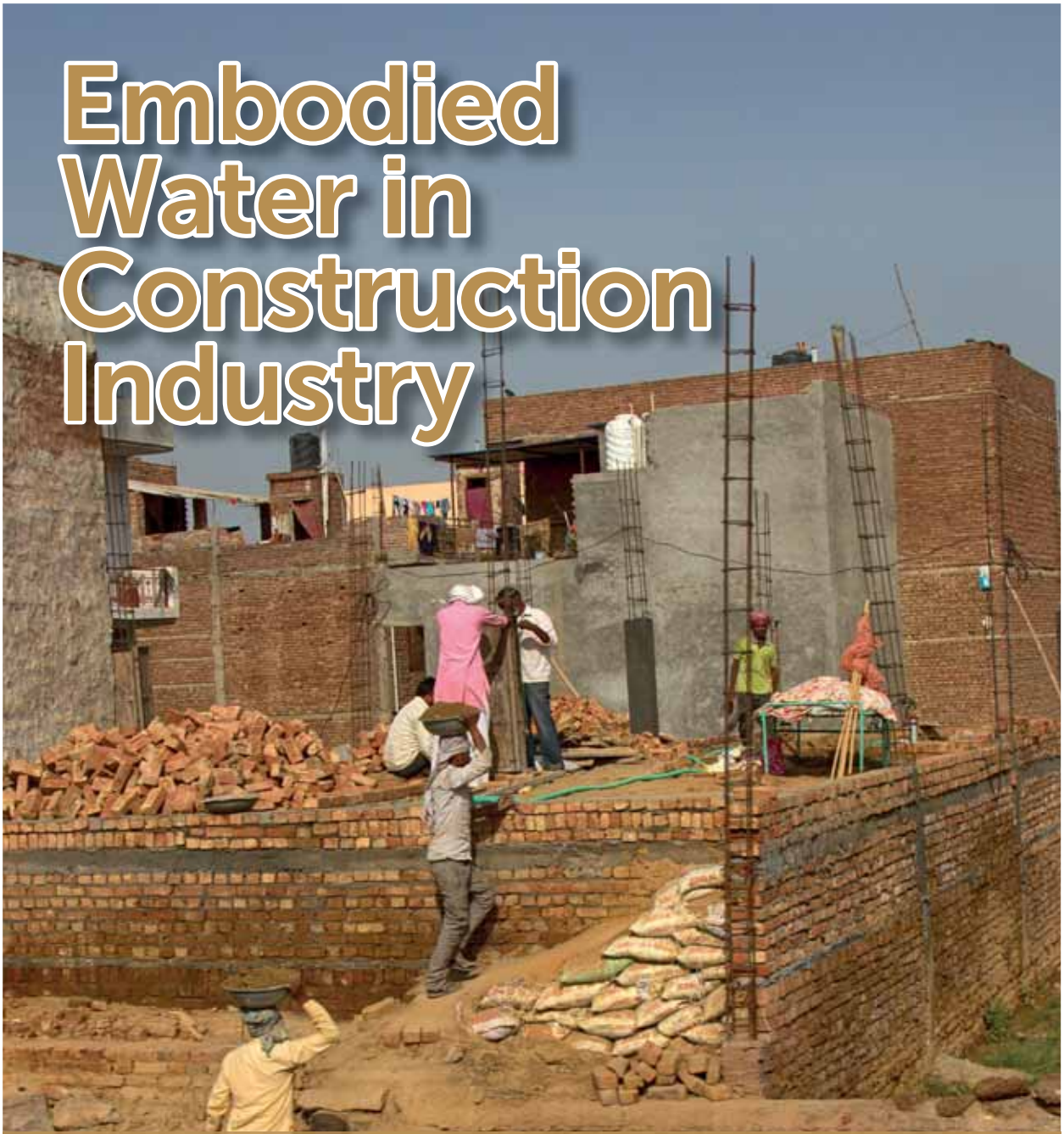
Embodied Water in Construction Industry



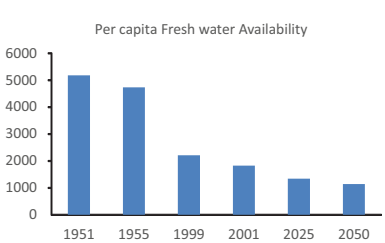
The construction industry causes significant environmental stress as it pollutes and wastes a lot of water. The growing water demand in the construction sector would simply mean growing water scarcity. In this article, **Er. Abhishek Pathade** and **Ar. Namrata Mahal** stress on the fact that sufficient awareness must be created amongst the stakeholders in the construction sector about the significance of water, water-stress levels, and the problems that will arise in the near future, if we continue with the business-as-usual scenario.

As per the World Economic Forum's *Global Risks Report 2017*, water crisis is at the third position in the annual list in terms of impact. The situation in India is no different. According to the World Resources Institute, India comes under the red zone, which indicates that it is amongst the highly water-stressed countries. Despite being home to 16.9 per cent of the world's population, India accounts for only 2.4 per cent of the world's surface area and 4 per cent of the world's water resources at disposal. At present, the per capita availability of freshwater in India is 1,820 cu. m, which was 5,177 cu. m in 1951—signifying a decrease by 60 per cent in the per capita availability of water. If the situation persists, we will fall under the category of highly water-stressed country and the per capita availability is likely to come down to 1,140 cu. m by 2050. This is undoubtedly due to the increasing population, changing climatic conditions, industrialization, and fast-changing lifestyles. Having said that, the predominant water-intensive sectors are agriculture, followed by industrial and construction sector s. The growing water demand in these sectors would simply mean growing water scarcity. Given this situation, many firm and effective steps have been taken in the past and are being taken to save and use water efficiently in these sectors.

Precisely talking about the construction industry, a lot of emphasis has been given on reducing and optimizing the water demand at the building level and site level, that is, the water requirement of the green spaces. On the contrary, negligible prominence is given to the management of pre-operational water usage of buildings. It is a very less explored subject. Minimal studies have been conducted that have substantiated that the embodied water for construction is equivalent to the operational water of that structure for approximately 6–7 years. As per the previous research studies carried out by Bardhan and Indraneel Roy Choudhuri at Kolkata and Pune, the embodied water in materials came up to be 61.45 per cent and 82 per cent, respectively. The study revealed that of the total embodied water, the major share of water is consumed for manufacturing of the materials rather than the actual construction process. This that steps should be taken to reduce the water usage during the manufacturing process by discovering alternatives that will require minimum water.

Window of Opportunity

For conservation of water, we must first quantify the water involved in the construction process. Aspects such as the source of construction water-whether it is water tanker, borewell or municipal connection, whether it being monitored, and so on- should be taken into consideration. The few site visits conducted to the conventional sites have revealed that the water required during the construction process is totally unaccounted on site, no records are being kept about the water usage during the construction work, hardly any data was maintained on site, except the bills of water tankers. When interviewed and interacted further, the reason identified for the above was a lack of awareness and the myth that water is available in plenty. One of the striking reasons given was that water is available cheaply and the people in the construction industry can easily afford it. This vividly shows that lack of knowledge and training are major barriers amongst the workforce in India, which leads to a lot of wastage of the most valuable resource on the planet.



One of the ways to address the afore mentioned lacuna is to monitor pre-operational water usage of the building by metering the usage of the water at source, that is, groundwater or municipal connection, in case of water tankers by keeping a record of usage on site. It is very difficult to practically monitor water used for each activity on site, but the overall water used per day can be measured and recorded daily so that some preventive steps can be taken to use water efficiently during construction and to reduce unwanted consumption and wastage of water. Almost 20 per cent of the water can be saved during construction by effective building design and water management on site.

For efficient water usage the following measures can be undertaken:

- Use of wet Hessian cloth or sprays for curing of columns, ponding technique for curing of slabs, and use of curing compounds should be adopted during the construction phase to ensure efficient water use during construction.
- Use of treated wastewater for flushing requirement in labour camps, cleaning purposes, and so on.
- Proper supervision and avoiding leakage can be a preventive measure

to save a large quantity of water from getting wasted. Proper and regular training should be given to the workers so that they can technically use water efficiently.

- Alternative building materials that consume less water can be used (for example, Dryfix can be used as a bonding material for bricks instead of cement mortar).
- Since concrete is a major component in the construction industry, modern construction techniques such as using admixtures and super plasticizers can reduce the water requirement in concrete without affecting the quality of work.
- Water stored in buckets should be used for cleaning of equipment rather than running water.
- Water previously used for washing concrete tools and equipment for making concrete mix can be used again efficiently on site.
- If space is available onsite, artificial ponds and water tanks can be made to store rainwater that can be used for construction.
- Adequate measures should be taken to recharge aquifers during the rainy season and then use their water for construction activities through borewells.

There may be practical issues and resistance in adopting these practices but the major hindrance is a lack of intent to adopt these practices. Hence, the foremost thing here becomes creating awareness amongst people about the significance of water, water-stress levels, and the problems that will arise in the near future, if we continue the same way. Since India is a developing country, a lot of construction work is yet to come up. According to the Centre for Science and Environment (CSE), more than 70 per cent of buildings that should be built by 2030 are yet to be constructed. If we try and save 15–20 per cent of the water used during construction by undertaking effective measures, then huge quantities of water can be saved water at a cumulative level.

Conclusion

Since water is the driving force of life, its importance should be known to all and we should use this resource wisely. It is the collective responsibility of all the inhabitants of planet Earth. 'Thousands have lived without love, not one without water'; so we must preserve this precious resource as much as we can. Since the construction sector is one of the major consumers of water, it is the duty of every professional in this sector to know their responsibility towards the environment and to create awareness amongst those who are uneducated and also amongst those who are literate but unaware of this global risk which is soon going to hit our future generation if not addressed now. As they say, 'Save water today, it will save your future.' □

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Air Quality

Management in India: Pioneering a Paradigm Shift

At Magneto Cleantech understanding that air pollution is pervasive is not enough. In order to combat this effectively, industry stakeholders must realize the nature of the air pollution; the composition of the particulate matter; the geography that impacts climatic change in that region, and the efficiency of the existing technology. In this article, **Himanshu Agarwal** talks about the different aspects of air pollution and how at Magneto Cleantech a technology has been pioneered to deal with this challenge.

Himanshu Agarwal *is the Founder, CEO of Magneto Cleantech. He is well recognized in the HVAC industry as a thought leader who has spent the last 38 years establishing brands, such as Daikin and Trane in India. He serves on the technical board for the Indian Green Building Council (IGBC), is an active member of The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and the Indoor Air Quality Association (IAQA). He is a frequent speaker at several indoor air quality (IAQ) forums hosted by the Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) and many others. He can be reached at ceo@magneto.in*

Providing access to clean air is a massive problem in India and we are definitely not the only country struggling with it. China, for example, has also been battling with air pollution on a substantial scale. Certain regions in the developed nations, too, such as California and Washington, have seasonal changes and wildfires that lead to poor air quality. Learning from other world leaders, we in India have adopted popular international techniques for combating air pollution, but in the process, have overlooked the subtle differences in our specific needs and are thus unable to effectively combat air pollution whether indoor or outdoor. The Indian subcontinent has its own unique set of challenges that require a paradigm shift in the fundamental design of traditional air purification systems to be tackled effectively.

Earlier this year, several regional authorities in the United States of America had issued 'air-quality alerts' due to the wildfires of California that affected the major parts of the West Coast. In some parts of Oregon, particulate matter measurements had exceeded 500 ug/m3.[1]While these values are quite high and dangerous, viewed in the Indian context, these have become commonplace, especially the foggy winter-morning air in Delhi. A quick, short-lived exposure to a high concentration of microparticles undoubtedly has health effects, but a long-term exposure, in our case to PM 2.5 values of 1,400 ug/m3 even in June,[2] has a catastrophic impact on human health. The important thing to recognize here is that the problem of air quality that we in India are dealing with is of a greater magnitude and pervasive. Similarly, China is home to some of the most polluted cities in the world, including Beijing. Unfavorable weather conditions and increasing emissions from industrial operations

in the country have frequently been the cause of toxic winters.[3] Not surprisingly, the scale of the air quality problems in China is comparable to India's; however, there are several important geographical differences between the regions. India is a much warmer country with the inland regions being the hottest; it is guarded by mountains and ranges. These inland regions that get very hot and dry are also the ones with the highest levels of air pollution.

According to the traditional approach to air purification in the USA, Europe, and China, a high-efficiency particulate air (HEPA filter or a pleated MERV 13 filter is used for the removal of particulate matter. But, when this classical approach is applied to the Indian scenario, it fails miserably. This is due to the fact that HEPA or MERV 13 filters are not reusable and cannot work with the Indian air conditioning systems. Even though they are exceptional at filtering particles, when exposed to the Indian scale of dust, they get loaded quickly and need to be replaced every 1–2 months. Further, they add a massive pressure drop to the air conditioning systems and significantly inhibit their cooling efficiency. Both these factors, when dealing with a hot-climatic region and a developing nation such as India, require extreme cooling and are cost conscious, thus making the use of these filters impractical. It is unreasonable to imagine that users in India would be willing to suffer through extreme heat just to purify the air and yet have to buy expensive filters up to six times a year. To effectively deal with the Indian measure of air pollution, a filtration mechanism—one that is reusable; has a low-pressure drop on air conditioners; and has a high filtration efficiency—is necessary.

Conventional filters that work on trapping dust by imposing a mechanical barrier have an inherent trade-off between the pressure drop and filtration efficiency. The finer the filter barrier, the higher is the filtration efficiency and the higher is the pressure drop (tonnes per square inch). Recently, the USA has developed a number of techniques that have overcome this bottleneck; however, due to a lack of demand, these techniques are yet to gain prominence. True to the proverb 'necessity is the mother of invention', India can help drive the need for the development of these alternative techniques. An emerging design of filtration systems involves the use of electron-charging methods to electromagnetically

1 *The Washington Post*.

2 *Hindustan Times*.

3 Reuters.

charge the particles in the air stream and then subsequently capture them on a magnetized, polarizing surface. These techniques have the ability to deliver a high particle filtration efficiency with a low-pressure drop. Such systems are, however, a lot more complex to design correctly. Most electronic-based systems when made into products fall short of delivering their promise, since they require extensive research and development for testing and verification for safety and performance. More recently, at Magneto Cleantech, a system that has a HEPA-like filtration efficiency, has minimal pressure drop, and is washable for reuse, has been pioneered. This is a paradigm shift in the underlying design of filtration systems that accounts for the needs of India. Additionally, at Magneto Cleantech we recognize the need to combat infectious diseases in India where there are more than 16 lakh tuberculosis patients (Global Health Environment). The system traps microbes and kills them to stop the propagation of diseases, which was not possible with the conventional filtration approach. Our system has received a provisional patent and recognition at various platforms. These efforts help in establishing India as a leader in technological innovation and can drive us towards the continued development of pragmatic, sustainable solutions. By building such solutions, we are able to protect people, their assets, and the environment. Within 2017, through our technology and by the application of these filters within the HVAC system, we have improved the health of 4,534 people, ensured that 3,67,727 sq. ft of area would be safe at all times, and saved the planet from emitting 619 metric tonnes of CO_2. We urge all industry stakeholders and policymakers to learn from other nations but also recognize India's specific differences in providing solutions that can help build a modern, sustainable India. □

PSG INSTITUTE OF TECHNOLOGY AND APPLIED RESEARCH

The campus of PSG Institute of Technology and Applied Research has been planned in six established modules with each module designed as an independent department, interlinked with a central courtyard. The unit is an assemblage of classrooms, tutorial rooms, electric halls, staffrooms, and other basic amenities. The purpose for designing it such was such that all the usable rooms are assembled around the central corridor, which is brightly lit and highlights every entry point. The play of materials extends a unique identity and purpose to each department. The combination of the blocks appears to be arranged symmetrically with the spaces in between, thereby creating an air chute of sorts for cross-ventilation purposes.

The campus has adopted a variety of sustainable measures, such as passive design elements, local building material, solar panels, calculated light fittings, non-toxic paints, adequate natural light and ventilation, and acoustically treated lecture halls. In sync with the GRIHA principles, the campus exhibits a well-calibrated use of technology and aesthetics, and neither aspect has been compromised. Going beyond the typical design parameters, it was a wise decision to create a mini forest zone in the campus' south-west direction. The trees in this region added to the biodiversity and in addition to the pleasing aesthetics, the passers-by, too, have greatly appreciated the leisure space it has created for them.

Architect Sangeet Sharma is a partner in the firm SD Sharma & Associates, Chandigarh. He has been conferred with an honorary doctorate by the University of California, Berkeley. His architecture can best be understood as 'cubist modernist' and is highly influenced by Chandigarh's modern and sustainable construction and design. He is widely published and has won many awards.

While the campus awaits its final rating, every attempt has been made to abide by GRIHA's list of criteria and parameters. The team at GRIHA is extremely helpful in terms of the guidance and handholding. The on-going journey of getting our project GRIHA rated is a rewarding experience and worth all the efforts to make the building stand out.

Interestingly, the GRIHA rating also applies to the building's construction phase. Throughout the project, the construction areas were fully protected and safety precautions for the workers were well taken care of. Inspired by the GRIHA criteria, the team was particular to optimize activities and curtail wastage, especially of energy and water. As we await the rating, working with the GRIHA team was truly a unique experience. We also won the GRIHA Exemplary Performance Award in the Passive Architecture Design 2017 category.

Women and Sustainability

Fostering Partnerships through Womens' Participation

The binary of the home and the world is a well-known concept. Equally well known is the fact that women have been denied equal opportunities in all walks of life. In this article, **Dr Meenakshi Mital** and **Dr Meenal Jain** draw our attention to the benefits, not to mention the urgency, of bringing women into the folds of various administrative works, ranging from decision-making to policy execution to build a sustainable tomorrow.

Dr Meenakshi Mital is an associate professor at the Department of Resource Management and Design Application at Lady Irwin College, University of Delhi. Her PhD reflects scholarship in areas such as women, poverty, and urban slums. She is also an MBA in marketing and has more than 20 years of work experience. Her research areas include resource management, sustainable built environment, and climate change. She can be reached at meenakshimital@gmail.com

Dr Meenal Jain is an assistant professor at the Department of Resource Management and Design Application at Lady Irwin College, University of Delhi. She did her PhD in the area of solar energy policies in the six states of India, in collaboration with the School of Planning, Design and Construction, Michigan State University, USA. She was awarded a gold medal for her outstanding doctoral work. Her interest areas include resource management, climate change, sustainable development, renewable energy, and green habitat. She can be reached at meenal_11287@yahoo.com

Women as the Agents of Change

'When you educate a man, you educate an individual, but when you educate a woman, you educate a family', such is the power of women. When empowered and viewed as agents of change, the society benefits at large. In the past several years, we have seen the growing participation of women in every sector. While there is no denying the importance and necessity of this participation, it is equally urgent to realize how women are integral to building and sustaining nations.[1]

A key question that needs to be answered is how to integrate gender equality into sustainability policies and, more importantly, why to do so? As per the World Bank, the Food and Agriculture Organization, and the International Fund for Agricultural Development, sustainability has many gender-specific characteristics, especially with regard to their social

[1] Wollack, K. 2010. 'Women as Agents of Change: Advancing the Role of Women in Politics and Civil Society'. Retrieved from http://www.ndi.org/files/Women_As_Change_Agents_Testimony_090610_0.pdf; last accessed on October 11, 2018.

roles, discrimination, poverty, and so on. Additionally, women continue to be underrepresented in various decision-making processes, ranging from adaptation and mitigation strategies to forming policies and laws. Their conspicuous absence from important decision-making fora continues to hamper growth and development.[2]

Women's participation should be increased, particularly at grass-roots levels as decision-makers, entrepreneurs, planners, evaluators, managers, etc., and as beneficiaries in the design, development, implementation, and monitoring of climate change policies. Governments should ensure women equal opportunities to education, media, information, communication, technology, and so on in order to encourage thier equal participation in training and capacity building. Governments, international financial facilities and institutions, and private sectors should further promote woman's participation and ensure that a gender perspective is incorporated into the design approval, execution, and monitoring of various sustainability-related projects. In addition, international relations should be strengthened in terms of technology transfer to address the challenges faced by women.[3]

Lambrou and Piana (2005)[4] point out that:

- Experience shows that in both developed and developing countries, women are not adequately represented amongst those most impacted by environmental changes. Many reasons are at the base of this attitude, for instance, women's income levels are lower than men's. Moreover, in many parts of the world, women lack ownership or control of resources, access to information, and decision-making authorities. There is a need to take measures to ensure that the effects of climate change do not further impoverish women and plunge them further into the perpetuation of poverty. However, focusing solely on vulnerability may be misleading since women often have untapped skills, coping strategies, and knowledge that could be used to minimize the impacts of crisis, environmental change, and disasters.

What is required for effective partnerships for sustainable habitat is the integration or 'mainstreaming' of gender into all policies, programmes, and projects. Until we have focussed sustainability polices, which take into consideration the specific needs of women, the policies will not be effective in achieving their goals.[5] One of the ways to involve women is to allocate funds and encourage the financing institutions, the United Nations, and other national and international organizations to support women to contribute effectively and efficiently at all levels, such as sustainable agriculture, forest and water management, increasing the use of renewable energy, and other mitigation and adaptation measures/efforts.[6] The policymakers need to be flexible while drafting the policies related to sustainability depending on the varied needs of men and women. New mechanisms need to be included in order to address the most vulnerable populations through adequate funds.

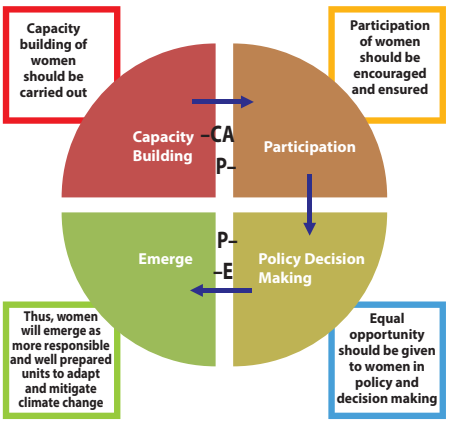
[2] Wanner, T K. 2009. 'Climate Change Policies in Australia: Gender Equality, Power and Knowledge'. *World Academy of Science, Engineering and Technology*, 54, 857–62. Retrieved from http://www.waset.org/journals/waset/v54/v54-148.pdf; last accessed on October 10, 2018.

[3] The Economic and Social Council (United Nations). 2011. 'Mainstreaming Gender Equality and Promoting Empowerment of Women in Climate Change Policies and Strategies'. Retrieved from http://www.un.org/womenwatch/daw/csw/csw55/other-outcomes/Climate-change-adv-unedit.pdf; last accessed on October 10, 2018.

[4] Lambrou, Y. and G. Piana, 2005. 'Gender: The Missing Component in the Response to Climate Change'. Retrieved from www.fao.org/sd/dim_pe1/docs/pe1_051001d1a.doc; last accessed on October 10, 2018.

[5] Wanner, T K. 2009. 'Climate Change Policies in Australia'.

[6] Women Environment and Climate Action Network. 2009. 'Women and Climate Change'. Retrieved from www.worldpulse.com/files/upload/100/wecansweetfair.docx; last accessed on October 10, 2018.



» **Figure 1:** CAPPE model integrating gender equality in sustainable policies

Additionally, a participatory approach needs to be followed. It is often said that one learns the best when the experience is hands-on. Similarly, unless women are actively encouraged to be part of processes, they will not be able to acquire the full benefit of the policies being made for them. Women need to have an equal opportunity for participation at every stage of environmental issues. Their unique knowledge and coping mechanisms need to be understood and we, in order to have a holistic perspective, need to draw upon them. Such mitigation and adaptation programmes need to be prepared that improve the welfare of women in terms of capacity building, information dissemination, improved access to resources, sustainable energy, and so on.[7] For doing so, the three Es, equality in information dissemination, equality in participation, and equality in decision-making, need to be followed for successfully integrating gender equality in sustainability policies. The following measures can be taken to achieve this, first, both men and women should have equal rights to information, that is, they should be given access to information as per their needs and vulnerability. Second, they should be given an equal chance to participate in various aspects related to sustainable habitat. Third, they should be given an equal opportunity in decision-making at all levels, ranging from the local to an international level. Here, a CAPPE model has been proposed suggesting how to appropriately integrate gender equality in sustainability policies.

Women's capacity building, initiated at the grass-roots level, should take place, wherein they should be informed, educated, and empowered with respect to the issues related to sustainable habitat, their role in the community vis-à-vis gender-specific issues. Furthermore, they need to be persuaded to participate and act as powerful representatives and driving force in various happenings related to sustainable habitat and share their problems, experiences, and viewpoints. Women need to be involved in policymaking or the decision-making processes. As homemakers or professionals, rural or urban, young or old, women from different walks of life have their unique experience and as knowledge equals power, this collective experience must be understood in order to foster global development. Doing so will not only help women in becoming global citizens, it will also create a harmonious habitat wherein each individual will matter, and in turn be accountable for, in the struggle to establish sustainable habitat.

As William McDonough has said, 'In the end, the question is not, how do we use nature to serve our interests, it is how can we use humans to serve nature's interest.'

Involving women in the on-going battle against climate change should not be a choice, rather the long-pending inclusion should be taken on as a priority. With proper knowledge, insights, and the awareness of consequences, women themselves will be able to step forward and resolve the conflicts over the limited, valued resources. This inclusion can and will go a long way in conserving non-renewable resources.[8] For these reasons and many more, there is a call for integrating gender equality perspectives in sustainable developmental policies and programmes, especially as women are powerful agents of change and the key actors in contributing effective responses to the sustainability issues. □

[7] United Nations Population Fund. 2009. 'Climate Change Connections'. Retrieved from http://www.gender-climate.org/pdfs/climateconnections_2_policy.pdf; last accessed on October 10, 2018.

[8] Volunteers for Africa. 2009. 'The Role of Rural Women in Natural Resource Management in Kenya'. Retrieved from http://www.ammado.com/nonprofit/50795/articles/7325; last accessed on October 10, 2018.

GLIMPSE OF 9TH GRIHA SUMMIT 2017

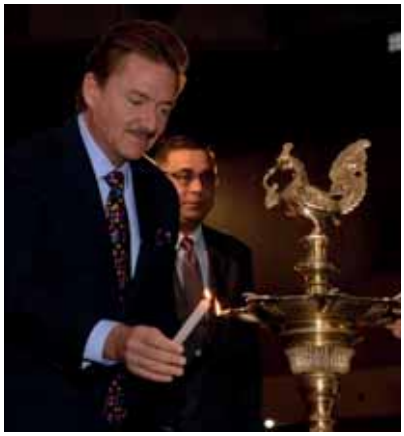
Valedictory Address delivered by Shri Durga Shanker Mishra, Secretary, Ministry of Housing & Urban Affairs

"New technology and development in control using AI and IOT is going to change the landscape of renewable integrate in building dramatically."

- Mr Shirish Garud

Sustainability should not be compromised while keeping affordability in mind.

-H E Dr Andreas Baum



The biggest challenge today is the necessity to enhance resource efficiency.

-Dr Ajay Mathur

Keynote Adress delivered by
Ar. Christopher Charles Benninger

Valedictory & Award Evening

Fostering Partnerships for 'Climate-Smart' Cities

As many feel, climate change is the unfortunate consequence of large-scale urbanization and industrialization. With countries racing to increase their respective GDPs, and with the increasing stress on natural resources, we seem to have landed in a catch-22 situation. In this article, **Dr Komal Yenneti** discusses the harm caused by the urban heat island effect and the ways in which this situation can be mitigated.

Dr Komali Yenneti *is an Australia India Institute 'New Generation Network Scholar' at the Faculty of Built Environment, University of New South Wales. She has over a decade of experience in sustainable smart cities, low-carbon development, and energy policy. She currently leads a number of projects on climate-smart cities and smart energy management in the Asia-Pacific. She can be reached at k.yenneti@unsw.edu.au*

Urban Heat in India: An Overview

India is in the middle of a smart cities revolution. The smart cities mission promises to make cities more liveable, sustainable, and resilient. However, can this be achieved when cities face a complex set of challenges related to climate change? Cities are getting hotter, with a serious impact on public life and the economy (see Figure 1).

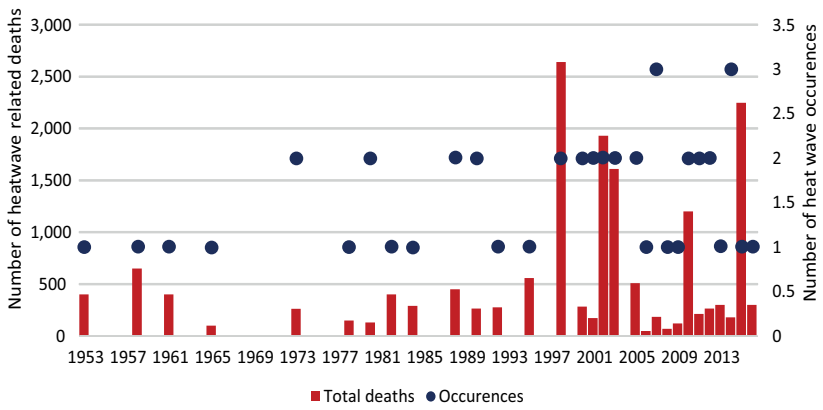
Cities heat up faster than the surrounding rural areas due to the urban heat island (UHI) effect, a phenomenon caused by heat trapped by large dark concrete buildings, asphalt roads, and close structures combined with concentrated energy released by vehicles, building air-conditioning, and industrial output.[1] The UHI effect is more severe in India due to rapid unplanned urbanization, overcrowding, and reduced green cover. Experimental studies on the UHI effect in India suggests that the average temperature in highly urbanized areas is 2 °C–12 °C higher than the surrounding rural areas.[2] Evidence from the top 20 smart cities shows an increase in the frequency and intensity of extreme temperatures (see Figure 2).

S.No.	Smart Cities	Extreme Temperatures (days more 35°C)	Temperature Trend
1	Ahmedabad	◆	◆
2	Belagavi	◆	◆
3	Bhopal	◆	◆
4	Bhubaneswar	◆	◆
5	Chennai	◆	◆
6	Coimbatore	◆	◆
7	Davanagere	◆	◆
8	Guwahati	◆	◆
9	Indore	◆	◆
10	Jabalpur	◆	◆
11	Jaipur	◆	◆
12	Kakinada	◆	◆
13	Kochi	◆	◆
14	Ludhiana	◆	◆
15	New Delhi	◆	◆
16	Pune	◆	◆
17	Solapur	◆	◆
18	Surat	◆	◆
19	Udaipur	◆	◆
20	Visakhapatnam	◆	◆

◆ Increase ◆ Constant ◆ Decrease

Figure 2 Extreme temperature trends between 1990 and 2013 in the top 20 smart cities[3]

[3] Jogesh, A, U Rjasekar, and S Chakraborty. 2017. Climate Disconnect in India's Smart Cities Mission[cited July 17, 2018]; available at: http://indiaclimatedialogue.net/2017/10/11/climate-disconnect-indias-smart-cities-mission/; last accessed on October 30, 2018.



» Figure 1 Heatwave occurrences and deaths in India, 1953

Source EM-DAT

[1] Yenneti, K. 2018. Making 'Climate-Smart' Indian Cities, in Very Short Policy Brief Series.Australia India Institute, pp. 11–16.

[2] Yenneti, K, D Prasad, and M Santamouris. 2017. 'Future Cities—Hot and Smart: Urban Heat, Impacts, Risk and Resilience in India', in INSPIRE. Jaipur: AEEE.

Cities and Climate-smart Interventions

A range of climate-smart technologies and strategies can be used to support policymakers and urban planners in managing urban microclimates and guiding sustainable urban development in India. These innovative solutions can be broadly categorized into two areas: (i) solutions that decrease the absorption of solar radiation and release of heat to the atmosphere and keep urban surfaces cool (e.g., cool roofs and cool pavements), and (ii) increase evapotranspiration in an urban environment (e.g., urban greenery, green infrastructure, and water-based systems).

Water-based urban landscape

The use of water in reducing ambient temperatures has been known for many centuries. Water-based urban landscape, such as lakes, rivers, and wetlands, contribute to 'urban cooling islands' through water retention and evaporative cooling and can decrease urban ambient temperatures by 3°C–8 °C.[4] Apart from natural water bodies, a variety of passive systems and active or hybrid water components such as pools, ponds and fountains, evaporative wind towers, sprinklers, and water fountains can be implemented in public spaces for both decorative and climatic purposes.

Urban greenery

Various forms of natural and designed urban greenery, such as nature reserves, urban parks, street trees and hedges, and open spaces decrease urban temperatures and cool ambient air through shading, evapotranspiration, and alteration of wind movement. Urban greenery may be part of urban landscapes, parks, streets, and open spaces, and may also be integrated into the building envelope through green roofs and green walls.

In tropical and subtropical climate zones with sunny summer skies, like that of India, urban greenery is an economic and effective heat mitigation strategy.[5] For example, evidence suggests that increasing street tree and canopy cover by 14%–40% can lower afternoon ambient temperatures by as much as 5.5°C.[6] The results of an experimental investigation in Ujjain city show that green roofs can not only reduce high daytime temperature in summer, but also reduce the energy load for air conditioners.[7] To design urban green spaces with the greatest cooling effect in hot summer weather, architects and urban planners need to collaborate at the design stage.

Reflective materials

Increasing the albedo of cities through reflective materials, also called cool materials, can greatly mitigate extreme temperatures, increase thermal comfort and reduce energy demand in air-conditioned buildings. Advanced cool materials with very high reflectivity and high emissivity are now commercially available. The common cool materials are white and come in single ply or liquid forms. The standard liquid products are usually white paints, acrylic, elastomeric or polyurethane coatings, while single ply products are EPDM (ethylene propylenediene tetrolymer membrane), PVC (polyvinyl chloride), CPE (chlorinated polyethylene), TPO (thermoplastic polyolefin), and CPSE (chlorosulfonated polyethylene).[8] Typical reflective materials used for street surfaces are fly ash (concrete additive), chip seal, slurry coating, reflective synthetic binders, and light-colour coating. In the recent years, researchers at the University of New South Wales (UNSW) have developed ground-breaking coloured thermochromics materials that become highly reflective at higher temperatures.[9] Through these materials, building owners do not require to compromise on aesthetics. Research has also been carried out to advance very high reflective materials for pavements, including water-retentive or permeable materials, infrared reflective coating, heat-reflecting coating, colour-changing coating, and photovoltaic-based pavements.[10]

4 Manteghi, G, H bin Limit, and D Remaz. 2015. 'Water Bodies an Urban Microclimate: A Review', *Modern Applied Science* 9(6): 1–10.

5 Govindarajulu, D. 2014. 'Urban Green Space Planning for Climate Adaptation in Indian Cities', *Urban Climate* **10**(Part 1): 35–41.

6 Vailshery, L S, M Jaganmohan, and H Nagendra. 2013. 'Effect of Street Trees on Microclimate and Air Pollution in a Tropical City', *Urban Forestry & Urban Greening* **12**(3): 408–15.

7 Pandey, S, D A Hindoliya, and R mod. 2012. 'Artificial Neural Network for Predation of Cooling Load Reduction Using Green Roof over Building in Sustainable City', *Sustainable Cities and Society* **3**: 37–45.

8 Santamouris, M. 2015. 'Regulating the Damaged Thermostat of the Cities—Status, Impacts and Mitigation Challenges', *Energy and Buildings* **91**: 43–56.

9 Synnefa, A, M Santamouris, and K Apostolakis. 2007. 'On the Development, Optical Properties and Thermal Performance of Cool Colored Coatings for the Urban Environment', *Solar Energy* 81(4): 488–97.

10 Santamouris, M. 2013. 'Using Cool Pavements as a Mitigation Strategy to Fight Urban Heat Island—A Review of the Actual Developments', *Renewable and Sustainable Energy Reviews* 26: 224–40.

Reflective materials can be applied to the exterior surfaces of buildings (cool roofs and cool façades) or outdoor spaces (cool roads and pavements). Experimental research suggests that cool roofs can reduce the average summer indoor temperature upto 2 °C–5 °C in India.[11] While cool roofs can offer significant opportunities to save energy and cool cities in India, the lack of sufficient technical knowledge, relevant policies, and building codes with cool roof credits or requirements can create challenging conditions.

Climate-responsive building design

The integration of climate-responsive building design and adaptive design techniques in the existing buildings can reduce indoor and outdoor temperatures and significantly increase thermal comfort. Using urban greenery, artificial structures (e.g., temporary shades, sunshades, and shades using solar panels), or a combination of both on shopping streets, building entrances, and public spaces can prevent solar radiation and increase outdoor thermal comfort.

Partnerships Pave Positive Pathways

Urban heat management has been an important policy agenda for Indian policymakers, though largely as part of the central government efforts on energy efficiency and global climate change. Some local governments have developed heat action plans in partnerships with state disaster management authorities, health departments, and meteorological offices.[12] However, these plans focus on ad hoc emergency response,

neighbourhood outreach, and public awareness activities during extreme heat events and fail to address urban heat-related issues, such as energy failures, work place productivity, and economic costs. The technologies and strategies identified in this article can support governments at all levels in urban heat management. Individually, each strategy can mitigate high urban temperatures; taken together or in combination, citywide adoption can significantly reduce the UHI effect itself while providing many co-benefits.

Technologies are not simply absorbed and implemented through either a one-off policy or by one person. Relevant policies that bring together community, industry, and governments are crucial for wide-scale implementation of disruptive climate-smart technologies and their integration into mainstream urban policy. The cool roof project implemented in a low-income community in Hyderabad through collaboration between the UNSW, Administrative Staff College of India (ASCI), and DuPont Tyvek® is a great example of how partnerships can promise more liveable, sustainable, and resilient communities.

Australia and India can collaborate to build climate-smart cities through sharing best practices, ideas, and projects via knowledge exchange, strategic policy dialogues, formation of research-industry-government partnerships, and bilateral collaborations. Australia's expertise in delivering innovative urban heat management policies, projects, and programmes makes it an ideal partner for urban heat management in India. Australia's rising urban temperatures can be compared more broadly with India. Australia has some clear national and local target-oriented objectives (e.g., 20 Million Trees by 2020 programme, city tree canopy targets), strategic directives and orders (e.g., cool roof regulations and trees preservation orders), local policies and programmes (e.g., city-level urban heat policies), community engagement activities (e.g., community gardens, cool city initiatives), and sound evidence collection systems (e.g., heat mapping tools, UHI decision-support tools).

The importance of partnerships cannot be understated, as we recognize that the process of delivering 'climate-smart cities' is (a) embedded in and supported by multi-stakeholder and multi-scale governance structures; (b) processual in nature; and (c) multi-faceted, activated through combinations of hard mitigation technologies, adaptive actions, local knowledge, and grassroots innovation. □

[11] Garg, V. 2016. 'Assessment of the Impact of Cool Roofs in Rural Buildings in India', *Energy and Buildings* 114: 156–63.

[12] Jaiswal, A. 2016. *'A Tale of Three Cities: Heat Action Plans Across India* [cited January 21, 2018]; available at: https://www.nrdc.org/experts/anjali-jaiswal/tale-three-cities-heat-action-plans-across-india; last accessed on October 30, 2018.

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Performance Gap between Energy Simulation and Real-Life Building Operations

Research suggests that buildings often do not perform as well as was anticipated in the design stage. For many architects, this performance gap is indicative of a building's actual energy consumption. Similar to the principle of hidden costs, studies further show how the predicted energy consumption is significantly overshot once it is in operation. In this article, **Riddhi Chatterjee** sheds light on this pressing issue and stresses the need to constantly monitor and check a building's performance post occupancy.

Riddhi Chatterjee *has an M.Sc. in civil engineering and management from the University of Glasgow, UK. Presently, she is working as a project manager in Design2Occupancy Services LLP. Her interests lie in building energy performance and sustainability materials, and can be reached at riddhi@design2occupancy.com.*

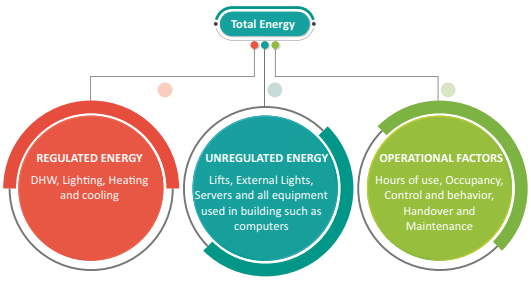
In the light of the current scenario where it is paramount to protect our environment, governments around the world are trying to achieve higher and better targets to make all buildings, both domestic and non-domestic, zero carbon by lowering the operational energy. This requirement has led to an extensive energy analysis at the design stage for all buildings to meet these energy-efficiency targets. Even in India, the green building and energy-efficient building renaissance has gained momentum and extensive research is being done in this field.

Energy modelling helps us estimate the energy requirement of buildings in the design stages and judge the greenness of the buildings. However, in all building simulations, often, the predicted energy for a new or refurbished building is unrealistically low than the actual consumption, that is, at the post-occupancy stage when the building is operating. This phenomenon termed as 'performance gap' provides us with significant evidence to suggest that buildings seldom perform as well as anticipated at the design stage. Studies also show that most energy models underestimate the actual energy by a factor of almost two to five, that is, that the actual energy can be as high as five times the predicted energy.[1]

One of the biggest contributors to the energy performance gap is the restricted scope of energy estimate that focuses largely on the 'regulated' loads. This is so named because almost all building regulations take these loads into consideration. Also, the excluded loads, referred to as the 'unregulated' loads, include loads, such as office equipment, plug loads, lifts, catering, and IT servers. Energy estimates reveal how the unregulated sources take up to 30 per cent to 50 per cent of the energy consumption in office buildings.[2]

1 Burman, E, D Mumovic, and J Kimpian. 2014. 'Towards Measurement and Verification of Energy Performance under the Framework of the European Directive for Energy Performance of Buildings'. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360544214006835; last accessed on November 28, 2018.

2 Burman, E, D Mumovic, and J Kimpian. 2014. 'Towards Measurement and Verification of Energy Performance under the Framework of the European Directive for Energy Performance of Buildings'.



» **Figure 1** Division of total energy consumption

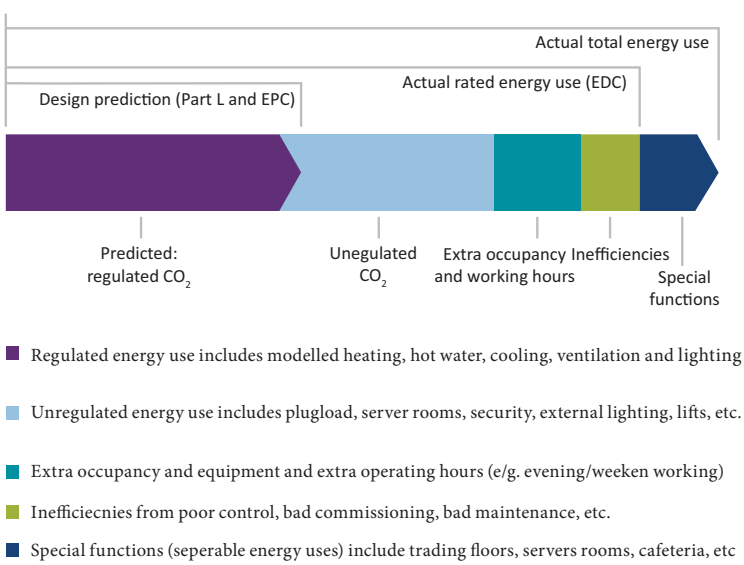
Now, the total energy consumption in any building can, therefore, be divided into three main components, namely, regulated, unregulated, and operational (see Figure 1).[3]

The very first step towards bridging this gap is, therefore, unbiased quantification and developing estimates for these unregulated loads in the regulations or to exclude such loads from the actual consumption comparison. There is a lot of focus on the performance gap at the moment and this discrepancy has become a major concern for the industry. The magnitude of the problem lies in the fact that it highlights the products that are in use that do not meet the quantified energy-saving targets. This deters the confidence of customers in energy efficiency while questioning the credibility of the building's design and engineering disciplines.[4] Moreover, the performance gap also puts developers on the back footing and questions their ability to develop buildings that are able to meet the growing needs of future requirements vis-à-vis post occupancy and climate change. It has also become very important to attempt to reduce the gap by carrying out more accurate modelling so as to produce better forecasts of energy requirements. An accurate, operational energy predicted for a building would help us to foresee the exact energy demands, and hence the ensuing carbon footprint.

3 Clark, David H. 2012. 'What Colour is Your Building? Measuring and Reducing the Energy and Carbon Footprint of Buildings. RIBA Publishing.

4 Wilde, P and R Jones. 2014. 'The Building Energy Performance Gap: Up Close and Personal'. A , conference paper.

It is a known fact that a building's performance depends on a lot of factors, including how a building is managed and operated post occupancy. Hence, apart from the absence of unregulated loads, the other practical reason for the gap is due to the mismatch between the design and a real-life situation. An incongruity such as this often arises at the inception stage and continues unresolved till the last stage of completion. Inaccurate predictions, complex building controls and systems, lack of a monitoring and feedback system post occupancy, and, most often, the improper handling of the building by the occupants are some of the recurring reasons for the gap. Achieving a low-carbon performance is an ongoing process that needs improvement. Figure 2 shows the usual gap observed in most cases.



» **Figure 2** Usual performance gap

The primary solution can be to carry out a detailed modelling to reduce the performance gap, which is essentially between performance as designed and performance as built. The other ways to bridge the gap is by putting in place a proper management, operation, and maintenance system. Feedback and learning from past mistakes can provide good results. In addition, monitoring energy consumption regularly and addressing issues related to energy and carbon performance immediately are recommended to lessen the gap. Recent technologies such as automated metre reading and monitoring and targeting can help occupants, building owners, and operators become aware of the gap and the sources of generation. This will help them understand their building operations better. Maintenance activities such as seasonal commissioning of buildings can also help effectively. A detailed post-occupancy evaluation and developing instant corrective measures by a proactive operating and maintenance team is the best possible solution that all buildings must have.

Extensive research and studies are underway to provide a holistic understanding of the gap, methods, and techniques so as to avoid them. Building designers, engineers, and operators must work in alliance to achieve better results and higher efficiency in order to build 'occupant/climate change proof' buildings and expect to move forward towards newer and more innovative business models for which clients are willing to pay the price. □

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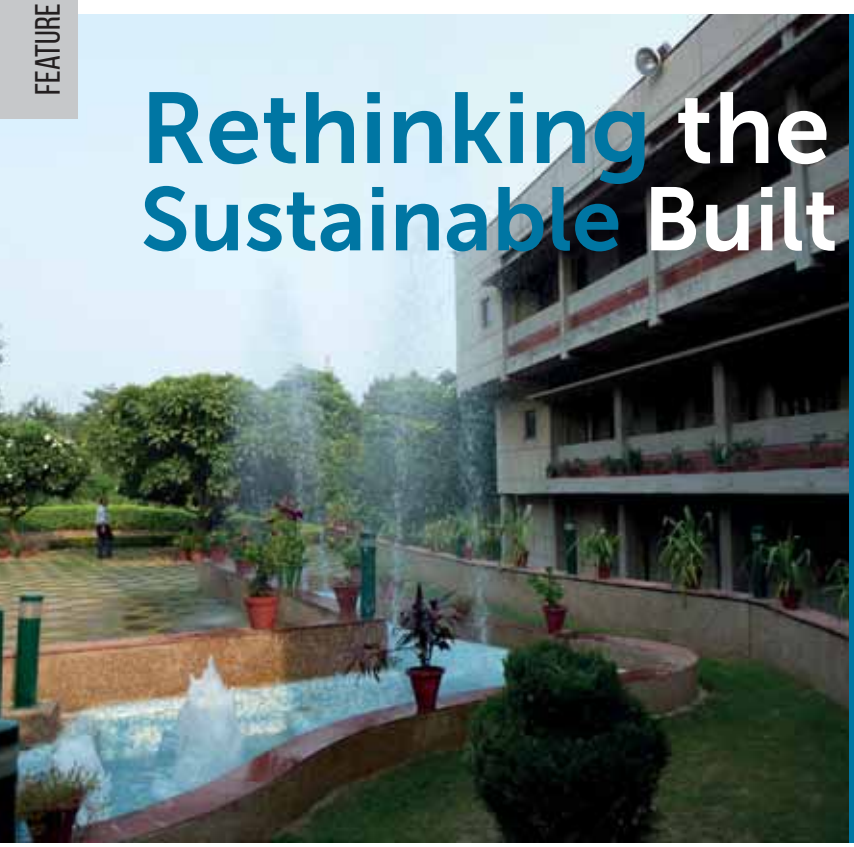


Rethinking the Future of Sustainable Built Environment

Over the last two decades, we have understood what it truly means to preserve and revitalize buildings. While in the name of progress, our urban spaces have massively grown, how much of it is truly adding value not just to the quality of life, a pressing concern nowadays, but also to the environment. In this article, Professor **(Dr) Chitrarekha Kabre** and **Ar. Parvesh Kumar** discuss the ways in which sustainable development in India can be in harmony with the natural environment.

Professor (Dr) Chitrarekha Kabre *received her PhD from the University of Queensland, Australia, and has more than 27 years of experience. In her current role as a professor of architecture at DCR University of Science and Technology, Murthal, she has successfully mainstreamed sustainable architecture in teaching and research. She is a Fulbright visiting professor, North Dakota State University, Fargo, USA, 2012, a GRIHA-certified professional, and an evaluator. She can be reached at drchitrarekhakabre.arch@dcrustm.org.*

Ar. Parvesh Kumar *has a bachelor's degree in architecture from the Government College of Architecture, Lucknow, and has six years of experience working with eminent architects. Presently, he is a final-year M.Tech student studying construction and real estate management in DCR University of Science and Technology, Murthal. He can be reached at parveshgca@gmail.com.*

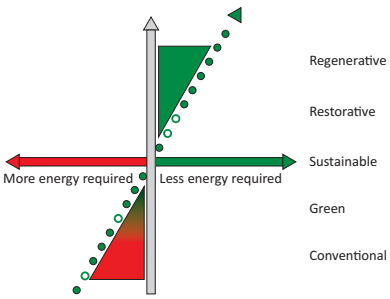
Introduction

Vasudhaiva kutumbakam
Mata bhumi hi putro aham
prthivyah[1]

Our environmental understanding, which has developed over the last few decades, makes it clear that resource depletion and environmental degradation ought to be reduced to maintain the natural life cycle processes. In this case, maintaining does not mean simply preserving, rather it means revitalizing and regenerating to have net positive environmental benefits for the living world (see Figure 1).

Green building rating systems are transforming the real estate industry by focusing on environmentally

1 The whole world is one family.... We, the humans, are the children of Mother Earth (The Atharva Veda).



» **Figure 1** Environmentally responsive trajectory

Source Reed B. 2006. 'The Trajectory of Environmental Design'.

responsible and resource-efficient buildings. However, the current trajectory of sustainability practices applied to the built environment, which aims to do 'less harm', is moving in an forced manner and is, therefore, insufficient to achieve the sustainable environment goals. Professional environmentalists and designers have scrutinized ecological configurations and drawn prescriptive lessons from such scrutiny (see Table 1).

This article argues if development can be conceived as a phenomenon integrated with nature, instead of it being detrimental to nature or the ecosystem, one can devise a viable sustainability pattern, which, in turn, can contribute in creating an inclusive society and a rich built environment in term of the use of natural resources, economic progress, and quality of life.

Sustainable Development in India

In India there is a growing awareness, particularly over the last two decades, of the importance of a sustainable built environment. This is reflected in a number of waysto ensure efficiency in resource use for large projects (i.e., more than 20,000 sq m of built up area), the Energy Conservation Building Code (ECBC) applicable to air conditioned commercial buildings with a connected load more than 100 kW, the National Building Code (2016, Chapter 11, Sustainability), and GRIHA (Green Rating for Integrated Habitat Assessment)—India's own recognized green building rating system in India's Intended Nationally Determined Contributions submitted to the UNFCC (2015) and the establishment of the Bureau of Energy Efficiency.

It is important to consider whether the existing actions, such as GRIHA, the ECBC and NBC, are sufficient to bridge the gap between India's existing built environment and the sustainable built environment that is urgently needed. Additionally, in order to meet the future requirements, a significant shift in thinking is needed; the criteria laid out in the GRIHA rating need to be sorted into short-term and long-term impact criteria, and depending on whether a given criterion helps, the idea is to keep a building green for its expected lifetime. In other words, the criteria that affect the energy and resource efficiency in buildings for a shorter duration may be listed as short-term impact criteria and, conversely, those that would continuously affect energy and resource efficiency for the building's expected longevity may be listed as long-term impact criteria.

Table 1: Concepts of sustainability as applicable to the built environment

Business as usual	**Eco-efficiency**	**Restorative**	**Cradle-to-cradle**	**Bio-inspired design**	**Ecological design**	**Reconciliatory design**	**Regenerative development**
▪ Designs primarily aim to meet minimum regulations or codes for the lowest first-cost price.[1]	Green design: ▪ One that is aware of and respects nature and the natural order of things; it is a design that minimizes the negative human impacts on the natural surroundings, materials, resources, and processes that prevail in nature.2 Sustainable design: Achieves neutral environmental impact and maximum efficiency.[3]	▪ Questions how humans can restore ecosystems through development. ▪ Acknowledges environmental damage done by human activities and seeks to redress this through further development. ▪ Is a process of humans managing and manipulating ecosystems.[4]	▪ Questions and redesigns the goals and methods of design to produce products, buildings, or systems without negative environmental or social outcomes (termed 'good' design). ▪ Restores health of water/soil/air. ▪ Eliminates waste by using 100 per cent biodegradable or 100 per cent recyclable materials. Waste then becomes a resource. This is termed as 'waste equals food'.[5]	▪ Designs that have an understanding of the relationships between biology/ ecology and humans to improve human technology (biomimicry) or to improve human psychological well-being (biophilia).[6]	▪ Designs that create processes that are compatible with nature and may be mutually beneficial for improved human and non-human health. ▪ Design strategies may be modelled on ecosystems.7	▪ Acknowledges humans as an integral part of nature and that the two operate in one system.[8]	▪ Questions how humans can participate in ecosystems through development to create optimum health. ▪ Sees humans, human developments, social structures and cultural concerns as an inherent part of ecosystems. ▪ Seeks to create or restore capacity of ecosystems and bio-geological cycles to function without human management. ▪ Understanding the diversity and uniqueness of each place (socially, culturally, and environmentally) is crucial to the design. ▪ Sees the design process as ongoing and indefinite.[9]

A Case Study

The TERI retreat campus epitomizes the nature-integrated model of sustainability and offers innumerable lessons. The campus is situated 35 km south of Delhi at Gual Pahari, Gurugram, Haryana, covering an area of 36.5 ha. When TERI bought the land, it was rocky and devoid of any vegetation. Intense plantation activities were undertaken by scientists and researchers for improving the fertility of the land, and today it is covered with lush green forests and gardens full of beautiful flowers. Amidst this greenery and beauty lies the climate-responsive retreat building intended to serve as a model of sustainable habitat based on new and clean technologies. Application of solar energy and biomass has cut down the electricity requirements of the facility by about 60 per cent. The building is daylit all year round and the earth air tunnel keeps it warm in winters and cool in summers.

» TERI retreat, Gual Pahari, Gurugram

Conclusion

The built environment is always a collage of systems. It cannot survive in isolation from the natural system. Similarly, the sustainable built environment cannot survive without achieving a state of equilibrium with the ecosystem. As we know, interacting or interdependent set of entities, real or abstract, form an integrated whole. We need a balance the level of negotiation between the ecosystem and built environment not only to attain stasis with the cycle of nature but also to restore/recover from the past adversities.

Thus a sustainability framework in synergy with nature or ecosystem is necessary not only to preserve the environment but also to revitalize and regenerate the fragile and degraded environment.

Sustainable or green building evaluation is an important tool to revitalize sustainable development in the building industry. However, we need a balanced approach. In many conditions, man-made environment is better than the natural one, however, this should mean we do not need nature anymore; instead, looking at the complexity and contradiction of the modern built environment, we need nature more than ever before. A man-made environment has a certain purpose, set of objectives; natural systems may not have apparent objectives, but nevertheless has the capacity to uphold against any adversity and recover/change/adapt/heal from the same. It is not a question of controlling a built environment against a natural environment. It is important to remember that in order for harmony to exist between the two different environments, the systems must be well integrated. □

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1 McDonough, W and M Braungart. 2002. Cradle to Cradle: Remaking the *Way We Make Things. New York: North Point Press.*

2 ASHRAE. 2006. Green Guide: The Design, Construction*, and Operation of Sustainable Buildings. Amsterdam: Butterworth-Heinemann.*

3 McDonough, W and M Braungart. 2002. Cradle to Cradle; ISO. 2008. Sustainability in Building Construction–General Principles, Standard 15392, International Organization for S*tandardization.*

4 Couchman, A. 2007. 'Environmentally Restorative Architecture: Designing Buildings for the 21st Century'. Second International Conference on Sustainability Engineering and Science. Auckland, New Zealand; Reed B. 2007. 'A Livings Systems Approach to Design'. AIA National Convention, May, Theme Keynote Address.

5 McDonough, W and M Braungart. 2002. Cra*dle to Cradle.*

6 Benyus, J. 1997. Biomimicry: Innovation Insp*ired by Nature. New York, HarperCollins.*

7 Wells, M. 1982. 'A Regeneration-Based Checklist for Design and Construction' in Gentle Architecture. McGraw-Hill; Todd, N J an*d John Todd. 1984. Bioshelters, Ocean Arks, City Farming: Ecology as the Basis of Design. San Francisco: Sierra Club Books; McDonough, W and M Braungart. 2002. Cradle to Cradle; Lyle, J T. 1994. Regenerative Design for Sustainable Development. New York: John Wiley & Sons; Van der Ryn, S and S Cowan. 1996. Ecological Design. Washington: Island Press.*

8 Reed B. 2007. 'A Livings Systems Approach to Design'.

9 Cole, R J and S Charest and S Schroeder. 2006. 'Beyond Green: Drawing on Nature' (for the Royal Architectural Institute of Canada's 'Beyond Green: Adaptive, Restorative and Regenerative Design' course – SDCB 305). The University of British Columbia; Reed B. 2007. 'A Livings Systems Approach to Design'.

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Asahi India Glass Ltd.
Global Business Park, Tower – B,
8th Floor, Mehrauli – Gurgaon Road
Gurgaon – 122 002, Haryana,
Tel: (0124) 4062212-19
www.aisglass.com

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